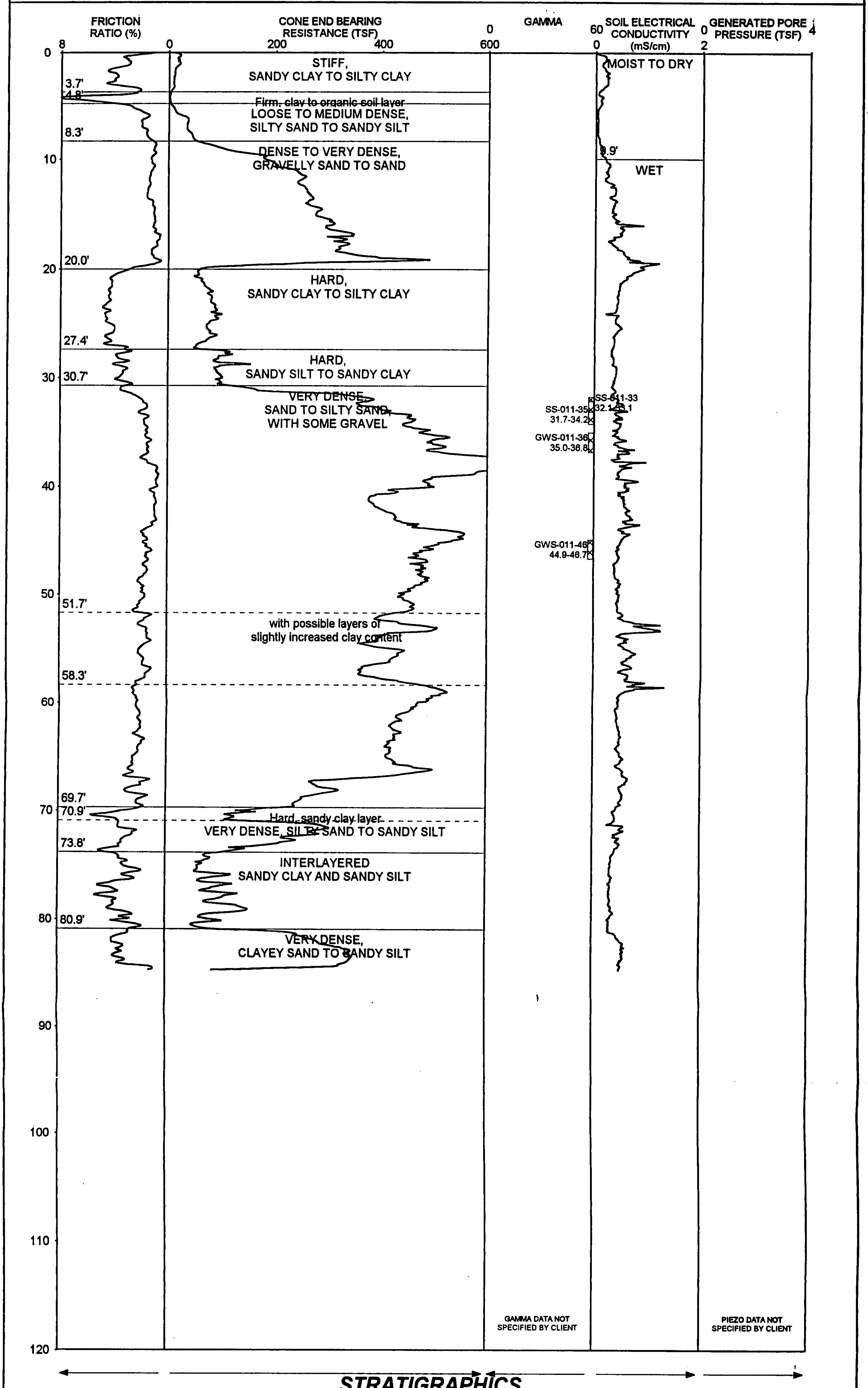
BORING LOG

Project Name: AlliedSignal -- South Bend	Project Number: 09822-00	Boring Id.: 01CPT011
Location: AlliedSignal Industrial Complex		Page 3 of 3
Date(s): 02/10/97 - 02/11/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 713.70'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 85.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
						650
65						
						645
70				sandy clay lense 1-foot-thick		
				SILTY SAND/SANDY SILT - very dense		
						640
75				INTERLAYERED SANDY CLAY AND SANDY SILT		
						635
80						
				CLAYEY SAND/SANDY SILT - very dense		
						630
85						
				END OF BORING AT 85 FEET		
						625

INTERPRETED CPT-EC LOG



PROJECT NAME: Allied Signal, South Bend, In
PROJECT NUMBER: 97-120-010

DATE: 2-10-1997
SOUNDING NUMBER: CP-011

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT012
Location: AlliedSignal Industrial Complex		Page 1 of 4
Date(s): 02/11/97 - 02/12/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 712.80'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 100.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				CLAYEY SILT/SILTY CLAY - stiff		
						710
5				silty sand layers		
				GRAVELLY SAND/SAND - dense to very dense		
						705
10						
				wet at 10.7 feet		
						700
15						
						695
20	01CPW01222					
						690
25				SANDY GRAVEL/GRAVELLY SAND - dense		
						685
	01CPW01230					

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT012
Location: AlliedSignal Industrial Complex		Page 2 of 4
Date(s): 02/11/97 - 02/12/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 712.80'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 100.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
						680
35				SAND/SILTY SAND - dense		
	01CPW01240					675
40						
						670
				elevated electrical conductivity 43.8'to 54.5'		
45						
	01CPW01250					665
50						
				CLAYEY SILT/SILTY CLAY - with sand layers		
						660
55						
						655

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT012
Location: AlliedSignal Industrial Complex		Page 3 of 4
Date(s): 02/11/97 - 02/12/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 712.80'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 100.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

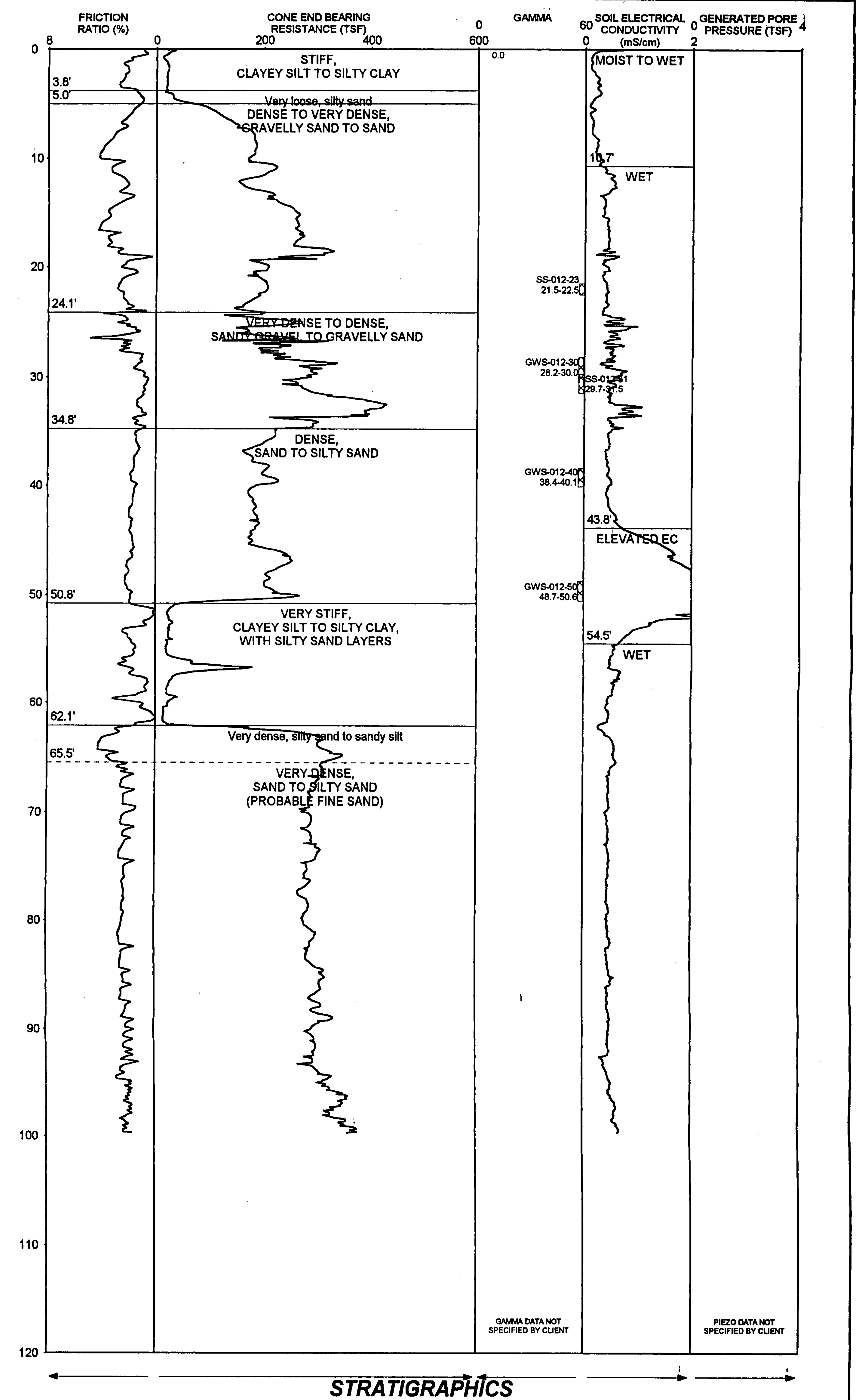
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				SILTY SAND/SANDY SILT - very dense		
						650
65				SAND - with silt, very dense		
						645
70						
						640
75						
						635
80						
						630
85						
						625

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT012
Location: AlliedSignal Industrial Complex		Page 4 of 4
Date(s): 02/11/97 - 02/12/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 712.80'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 100.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
						620
95						
						615
100				END OF BORING AT 100 FEET		
						610
105						
						605
110						
						600
115						
						595

INTERPRETED CPT-EC LOG



PROJECT NAME: Allied Signal, South Bend, In
PROJECT NUMBER: 97-120-010

DATE: 2-11-1997
SOUNDING NUMBER: CP-012A

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT013
Location: AlliedSignal Industrial Complex		Page 1 of 3
Date(s): 02/13/97 - 02/13/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 713.50'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 84.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				SANDY SILT/CLAYEY SILT - stiff		
						710
5				SAND/SILTY SAND - medium dense to dense		
						705
10						
						700
15						
						695
20	01CPW01322			SANDY GRAVEL/GRAVELLY SAND - very dense		
						690
25				GRAVELLY SAND/SILTY SAND - dense to very dense		
						685
	01CPW01331					

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT013
Location: AlliedSignal Industrial Complex		Page 2 of 3
Date(s): 02/13/97 - 02/13/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 713.50'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 84.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

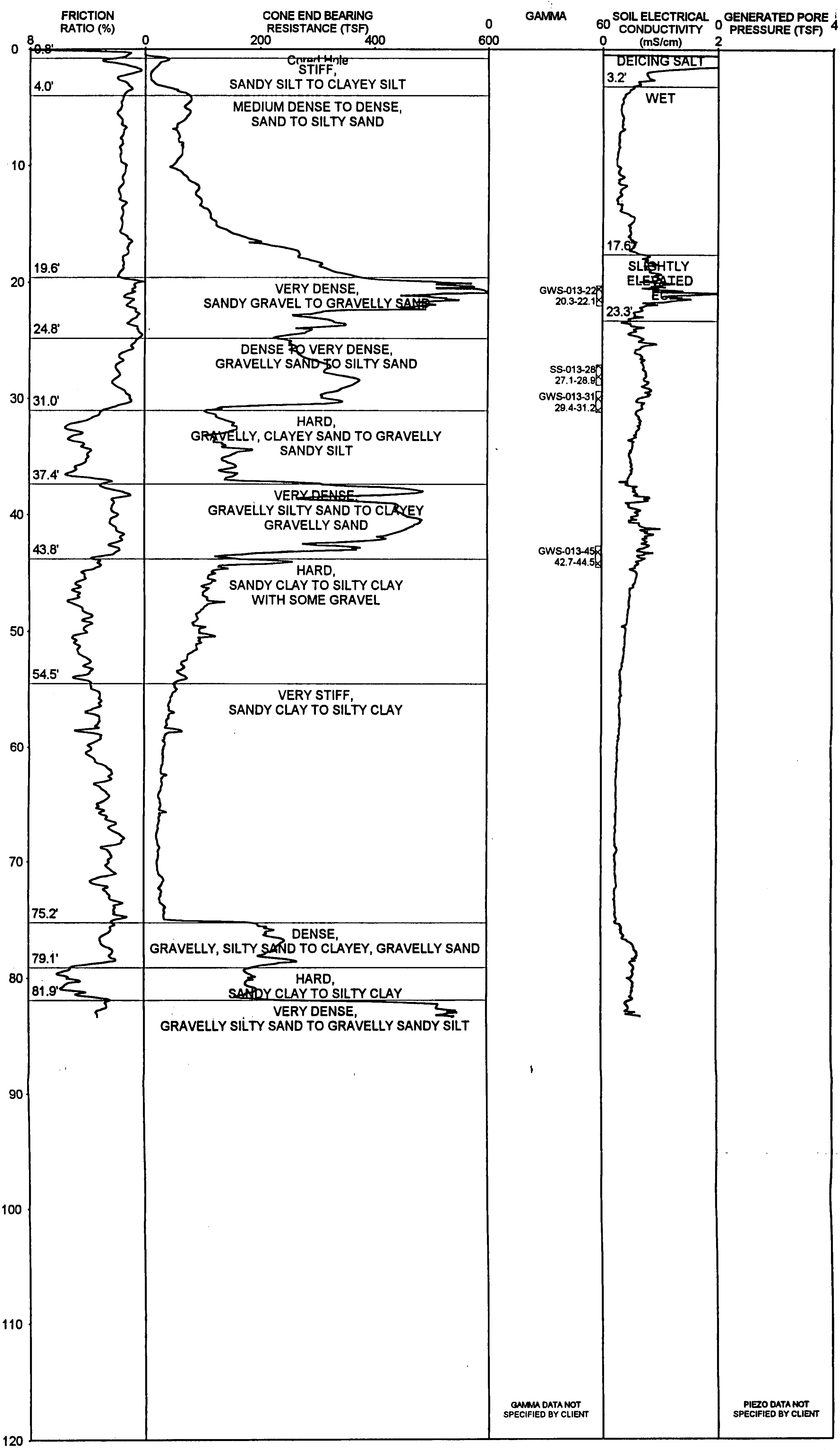
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				GRAVELLY CLAYEY SAND/GRAVELLY SANDY SILT - hard		
						680
35						
				GRAVELLY SILTY SAND/CLAYEY GRAVELLY SAND - very dense		675
40						
	01CPW01345			SANDY CLAY/SILTY CLAY - some gravel, hard		670
45						
						665
50						
						660
55				decreasing gravel content		
						655

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT013
Location: AlliedSignal Industrial Complex		Page 3 of 3
Date(s): 02/13/97 - 02/13/97		Datum: Mean Sea Level
Remarks: Borehole Grouted to Groundsurface.	Elevation: 713.50'	Logged By: J. Panco
	Contractor: Stratigraphics	Total Depth: 84.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
						650
65						
						645
70						
						640
75						
				GRAVELLY SILTY SAND/CLAYEY GRAVELLY SAND - dense		
						635
80				SANDY CLAY/SILTY CLAY - hard		
				GRAVELLY SILTY SAND/GRAVELLY SANDY SILT - very dense		
						630
85				END OF BORING AT 84 FEET		
						625

INTERPRETED CPT-EC LOG



PROJECT NAME: Allied Signal, South Bend, In
PROJECT NUMBER: 97-120-010

DATE: 2-13-1997
SOUNDING NUMBER: CP-013A

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT014
Location: AlliedSignal Industrial Complex		Page 1 of 4
Date(s): 07/21/97 - 07/21/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 92.40'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				SAND/SANDY SILT - medium dense to dense		
						715
5						
						710
10						
				SANDY GRAVEL/GRAVELLY SILTY SAND - very dense		
						705
15	01CPW01417			wet at 16.3 feet		
						700
20						
	01CPW01425					
						695
25						
				SAND/SILTY SAND - medium dense		
						690

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT014
Location: AlliedSignal Industrial Complex		Page 2 of 4
Date(s): 07/21/97 - 07/21/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 92.40'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
	01CPW01435					685
35						
40						680
	01CPW01445					675
45						
				SAND/SILTY SAND - with some gravel, dense		
50						670
	01CPW01455			gravelly seam at 52.2 feet		665
55						
				fine sand seam at 59 and 60 feet		660

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT014
Location: AlliedSignal Industrial Complex		Page 3 of 4
Date(s): 07/21/97 - 07/21/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 92.40'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

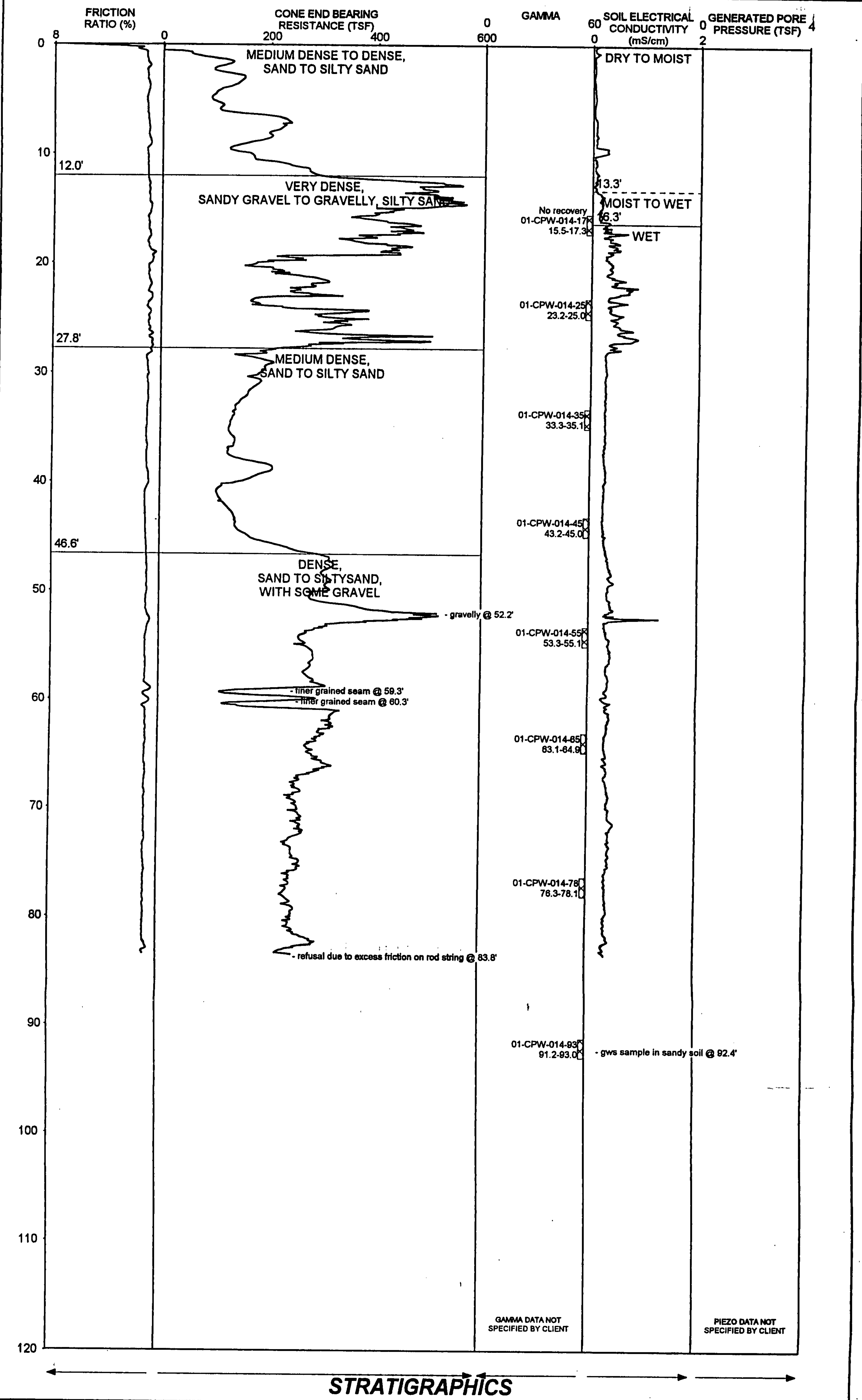
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
	01CPW01465					
						655
65						
						650
70						
						645
75						
	01CPW01478					
						640
80						
						635
85						
						630

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT014
Location: AlliedSignal Industrial Complex		Page 4 of 4
Date(s): 07/21/97 - 07/21/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 92.40'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
	01CPW01493			END OF BORING AT 92.4 FEET		
						625
95						
						620
100						
						615
105						
						610
110						
						605
115						
						600

INTERPRETED CPT-EC LOG



PROJECT NAME: Allied Signal, South Bend, In
PROJECT NUMBER: '97-120-160

DATE: 7-21-1997
SOUNDING NUMBER: 01-CPT-014

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT015
Location: AlliedSignal Industrial Complex		Page 1 of 4
Date(s): 07/22/97 - 07/22/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.50'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 98.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	Pi Meter	Material Description	Graphic Log	Elevation (ft)
				SAND/SILTY SAND - medium dense		
5						715
				change to dense		
10						710
				SANDY GRAVEL/GRAVELLY SAND - very dense		
15						705
20						700
				wet at 21.1 feet		
25						695
						690

BORING LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Boring Id.: 01CPT015
Location: AlliedSignal Industrial Complex		Page 2 of 4
Date(s): 07/22/97 – 07/22/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.50'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 98.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				SAND/SILTY SAND – medium dense to dense		
35						685
40				gravelly seam		680
45						675
50						670
				GRAVELLY SAND/SAND – dense to very dense		
55						665
				gravelly seam at 52.2 feet		660

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT015
Location: AlliedSignal Industrial Complex		Page 3 of 4
Date(s): 07/22/97 - 07/22/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.50'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 98.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

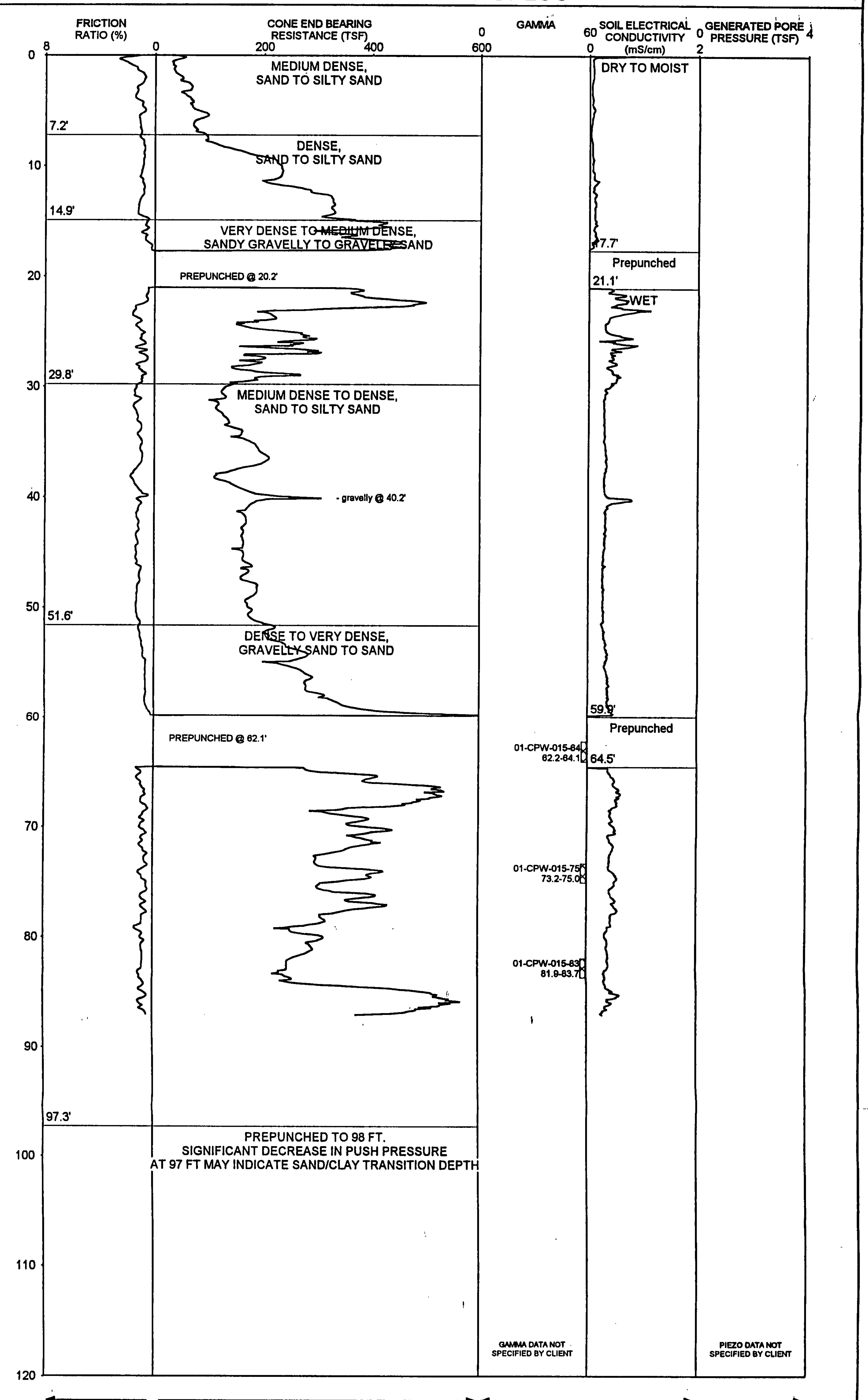
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
	01CPW01564					
65						655
70						650
	01CPW01575					
75						645
80						640
	01CPW01583					
85						635
						630

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT015
Location: AlliedSignal Industrial Complex		Page 4 of 4
Date(s): 07/22/97 - 07/22/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 719.50'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 98.00'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
95						625
				CLAY TRANSITION		
				END OF BORING AT 98 FEET		
100						620
105						615
110						610
115						605
						600

INTERPRETED CPT-EC LOG



PROJECT NAME: Allied Signal, South Bend, In
PROJECT NUMBER: 97-120-160

DATE: 7-22-1997
SOUNDING NUMBER: 01-CPT-015

BORING LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Boring Id.: 01CPT016
Location: AlliedSignal Industrial Complex		Page 1 of 3
Date(s): 07/24/97 – 07/24/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 713.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 62.90'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				SILTY SAND/SANDY SILT – with clay seams, medium dense to loose		
						710
5						
				SAND/SILTY SAND – dense to very dense		
						705
10						
						700
				wet at 13 feet		
15	01CPS01617					
				SANDY GRAVEL/GRAVELLY SAND – dense		695
20						
				1 foot silt layer at 21 feet		
						690
25				SAND/SILTY SAND – dense		
						685
	01CPW01631			SANDY GRAVEL/GRAVELLY SAND – dense to very dense		

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT016
Location: AlliedSignal Industrial Complex		
Date(s): 07/24/97 - 07/24/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 713.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 62.90'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

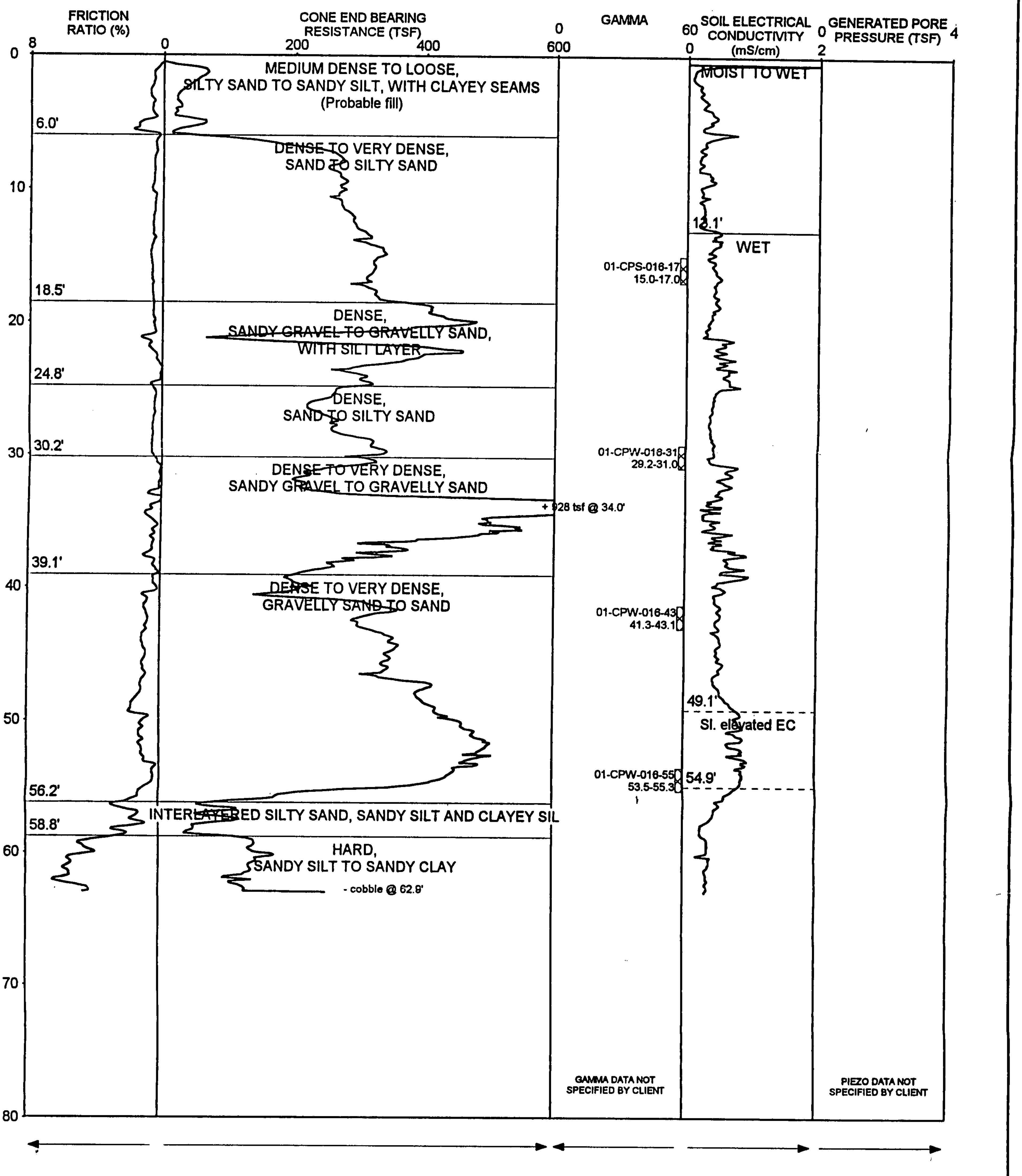
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
						680
35						
						675
40				GRAVELLY SAND/SAND - dense to very dense		
	01CPW01643					
						670
45						
						665
50						
						660
	01CPW01655					
55						
				INTERLAYERED SILTY SAND/CLAYEY, SANDY SILT		
						655
				SANDY SILT/SANDY CLAY		

BORING LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Boring Id.: 01CPT016
Location: AlliedSignal Industrial Complex		Page 3 of 3
Date(s): 07/24/97 - 07/24/97		Datum: Mean Sea Level
Remarks: Borehole Backfilled with Bentonite	Elevation: 713.00'	Logged By: P. Kaczor
	Contractor: Stratigraphics	Total Depth: 62.90'
	Drilling Method: CPT	
	Borehole Dia.: 2.00in	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Elevation (ft)
				END OF BORING AT 63 FEET		650
65						
						645
70						
						640
75						
						635
80						
						630
85						
						625

INTERPRETED CPT-EC LOG



STRATIGRAPHICS

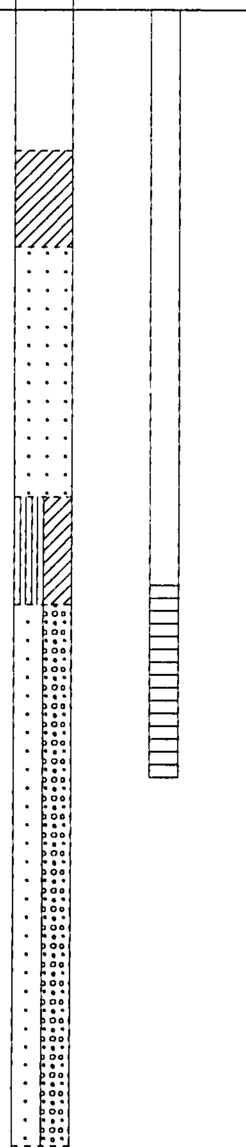
PROJECT NAME: Allied Signal, South Bend, IN
PROJECT NUMBER: 97-120-160

DATE: 7-24-1997
SOUNDING NUMBER: 01-CP-0016

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: 01CPT017
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	Page 1 of 3
Date(s): 07/25/97 - 07/25/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 1.25in fm: 0.0' to: 15.00'	Measuring Point: 718.00'	Completed Depth: 20.00'
	Elevation: 718.10'	Total Depth: 65.00'
Screens: type: Slotted size: 0.010in dia: 1.25in fm: 15.00' to: 20.00'	Contractor: Stratigraphics	
	Drilling Method: CPT	Borehole Dia.: 2.00in
Annular Fill: type: fm: to: / type: fm: to: / type: fm: to: / type: fm: to:	Remarks: Piezometer Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Elevation (ft)
				SAND/SILTY SAND - medium dense to loose	
					715
5				SILTY CLAY/CLAY - with sand seams, stiff	
				GRAVELLY SAND/SAND - dense	
					710
10					
				wet at 10.9 feet	
				INTERLAYERED SILTY CLAY AND SILTY SAND	
					705
15	01CPW01720				
				SANDY GRAVEL/GRAVELLY SAND - medium dense to dense, ec indicates potential product just below clay	
					700
20					
					695
25					
					690
				SAND/SILTY SAND - medium dense to dense	

Graphic Log / Well Construction



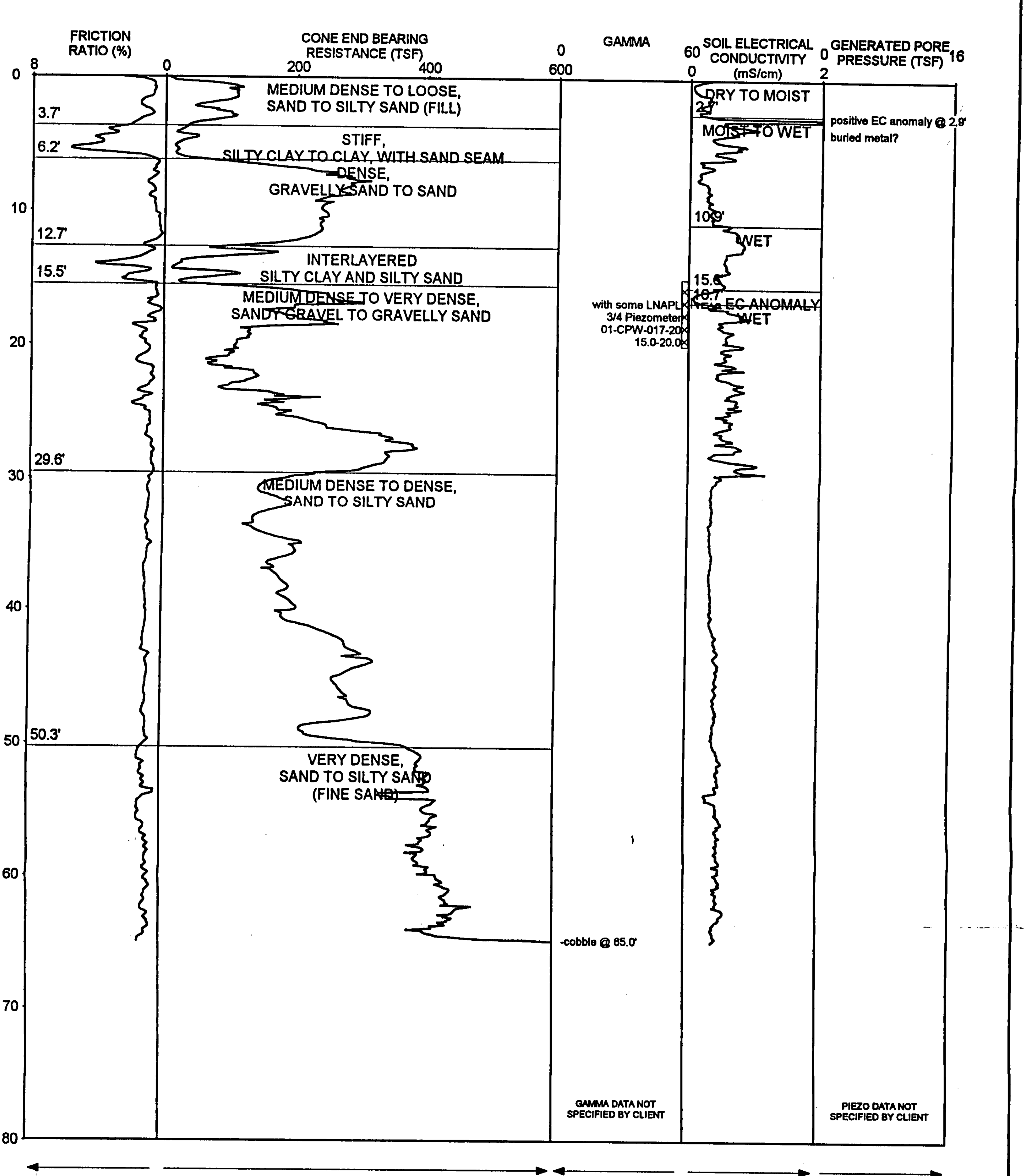
Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: 01CPT017
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	Page 2 of 3
Date(s): 07/25/97 - 07/25/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 1.25in fm: 0.0' to: 15.00'	Measuring Point: 718.00'	Completed Depth: 20.00'
	Elevation: 718.10'	Total Depth: 65.00'
Screens: type: Slotted size: 0.010india: 1.25in fm: 15.00' to: 20.00'	Contractor: Stratigraphics	
	Drilling Method: CPT	Borehole Dia.: 2.00in
Annular Fill: type: fm: to: type: fm: to: type: fm: to: type: fm: to:	Remarks: Piezometer Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
							685
35							
							680
40							
							675
45							
							670
50							
				SAND/SILTY SAND - fine, very dense			
							665
55							
							660

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: 01CPT017
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	Page 3 of 3
Date(s): 07/25/97 - 07/25/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 1.25in fm: 0.0' to: 15.00'	Measuring Point: 718.00'	Completed Depth: 20.00'
	Elevation: 718.10'	Total Depth: 65.00'
Screens: type: Slotted size: 0.010in dia: 1.25in fm: 15.00' to: 20.00'	Contractor: Stratigraphics	
	Drilling Method: CPT	Borehole Dia.: 2.00in
Annular Fill: type: fm: to: type: fm: to: type: fm: to: type: fm: to:	Remarks: Piezometer installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
							655
65				END OF BORING AT 65 FEET			
							650
70							
							645
75							
							640
80							
							635
85							
							630

INTERPRETED CPT-EC LOG



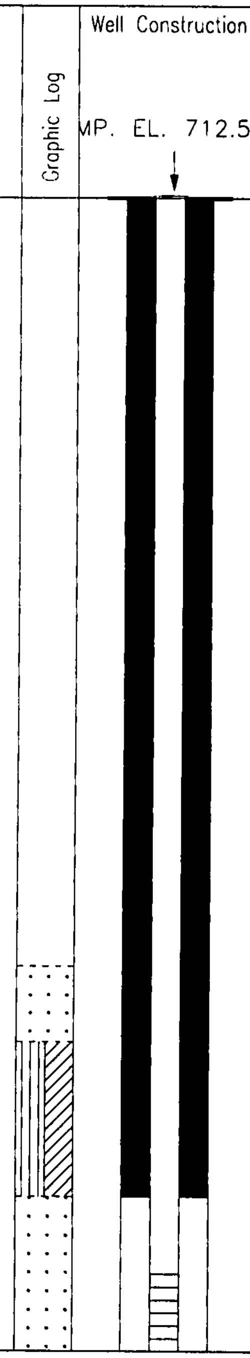
STRATIGRAPHICS

PROJECT NAME: Allied Signal, South Bend, IN
PROJECT NUMBER: 97-120-160

DATE: 7-25-1997
SOUNDING NUMBER: 01-CP-017

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Well Id: EW-1
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	Page 1 of 3
Date(s): 04/14/97 – 04/18/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 28.00'	Measuring Point: 712.58'	Completed Depth: 60.00'
	Elevation: 713.00'	Total Depth: 66.50'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 28.00' to: 58.00'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.25in
Annular Fill: type: Fill fm: 0.00' to: 5.00'; type: Bentonite Grout fm: 5.00' to: 26.00'; type: Sand Filter fm: 26.00' to: 66.50'; type: fm: to:	Remarks: Recovery Well Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction (MP. EL. 712.58)	Elevation (ft)
0				SAND – poorly graded, very fine-fine grained, light brown, (7.5YR6/3), SP			
5							710
10							705
15							700
20	(20–22')	6 10 13 14	31 ppm	SAND – trace silt and gravel, moderately graded, fine-coarse grained, brown, (7.5YR5/2), SW			695
				SILT – little sand and fine gravel, non plastic, medium dense, graysih brown, (7.5YR5/1), ML			690
25	(27–29')	8 8 10 14		SAND – moderately graded, fine-coarse grained, brown, (7.5YR5/3), SW			685



Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-1
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	
Date(s): 04/14/97 - 04/18/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 28.00'	Measuring Point: 712.58' Elevation: 713.00'	Completed Depth: 60.00' Total Depth: 66.50'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 28.00' to: 58.00'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.25in
Annular Fill: type: Fill fm: 0.00' to: 5.00' type: Bentonite Grout fm: 5.00' to: 26.00' type: Sand Filter fm: 26.00' to: 66.50' type: fm: to:	Remarks: Recovery Well Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
							680
35							
							67
40							
							670
45	(45-47')	3 20 34 40	4 ppm	SAND - poorly graded, very fine-medium grained, saturated, light brown, (7.5YR6/3), SP			
							665
50							
							660
55	(55-57')	5 10 22 23	4 ppm				
							655

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-1
Location: AlliedSignal Industrial Complex	Logged By: P. Kaczor	Page 3 of 3
Date(s): 04/14/97 - 04/18/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 28.00'	Measuring Point: 712.58'	Completed Depth: 60.00'
	Elevation: 713.00'	Total Depth: 66.50'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 28.00' to: 58.00'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.25in
Annular Fill: type: Fill fm: 0.00' to: 5.00'; type: Bentonite Grout fm: 5.00' to: 26.00'; type: Sand Filter fm: 26.00' to: 66.50'; type: fm: to:	Remarks: Recovery Well Installed at this Location	

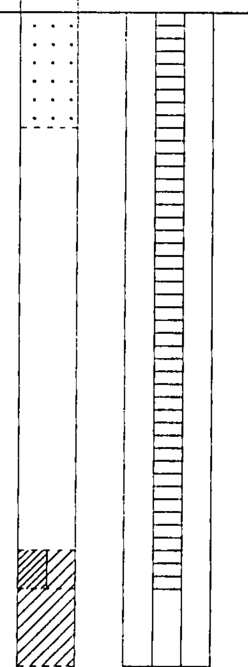
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
				SILT - little fine sand, slightly plastic, loose, moist, brown, ML			
							650
65	(64.5-66.5')	3 6 7 10	3 ppm				
				END OF BORING AT 66.5 FEET			645
70							
							640
75							
							635
80							
							630
85							
							625

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-2
Location: AlliedSignal Industrial Complex	Logged By: S. Murray	Page 1 of 2
Date(s): 06/09/97 - 06/10/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 25.00'	Measuring Point: 711.86'	Completed Depth: 47.00'
	Elevation: 712.30'	Total Depth: 47.00'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 25.00' to: 45.00'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.00in
Annular Fill: type: Fill fm: 1.00' to: 5.00' type: Bentonite Grout fm: 5.00' to: 20.00' type: Bentonite fm: 20.00' to: 22.00' type: Sand Filter fm: 22.00' to: 47.00'	Remarks: Extraction Well Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
				TOPSOIL		MP. EL. 711.86	
				SAND - fine-medium grained, poorly graded, loose, dry, light brown, SP			710
5							
							705
10							
							700
	(13-15')	8 12 15 15		wet at 13.2 feet			
15				SAND - very fine -fine grained, medium dense, wet, SP			
							695
	(18-20')	8 10 10 15		GRAVELLY SAND - very fine-coarse grained, medium dense, wet, SW			
20							
							690
25							
							685

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-2
Location: AlliedSignal Industrial Complex	Logged By: S. Murray	Page 2 of 2
Date(s): 06/09/97 - 06/10/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 25.00'	Measuring Point: 711.86'	Completed Depth: 47.00'
	Elevation: 712.30'	Total Depth: 47.00'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 25.00' to: 45.00'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.00in
Annular Fill: type: Fill fm: 1.00' to: 5.00' type: Bentonite Grout fm: 5.00' to: 20.00' type: Bentonite fm: 20.00' to: 22.00' type: Sand Filter fm: 22.00' to: 47.00'	Remarks: Extraction Well Installed at this Location	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
							680
	(33-35')	8 10 20 25		SAND - trace silt, fine grained, poorly graded, wet, light brown, SP			
35							
							675
40							
							670
	(43-45')	8 10 8 8					
45	(45-47')	10 12 12 12		SANDY CLAY - some silt, slightly plastic, moist, gray, SC-CL			
				SILTY CLAY - slightly plastic, stiff, moist, CL			
				END OF BORING AT 47 FEET			665
50							
							660
55							
							655



Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-3
Location: AlliedSignal Industrial Complex	Logged By: S. Murray	Page 1 of 2
Date(s): 06/11/97 - 06/12/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 25.00'	Measuring Point: 712.88' Elevation: 713.30'	Completed Depth: 31.00' Total Depth: 34.00'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 25.00' to: 29.00'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.00in
Annular Fill: type: Fill fm: 0.00' to: 5.00' type: Bentonite Grout fm: 5.00' to: 21.00' type: Bentonite fm: 21.00' to: 23.00' type: Sand Filter fm: 23.00' to: 31.00'	Remarks: Extraction Well Installed at this Location.	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Elevation (ft)
				CONCRETE	
				SAND - trace gravel, fine-medium grained, poorly graded, moist, SP	710
5					
					705
10					
	(13-15')	3 3 3 5		SAND - fine-medium grained, poorly graded, loose, wet, SP	700
15					
	(18-20')	3 5 5 5		SAND - some gravely and cobbles, fine-coarse grained, well graded, medium dense, wet, SW	695
20					
	(23-25')	7 10 10 12			690
25	(25-27')	7 10 12 20		GRAVELLY SILT - some sand, dense, wet, gray, ML	
				SAND - some silt, trace fine gravel, fine-medium grained, poorly graded, wet, SP	
	(28-30')	7 20 20 7			685

Graphic Log / Well Construction

MP. EL. 712.88

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: EW-3
Location: AlliedSignal Industrial Complex	Logged By: S. Murray	Page 2 of 2
Date(s): 06/11/97 - 06/12/97	Datum: Mean Sea Level	Static Water Level:
Riser: type: Carb Steel dia: 6.00in fm: 0.0' to: 25.00'	Measuring Point: 712.88'	Completed Depth: 31.00'
	Elevation: 713.30'	Total Depth: 34.00'
Screens: type: Wire-wrap size: 0.020in dia: 6.00in fm: 25.00' to: 29.00'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 16.00in
Annular Fill: type: Fill fm: 0.00' to: 5.00'; type: Bentonite Grout fm: 5.00' to: 21.00'; type: Bentonite fm: 21.00' to: 23.00'; type: Sand Filter fm: 23.00' to: 31.00'	Remarks: Extraction Well Installed at this Location.	

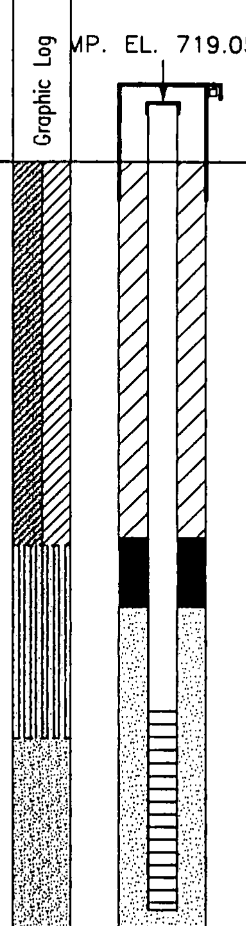
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
	(30-32')	6 10 10 19		6" silt seam			
	(32-34')	8 12 12 18					
				CLAY - trace sand, hard, dry			680
35							
				END OF BORING AT 34 FEET			
							675
40							
							670
45							
							665
50							
							660
55							
							655

BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Well Id: MW-1
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/12/96 – 12/12/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: –1.5' to: 14.30'	Measuring Point: 719.05'	Completed Depth: 19.50'
	Elevation: 717.00'	Total Depth: 20.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 14.30' to: 19.30'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.00' to: 9.80' type: Bentonite fm: 9.80' to: 11.60' type: Sand Filter fm: 11.60' to: 20.00' type: fm: to:	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description
0			0 ppm	SANDY SILTY CLAY – trace coal, very fine grained, slighty plastic, dry, reddish brown (2.5YR5/3), SC-CL
5			0 ppm	moist
10			0 ppm	SILTY SAND – trace silty clay, fine grained, moist, loose, black and reddish brown (2.5YR5/3), SM
15			0 ppm	SAND – some silt, fine grained, moist to wet at 15.7', light brown (7.5YR6/4), SP coarse gravel seam at 16-17 feet
20			0 ppm	END OF BORING AT 20 FEET
25				

Graphic Log / Well Construction

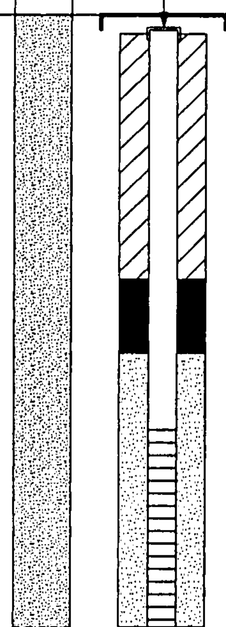


Elevation (ft): 715, 710, 705, 700, 695, 690

BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Well Id: MW-2
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/12/96 – 12/12/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 10.60in fm: 0.4' to: 10.80'	Measuring Point: 713.93' Elevation: 714.00'	Completed Depth: 16.00' Total Depth: 16.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 10.80' to: 15.80'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.50' to: 6.90' type: Bentonite fm: 6.90' to: 8.80' type: Sand Filter fm: 8.80' to: 16.00' type: fm: to:	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
				SAND – trace fine gravel, fine-medium grained, poorly graded, moist, loose, light brown (7.5YR6/4), SP		MP. EL. 713.93	
							710
5			0 ppm				
							705
10			0 ppm				
				SAND – some silt, fine grained, poorly graded, wet at 12.5 feet, gray (7.5YR5/1), SP trace gravel			
							700
15			0 ppm				
				END OF BORING AT 16 FEET			
							695
20							
							690
25							
							685



BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Well Id: MW-3
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/12/96 – 12/12/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.3' to: 12.90'	Measuring Point: 713.10'	Completed Depth: 18.10'
	Elevation: 713.50'	Total Depth: 20.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 12.90' to: 17.90'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in

Annular Fill:

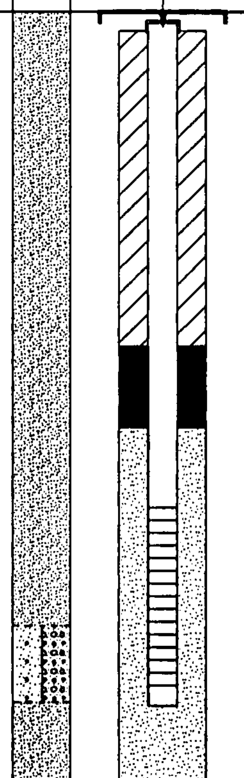
type	fm	to
Grout	0.50'	8.70'
Bentonite	8.70'	10.80'
Sand Filter	10.80'	20.00'

Remarks:

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description
0–3	01ST00304			SAND – some fine gravel, medium grained, damp, medium dense, brown (7.5YR4/3), SP
5			0 ppm	
10			0 ppm	SAND – fine grained, poorly graded, moist, loose, light brown (7.5YR6/3), SP
15			1.7 ppm	trace silty clay
16				GRAVELLY SAND – fine–coarse grained, well graded, wet, gray (7.5YR5/1), SW
20			4.7 ppm	SAND – fine grained, poorly graded, wet, dense, light brown (7.5YR6/3), SP
				END OF BORING AT 20 FEET

Graphic Log / Well Construction

MP. EL. 713.10



Elevation (ft): 710, 705, 700, 695, 690, 685

BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: MW-4
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/11/96 - 12/11/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.6' to: 15.30'	Measuring Point: 712.66'	Completed Depth: 20.50'
	Elevation: 713.00'	Total Depth: 21.50'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 15.30' to: 20.30'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in

Annular Fill:

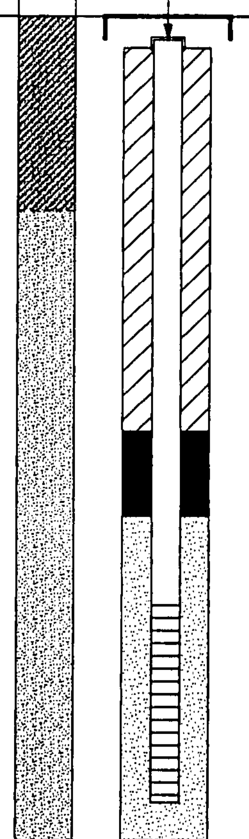
type	fm	to
Grout	0.80'	10.80'
Bentonite	10.80'	13.00'
Sand Filter	13.00'	21.50'

Remarks:

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description
0–5				CLAYEY SAND - fine grained, poorly graded, loose, moist, brown-black (7.5YR4/4), SC
5			0.6 ppm	
10	01ST00412		3.5 ppm	
11				SAND - fine grained, poorly graded, loose, moist, dark brown (7.5YR3/3), SP
15			4.2 ppm	
21.5				END OF BORING AT 21.5 FEET

Graphic Log | Well Construction | Elevation (ft)

MP. EL. 712.66



Elevation (ft): 710, 705, 700, 695, 690, 685

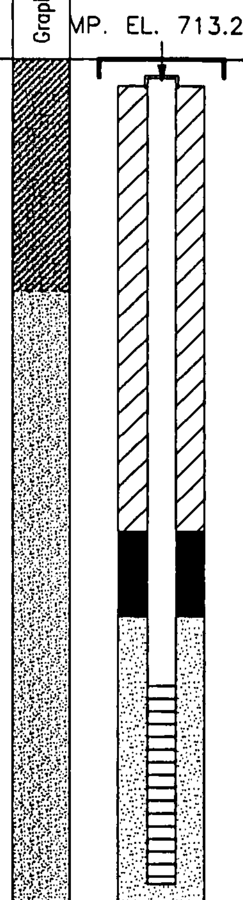
Depth (ft): 5, 10, 15, 20, 25

BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal – South Bend	Project Number: 09822-00	Well Id: MW-5
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/11/96 – 12/11/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.5' to: 16.30'	Measuring Point: 713.21' Elevation: 713.77'	Completed Depth: 21.50' Total Depth: 22.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 16.30' to: 21.30'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.70' to: 12.30' type: Bentonite fm: 12.30' to: 14.50' type: Sand Filter fm: 14.50' to: 22.00' type: fm: to:	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Elevation (ft)
				SANDY CLAY – trace gravel, slightly plastic, very fine grained sand, loose, moist, dark brown-black	710
5	01ST00508		1.4 ppm	SAND – trace clay, fine-medium grained, loose, moist, light brown (7.5YR6/2), SP	705
10			1.2 ppm		700
15			2.4 ppm		695
20				END OF BORING AT 22 FEET	690
25					685

Graphic Log / Well Construction

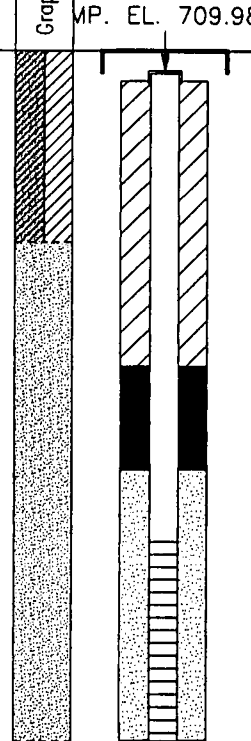


BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: MW-6
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/10/96 - 12/10/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.6' to: 12.80'	Measuring Point: 709.98'	Completed Depth: 18.00'
	Elevation: 710.50'	Total Depth: 18.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 12.80' to: 17.80'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.80' to: 8.20'; type: Bentonite fm: 8.20' to: 10.90'; type: Sand Filter fm: 10.90' to: 18.00'; type: fm: to:	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Elevation (ft)
			97.5 ppm	SANDY SILTY CLAY - trace gravel, slightly palstic, loose, moist, black and brown (7.5YR4/4), SC-CL	710
5			203 ppm	SAND - trace clay, fine grained, poorly graded, loose, moist-wet, light brown trace black (7.5YR6/4), SP	705
10			1703 ppm		700
15			783 ppm		695
			2500 ppm	very fine grained	
20				END OF BORING AT 18 FEET	690
25					685

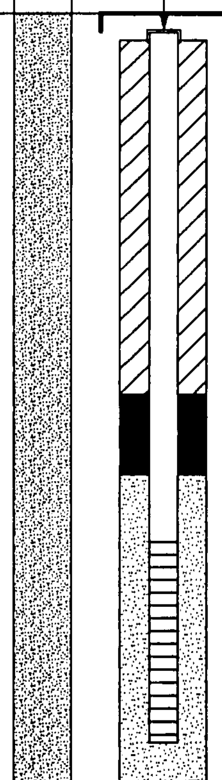
Graphic Log / Well Construction



BORING AND WELL INSTALLATION LOG

Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: MW-7
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/10/96 - 12/10/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.5' to: 13.80'	Measuring Point: 712.59' Elevation: 713.00'	Completed Depth: 19.00' Total Depth: 20.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 13.80' to: 18.80'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.70' to: 9.90' type: Bentonite fm: 9.90' to: 12.00' type: Sand Filter fm: 12.00' to: 20.00' type: fm: to:	Remarks:	

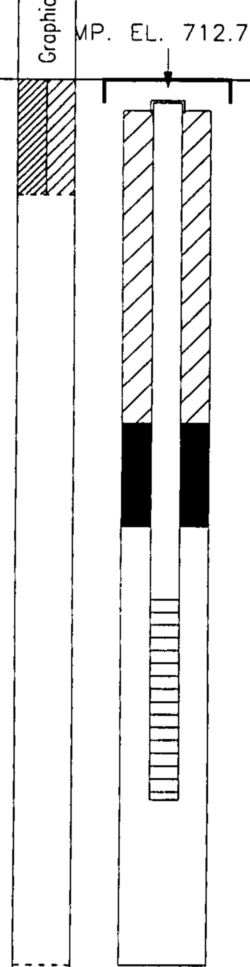
Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Graphic Log	Well Construction	Elevation (ft)
				SAND - fine grained, poorly graded, loose, moist, light brown (7.5YR6/4), SP		MP. EL. 712.59	
							710
5			3.7 ppm				
							705
10			0 ppm				
							700
				trace gravel			
15			0 ppm				
							695
20				END OF BORING 20 FEET			
							690
25							
							685



Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: MW-8
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/09/96 - 12/09/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.6' to: 13.50'	Measuring Point: 712.79'	Completed Depth: 18.70'
	Elevation: 713.00'	Total Depth: 23.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 13.50' to: 18.50'	Contractor: AEC	
	Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.80' to: 8.90' type: Bentonite fm: 8.90' to: 11.60' type: Sand Filter fm: 11.60' to: 23.00' type: fm: to:	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description	Elevation (ft)
				SANDY CLAY - slightly plastic, loose, very dry, dark brown (7.5YR3/3), SC	710
5			3 ppm	SAND - very fine-fine grained, loose, dry, light brown (7.5YR6/3), SP	
				oil-like odor noted	705
10			3 ppm		
					700
15			5.3 ppm	change to gray	
					695
20			9.7 ppm		
				END OF BORING AT 23 FEET	690
25					
					685

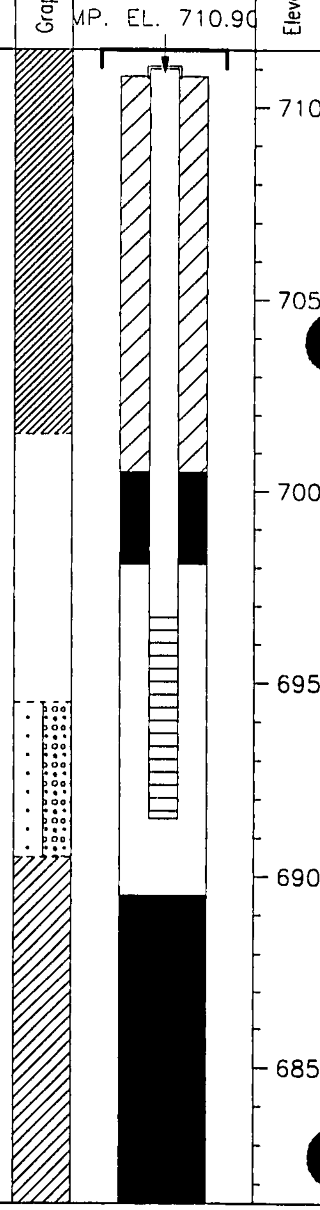
Graphic Log | Well Construction



Project Name: AlliedSignal - South Bend	Project Number: 09822-00	Well Id: MW-9
Location: AlliedSignal Industrial Complex	Logged By: J. Kirkland	Page 1 of 1
Date(s): 12/13/96 - 12/13/96	Datum: Mean Sea Level	Static Water Level:
Riser: type: PVC dia: 2.00in fm: 0.5' to: 14.80'	Measuring Point: 710.90' Elevation: 711.50'	Completed Depth: 20.00' Total Depth: 30.00'
Screens: type: Slotted size: 0.010in dia: 2.00in fm: 14.80' to: 19.80'	Contractor: AEC Drilling Method: Hollow Stem Auger	Borehole Dia.: 8.25in
Annular Fill: type: Grout fm: 0.70' to: 11.00' type: Bentonite fm: 11.00' to: 13.40' type: Sand Filter fm: 13.40' to: 22.00' type: Fill fm: 22.00' to: 30.00'	Remarks:	

Depth (ft)	Sample Id.	Blow Counts	PI Meter	Material Description
				SANDY CLAY - slighty plastic, loose, moist, dark brown (7.5YR4/3), SC
5			0 ppm	SAND - trace gravel, fine-medium grained, loose, moist, light brown (7.5YR6/3), SP
10			0 ppm	
15	01ST00916		0 ppm	change to wet
				Gravelly
20				SILTY CLAY - plastic, soft, moist, gray (7.5YR6/1) CL
25				
				END OF BORING AT 30 FEET

Graphic Log | Well Construction | Elevation (ft)



APPENDIX F

WELL DEVELOPMENT RECORDS

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9322-00	12/18/96	MW-1

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☒
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☐
- Other ______

Sediment in Well

(1) Well depth at time of installation (from top of well casing) ______ ft.

(2) Well depth prior to development (from top of well casing) ______ ft.

(3) Sedimentation prior to development [(1) minus (2)] ______ ft.

(4) Well depth after development (from top of well casing) ______ ft.

(5) Sedimentation after development [(1) minus (4)] ______ ft.

Time spent developing well: 51 min ~~hrs~~

Depth to water before development (from top of well casing): 15.70 ft

Depth of well (from top of well casing): 21.21 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.88 gal

Volume of water removed from well: 32 gal

Average rate of removal: 0.63 gal/min

Volume of water added (if any): ——— gal

Source of water added: ______

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 17.43 ft

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☒
Turbid	☒	Turbid	☐

initially brown, opaque, silty
Final: translucent, light brown

	Before Development	After Development
Temperature	11.1 °C	10.8 °C
Specific conductance	1.20 mS/cm	1.15 mS/cm
pH		

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

21.21 − 15.70 = 5.51 ft x 0.16 gal/ft = 0.88 gal

Well developed by the following persons:

Name: P. Kaczor (print)	Name: ______ (print)	Name: ______ (print)
Signature: [signature]	Signature: ______	Signature: ______
Firm: ABB	Firm: ______	Firm: ______

ABB Environmental Services, Inc.

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822.00	12/14/96	MW-2

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Time spent developing well: 45 min hrs

Depth to water before development (from top of well casing): 12.20 ft

Depth of well (from top of well casing): 15.35 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): NR gal

Volume of water removed from well: NR gal

Average rate of removal: ______ gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 11.82 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing): 16.00 ft.

(2) Well depth prior to development (from top of well casing): 15.25 ft.

(3) Sedimentation prior to development [(1) minus (2)]: .75 ft.

(4) Well depth after development (from top of well casing): 15.35 ft.

(5) Sedimentation after development [(1) minus (4)]: .65 ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

Initially gray, opaque, silty
Final: gray, opaque, slightly silty

	Before Development	After Development
Temperature	10.7°C	8.5°C
Specific conductance	1.21 mS/cm	1.28 mS/cm
pH	6.98	6.88

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

Well developed by the following persons:

Name: Scott Ahs (print)	Name: Duke Brown (print)	Name: ______ (print)
Signature:	Signature:	Signature:
Firm: AEC	Firm: AEC	Firm:

ABB Environmental Services, Inc.

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822-00	12/14/96	MW - 3

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Time spent developing well: 28 min ~~hrs~~

Depth to water before development (from top of well casing): 14.20 ft

Depth of well (from top of well casing): 17.21 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.48 gal

Volume of water removed from well: ______ gal

Average rate of removal: ______ gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 13.81 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing): 18.10 ft.

(2) Well depth prior to development (from top of well casing): ______ ft.

(3) Sedimentation prior to development [(1) minus (2)]: ______ ft.

(4) Well depth after development (from top of well casing): 17.21 ft.

(5) Sedimentation after development [(1) minus (4)]: 0.89 ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

light brown, silty, opaque

	Before Development	After Development
Temperature	5.9°C	12.7°C
Specific conductance	0.473 mS/cm	0.941 mS/cm
pH	3.99	6.39

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

17.21-14.20 = 3.01 ft x 0.16 gal/ft = 0.48 gal

Well developed by the following persons:

Name: Scott Aho (print)	Name: Duke Brown (print)	Name: ______ (print)
Signature: ______	Signature: ______	Signature: ______
Firm: AEC	Firm: AEC	Firm: ______

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9403050A.WK1\IN050

30-Jun-94

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822-00	12/13/96	MW-4

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Time spent developing well: 16 mins hrs

Depth to water before development (from top of well casing): 16.50 ft

Depth of well (from top of well casing): 19.85 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.54 gal

Volume of water removed from well: 17 gal

Average rate of removal: 1.1 gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 16.11 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing): 20.50 ft.

(2) Well depth prior to development (from top of well casing): 19.95 ft.

(3) Sedimentation prior to development [(1) minus (2)]: 0.65 ft.

(4) Well depth after development (from top of well casing): ______ ft.

(5) Sedimentation after development [(1) minus (4)]: ______ ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☒
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

Final water: clear, free of sediments

	Before Development	After Development
Temperature	13.4°C	14.4°C
Specific conductance	1.29 mS/cm	1.31 mS/cm
pH	6.94	6.89

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

19.95 − 16.50 = 3.35 ft x 0.16 gal/ft = 0.54 gal

Well developed by the following persons:

Name: J Kirkland (print)	Name: Scott Aho (print)	Name: ______ (print)
Signature:	Signature:	Signature:
Firm: ABB	Firm: AEC	Firm:

ABB Environmental Services, Inc.

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9322-00	12/13/96	MW-5

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Time spent developing well: 16 mins ~~hrs~~

Depth to water before development (from top of well casing): ~~15.10~~ 17.00 ft

Depth of well (from top of well casing): 20.85 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): ~~0.62~~ 0.34 gal

Volume of water removed from well: 17 gal

Average rate of removal: 1.06 gal/min

Volume of water added (if any): ϕ gal

Source of water added: —

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 16.24 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing) ______ ft.

(2) Well depth prior to development (from top of well casing) ______ ft.

(3) Sedimentation prior to development [(1) minus (2)] ______ ft.

(4) Well depth after development (from top of well casing) ______ ft.

(5) Sedimentation after development [(1) minus (4)] ______ ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☒
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

Final water: clear, free of sediments

	Before Development	After Development
Temperature	12.1°C	13.3°C
Specific conductance	1.27 mS/cm	1.14 mS/cm
pH	6.74	6.84

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

20.85 − 17.00 = 2.15 ft × 0.16 gal/ft = 0.34 gal

Well developed by the following persons:

Name: J. Kirkland (print)	Name: ______ (print)	Name: ______ (print)
Signature:	Signature:	Signature:
Firm: ABB	Firm:	Firm:

ABB Environmental Services, Inc.

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822-00		MW-6

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Time spent developing well: 48 min ~~hrs~~

Depth to water before development (from top of well casing): 13.90 ft

Depth of well (from top of well casing): 17.50 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.58 gal

Volume of water removed from well: 45 gal

Average rate of removal: 0.9 gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☒ NO

Depth to water after development (from top of well casing): 13.23 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing) ______ ft.

(2) Well depth prior to development (from top of well casing) ______ ft.

(3) Sedimentation prior to development [(1) minus (2)] ______ ft.

(4) Well depth after development (from top of well casing) ______ ft.

(5) Sedimentation after development [(1) minus (4)] ______ ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

Product observed before and after developing
Final: clear

	Before Development	After Development
Temperature	13.4°C	13.5°C
Specific conductance	2.10	1.96
pH	6.70	6.59

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

17.50 - 13.90 = 3.60 ft x 0.16 gal/ft = 0.58 gal

Well developed by the following persons:

Name: S. Murray (print)	Name: Duke Brown (print)	Name: ______ (print)
Signature: [signature]	Signature: ______	Signature: ______
Firm: ABB	Firm: AEC	Firm: ______

ABB Environmental Services, Inc.

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30-Jun-94

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822-00	12/14/96	MW-7

Can this well be purged dry? ☒ YES ☐ NO ☐ UNKNOWN

Well development method
- surged with bailer and bailed ☐
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☒
- Other ______

Sediment in Well

(1) Well depth at time of installation (from top of well casing) 19.00 ft.

(2) Well depth prior to development (from top of well casing) ______ ft.

(3) Sedimentation prior to development [(1) minus (2)] ______ ft.

(4) Well depth after development (from top of well casing) 18.24 ft.

(5) Sedimentation after development [(1) minus (4)] 0.76 ft.

Time spent developing well: 35 min ~~hrs~~

Depth to water before development (from top of well casing): 15.10 ft

Depth of well (from top of well casing): 18.24 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.50 gal

Volume of water removed from well: ______ gal

Average rate of removal: ______ gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing): 14.96 ft

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☐
Turbid	☐	Turbid	☐

Brown, opaque

	Before Development	After Development
Temperature	12.0°C	12.6°C
Specific conductance	1.23 mS/cm	1.23 mS/cm
pH	6.77	6.62

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

18.24 − 15.10 = 3.14 ft × 0.16 gal/ft = 0.50

Well developed by the following persons:

Name: Steve Murray (print)	Name: Duke Brown (print)	Name: ______ (print)
Signature: ______	Signature: ______	Signature: ______
Firm: ABB	Firm: AEC	Firm: ______

ABB Environmental Services, Inc.

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30-Jun-94

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9822-00	12/11/96	MW-8

Can this well be purged dry? ☐ YES ☐ NO ☐ UNKNOWN

Well development method

- surged with bailer and bailed ☒
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☐
- Other ____________

Time spent developing well: 1 hrs

Depth to water before development (from top of well casing): 15.10 ft

Depth of well (from top of well casing): 18.75 ft

Inside diameter of well: 2 in

Volume of water in well casing (show calculations below): 0.58 gal

Volume of water removed from well: 30 gal

Average rate of removal: 0.5 gal/min

Volume of water added (if any): — gal

Source of water added: —

Analysis performed on water added? ☐ YES ☒ NO

Depth to water after development (from top of well casing): 14.41 ft

Sediment in Well

(1) Well depth at time of installation (from top of well casing) ______ ft.

(2) Well depth prior to development (from top of well casing) ______ ft.

(3) Sedimentation prior to development [(1) minus (2)] ______ ft.

(4) Well depth after development (from top of well casing) ______ ft.

(5) Sedimentation after development [(1) minus (4)] ______ ft.

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results):

	Before Development	After Development
Clear	☐	☐
Sl. turbidity	☐	☐
Turbid	☒	☒

Initial: cloudy, opaque, gray, hydrocarbon-like odor

Final: same

	Before Development	After Development
Temperature	10.2°C	12.1°C
Specific conductance	1.93	1.75
pH	7.09	6.70

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

18.75 − 15.10 = 3.65 ft × 0.16 gal/ft = 0.58 gal

Well developed by the following persons:

Name (print)	Signature	Firm
John Kirkland		ABB
S. Murray	S. Murray	ABB

ABB Environmental Services, Inc.

9403050A.WK1\IN050

30-Jun-94

MONITORING WELL DEVELOPMENT

Project Name	Project Number	Development Date	Well Name
AlliedSignal South Bend	9322-00	12/18/96	MW-9

Can this well be purged dry? ☐ YES ☐ NO ☒ UNKNOWN

Well development method

- surged with bailer and bailed ☒
- surged with bailer and pumped ☐
- surged with block and bailed ☐
- surged with block and pumped ☐
- jetted and pumped ☐
- compressed air ☐
- bailed only ☐
- pumped only ☐
- Other ______

Sediment in Well

(1) Well depth at time of installation (from top of well casing) 20.0 ft
(2) Well depth prior to development (from top of well casing) 19.5 ft
(3) Sedimentation prior to development [(1) minus (2)] 0.5 ft
(4) Well depth after development (from top of well casing) 20.0 ft
(5) Sedimentation after development [(1) minus (4)] 0 ft

Time spent developing well 48 min ~~hrs~~

Depth to water before development (from top of well casing) 16.40 ft

Depth of well (from top of well casing) 19.50 ft

Inside diameter of well 2 in

Volume of water in well casing (show calculations below) .50 gal

Volume of water removed from well 20 gal

Average rate of removal 0.42 gal/min

Volume of water added (if any) —— gal

Source of water added ______

Analysis performed on water added? ☐ YES ☐ NO

Depth to water after development (from top of well casing) 15.53 ft

Describe changes in the water during development (include color, turbidity, odor, and air monitoring results): initially brown, opaque, very silty. end: light brown, translucent, slightly silty.

Before Development		After Development	
Clear	☐	Clear	☐
Sl. turbidity	☐	Sl. turbidity	☒
Turbid	☒	Turbid	☐

	Before Development	After Development
Temperature	12.0°C	14.9°C
Specific conductance	0.689 mS/cm	0.711 mS/cm
pH	6.80	6.52

Additional comments on development including equipment used (type/construction, decontamination procedures, average pumping rate, and drawdown/recharge observations):

19.50 − 16.40 = 3.1 ft × 0.16 gal/ft = 0.496 gal

Well developed by the following persons:

Name (print)	Signature	Firm
Peter Kaczar	[signature]	ABB

ABB Environmental Services, Inc.

9400050A.WK1\IN050

30-Jun-94

APPENDIX G

GROUNDWATER SAMPLING RECORDS

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-01-20
Sample Date: 12/20/96
Sample Time: 0950

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, ~~J. Pardy~~ (PK)
Activity Start: 0915
Activity End: 1005
Weather: 6°, sunny, mild wind
Well Type and Location: 2" PVC ~~flush-mount~~ (PK) stick up

WATER LEVEL/WELL DATA

Well Depth: 21.21 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 17.43 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 19.5 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ___ feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/Distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 3.78 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 1.8 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.6	1.2	1.8	
Time (Min.)	0937	0940	0944	
Temperature (C°)	10.8	10.9	10.8	
pH (Units)	6.38	6.43	6.49	
Conductivity at 25°C mS/cm ~~(umhos/cm)~~	1.16	1.14	1.16	

Total Volume Purged 2 gallons
Water Appearance (describe color, clarity odor:) light brown, translucent, slightly silty

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample; fetch bottle for metals
Sample Water Appearance (color, clarity, odor): Same as purge

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	N	Y
metals	6010	1x1000-ml		HNO3	Y	Y
CN⁻	9012	1x1-L AP		NaOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print) Peter Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-02-16
Sample Date: 12/20/96
Sample Time: 1033

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, ~~F~~ ~~Pau...~~ (PK)
Activity Start: 1010
Activity End: 1050
Weather: 6°F, mild wind, sunny, wind chill advisory
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 15.35 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 11.82 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 16 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ___ feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox / Distilled Water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 3.53 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 1.7 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.6	1.2	1.8	
Time (Min.)	1018	1021	1024	
Temperature (C°)	10.0	9.5	10.0	
pH (Units)	6.77	6.67	6.67	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	1.21	1.21	1.19	

Total Volume Purged 2.5 gallons
Water Appearance (describe color, clarity odor:) gray, translucent, slightly silty

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample, fetch bottle for metals
Sample Water Appearance (color, clarity, odor): dark gray, opaque, silty

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40 ml		HCl	N	Y
metals	6010	1x1000 ml		HNO3	Y	Y
CN	9012	1x1-L Amber		NaOH	N	Y
SVOC	8270	2x1-L AG		—	N	Y
PCB	8081	2x1-L AG		—	N	Y

OTHER OBSERVATIONS

NAME (Print) Peter Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-03-18
Sample Date: 12/20/96
Sample Time: 1125

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, ~~J. [illegible]~~ (PK)
Activity Start: 1105
Activity End: 1135
Weather: 10°F, breezy, sunny, wind chill advisory
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 17.21 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 13.81 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 18.1 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 3.4 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) X 3 casing volumes = 1.6 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.6	1.2	1.8	
Time (Min.)	1114	1117	1119	
Temperature (C°)	9.5	11.1	11.6	
pH (Units)	6.87	6.71	6.70	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	0.98	1.04	1.04	

Total Volume Purged ____ gallons
Water Appearance (describe color, clarity odor:) Clear

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sampling; fetch bottle for metals
Sample Water Appearance (color, clarity, odor): light brown, silty, opaque

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	Y (N)	(Y) N
metals	6010	1x1000-ml		HNO3	(Y) N	(Y) N
CN⁻	9012	1x1-L AP		NaOH	~~Y~~ (N) (PK)	(Y) N
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print) Peter Kaczor

SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-04-21
Sample Date: 12/19/96
Sample Time: 1713

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panco
Activity Start: 1647
Activity End: 1740
Weather: mostly sunny, breezy, 8°F, minus 15-25° windchill
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 19.85 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 16.11 (from top of well casing) feet using Solinst (measuring device)
Historical Well Depth: 20.5 feet (from ground surface)
Protective Casing Stickup: —— feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: —— feet using —— (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 3.74 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) X 3 casing volumes = 1.8 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.6	1.2	1.8	
Time (Min.)	1703	1706	1710	
Temperature (C°)	10.3	13.1	13.4	
pH (Units)	6.72	6.78	6.79	
Conductivity at 25°C (~~umhos/cm~~) mS/cm	1.33	1.29	1.24	

Total Volume Purged ____ gallons
Water Appearance (describe color, clarity odor:) dark brown, opaque, silty.

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample, fetch bottle for metals
Sample Water Appearance (color, clarity, odor): Same.

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	Y N (N circled)	Y (circled) N
metals	6010	1x1000-ml		HNO3	Y (circled) N	Y (circled) N
CN⁻	9012	1x1-L AP		NaOH	Y N	Y N
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print): Pete Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-05-22
Sample Date: 12/20/96
Sample Time: 1318

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panco
Activity Start: 1245
Activity End: 1413
Weather: 10°F, windy, sunny
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 20.85 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 16.29 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 21.5 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: — feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 4.56 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 2.2 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.8	1.6	2.4	
Time (Min.)	1258	1302	1306	
Temperature (C°)	9.6	12.1	12.8	
pH (Units)	6.72	6.58	6.59	
Conductivity at 25°C (~~umhos/cm~~ mS/cm)	1.28	1.22	1.20	

Total Volume Purged 3 gallons
Water Appearance (describe color, clarity odor:) dark brownish gray, opaque

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample; fetch bottle for metals
Sample Water Appearance (color, clarity, odor): same as purge

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	4 x 40-ml		HCl	N	Y
metals	6010	1 x 1000-ml		HNO_3	Y	Y
CN	9012 (PK)	2 x 1-L AP		NaOH	N	Y
SVOC	8270	4 x 1-L AG		—	N	Y
PCB	8081	4 x 1-L AG		—	N	Y

OTHER OBSERVATIONS

collected MS-MSD at this well and duplicate sample 01OD0522

NAME (Print) Pete Kaczor

SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

Duplicate of 01MW0522

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: ~~01-MW~~ 01QD0522
Sample Date: 12/20/96
Sample Time: —

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panco
Activity Start:
Activity End:
Weather:
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: ____ feet using Solinst (from top of well casing) (measuring device)
Water Depth: ____ feet using Solinst (from top of well casing) (measuring device)
Historical Well Depth: ____ feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: ____ feet using ____ (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures:
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: ____ ppm

PURGING PROCEDURES

Height of Water Column ____ feet X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) X 3 casing volumes = ____ gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)				
Time (Min.)				
Temperature (C°)				
pH (Units)				
Conductivity at 25°C (umhos/cm)				
Total Volume Purged	gallons			
Water Appearance (describe color, clarity odor:)				

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample; fetch bottle for metals
Sample Water Appearance (color, clarity, odor):

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	N	Y
metals	6010	1x1000-ml		HNO_3	Y	Y
CN⁻	9012	1x1-L AP		NaOH	N	Y
SVOC	8270	2x1-L AG		—	N	Y
PCB	8081	2x1-L AG		—	N	Y

OTHER OBSERVATIONS

SEE Record for 01MW0522

NAME (Print): Peter Kaczor

SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-06-18
Sample Date: 12/19/96
Sample Time: 1615

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Raczor, J. Panco
Activity Start: 1547
Activity End: 1640
Weather: MOSTLY CLOUDY, WINDY, 8°
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 17.50 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 13.23 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 18 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ___ feet
Floating Product Thickness: 1.34' feet using ORS oil-water interface probe (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0.3 ppm
Well Mouth: 20-55 ppm

PURGING PROCEDURES

Height of Water Column feet: 4.27 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 2.0 gallons to purge

Purge Method (see Note 2): ~~Teflon bailer, decon with Liquinox and distilled water~~ PERISTALTIC PUMP AND TEFLON TUBING.

Purge Vol. (gal)	0.7	1.4	2.1	
Time (Min.)	1558	1603	1608	
Temperature (C°)	10.7	~~12.6~~ 12.6	13.2	
pH (Units)	6.41	6.34	6.34	
Conductivity at 25°C mS/cm ~~(umhos/cm)~~	1.81	1.95	1.96	

Total Volume Purged: 2.1 gallons
Water Appearance (describe color, clarity odor:) CLEAR, SHEEN, PETRO LIKE ODOR

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): * ~~Teflon bailer, decon with liquinox and distilled water. Bottom-emptying device for VOC samples; fetch bottle for metals~~
Sample Water Appearance (color, clarity, odor): SAME AS ABOVE

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	N	Y
metals	6010	1x1000-ml		HNO3	Y	Y
CN⁻	9012	1X1L AP		NaOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

* SAMPLED W/ PERISTALTIC PUMP AND TEFLON TUBING.

NAME (Print): JOHN PANCO
SIGNATURE: John P. Panco II

Notes:
(1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-07-19
Sample Date: 12/19/96
Sample Time: 1410

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Raczor, J. Panco
Activity Start: 1348
Activity End: 1420
Weather: 10°, MOSTLY CLOUDY, BREEZY
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 18.24 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 14.96 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 19 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: — feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox / distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet: 3.28 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) X 3 casing volumes = 1.6 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.6	1.2	1.8	
Time (Min.)	1358	1401	1403	
Temperature (C°)	11.7	12.8	12.9	
pH (Units)	7.04	6.95	6.89	
Conductivity at 25°C mS/cm ~~(umhos/cm)~~	1.13	1.16	1.15	

Total Volume Purged: 1.8 gallons
Water Appearance (describe color, clarity odor.): BROWN, OPAQUE, HYDROCARBON ODOR.

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for voc sample, fetch bottle for metals
Sample Water Appearance (color, clarity, odor): SAME AS ABOVE.

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	N	Y
metals	6010	1x1000-ml		HNO_3	Y	Y
CN-	9012	1x500ml		NaOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print): JOHN PANCO
SIGNATURE: John P. Panco II

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-08-19
Sample Date: 12/19/96
Sample Time: 1325

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panco
Activity Start: 1303
Activity End: 1335
Weather: 40°, MOSTLY CLOUDY, BREEZY
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 18.75 feet using Solinst (from top of well casing) (measuring device)
Water Depth: 14.41 (from top of well casing) feet using Solinst (measuring device)
Historical Well Depth: 18.7 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: ___ feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0.3 ppm

PURGING PROCEDURES

Height of Water Column feet 4.34 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 2.1 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.7	(PK) ~~2.~~ 1.4	2.1	
Time (Min.)	1308	1311	1313	
Temperature (C°)	11.1	12.0	12.1	
pH (Units)	6.59	6.55	6.57	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	1.70	1.74	1.74	

Total Volume Purged 2.1 gallons
Water Appearance (describe color, clarity odor:) DARK GREY, SHEEN, HYDROCARBON ODOR

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample; fetch bottle for metals
Sample Water Appearance (color, clarity, odor): SAME AS ABOVE

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40 ml		HCl	N	Y
metals	6010	1x1000 ml		HNO3	Y	Y
CN⁻	9012	1x500ml		NaOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print) JOHN PANCO
SIGNATURE: John P. Panco II

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 01-MW-09-21
Sample Date: 12/20/96
Sample Time: 1615

SITE/SAMPLE LOCATION

Site Name: AlliedSignal South Bend
Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panco
Activity Start: 1544
Activity End: 1625
Weather: 10° breezy, sunny, wind chill advisory
Well Type and Location: 2" PVC flush-mount

WATER LEVEL/WELL DATA

Well Depth: 19.50 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 15.53 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: 20.5 feet (from ground surface)
Protective Casing Stickup: — feet (for above-ground surface)
Protect. Casing Well Casing Difference: feet
Floating Product Thickness: — feet using — (measuring device)
Well Condition (see Note 1): Good, locked
Measuring Device Contamination Procedures: Liquinox/distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet 3.97 X (X) .16 gal/ft (2 in) ( ) .65 gal/ft (4 in) ( ) ___ gal/ft (___ in) X 3 casing volumes = 1.9 gallons to purge

Purge Method (see Note 2): Teflon bailer, decon with Liquinox and distilled water

Purge Vol. (gal)	0.7	1.4	2.1	
Time (Min.)	1605	1608	1610	
Temperature (C°)	12.1	14.3	15.1	
pH (Units)	6.76	6.60	6.58	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	0.719	0.741	0.746	

Total Volume Purged 3 gallons
Water Appearance (describe color, clarity odor.) light brown, opaque, silty.

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, decon with Liquinox and distilled water. Bottom-emptying device for VOC sample, fetch bottle for metals
Sample Water Appearance (color, clarity, odor): Same as purge

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	Y N	Y N
metals	6010	1x1000-ml		HNO3	Y N	Y N
CN⁻	9012	1x1-L AP		NaOH	Y N	Y N
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print) Peter Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: 7-25
Sample Date: 12/20/96
Sample Time: 1526

SITE/SAMPLE LOCATION

Site Name: Allied Signal South Bend
Project No.: 9822-00
Personnel Present: P Kaczor; J. Panico
Activity Start: 1430
Activity End: 1549
Weather: 10°F, breezy, sunny, wind chill advisory
Well Type and Location: Stick up

WATER LEVEL/WELL DATA

Well Depth: 26.63 feet using Solinst (from top of well casing) (measuring device)
Water Depth: 20.36 feet using Solinst (from top of well casing) (measuring device)
Historical Well Depth: ______ feet (from ground surface)
Protective Casing Stickup: ______ feet (for above-ground surface)
Protect. Casing Well Casing Difference: ______ feet
Floating Product Thickness: ―― feet using ―― (measuring device)
Well Condition (see Note 1): Okay, locked
Measuring Device Contamination Procedures: Liquinox + distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column 6.27 feet X (PK) ~~(x)~~ .16 gal/ft (2 in) (x) .09 gal/ft (1.5 in) ( ) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) x 3 casing volumes = ~~3.0~~ 1.8 (PK) gallons to purge

Purge Method (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse

Purge Vol. (gal)	(PK) ~~1.0~~ 0.6	(PK) ~~2.0~~ 1.2	(PK) ~~3.0~~ 1.8	
Time (Min.)	1449	1506	1520	
Temperature (C°)	8.1	8.0	8.4	
pH (Units)	7.18	7.02	7.00	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	0.661	0.672	0.676	

Total Volume Purged ______ gallons
Water Appearance (describe color, clarity odor:) light brown, translucent, suspend particles

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse; bottom-emptying device for VOC samples
Sample Water Appearance (color, clarity, odor):

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	Y (N)	(Y) N
Metals	6010	1x500-ml poly		HNO_3	(Y) N	(Y) N
CN⁻	9012	1x1-L AP		NaOH	Y (N)	(Y) N
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print): Peter Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: ~~[illegible]~~ 86-4 (JP)
Sample Date: 12/19/96
Sample Time: 1500

SITE/SAMPLE LOCATION

Site Name: Allied Signal South Bend
Project No.: 9822-00
Personnel Present: A Kaczor, J. Panco
Activity Start: 1433
Activity End: 1520
Weather: 10° CLOUDY, LT. SNOW, WINDY
Well Type and Location: Stick up

WATER LEVEL/WELL DATA

Well Depth: 23.65 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 17.51 (from top of well casing) feet using Solinst (measuring device)
Historical Well Depth: ____ feet (from ground surface)
Protective Casing Stickup: ____ feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: —— feet using —— (measuring device)
Well Condition (see Note 1): Okay, locked
Measuring Device Contamination Procedures: Liquinox + distilled water
PI Meter ID: Toxi Rae
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column feet X ~~( ) .16 gal/ft (2 in)~~ 1½" .092 X 3 casing volumes = ~~2.9~~ 1.7 gallons to purge
6.14 ( ) .65 gal/ft (4 in)
( ) ____ gal/ft (____ in)

Purge Method (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse

Purge Vol. (gal)	~~1.0~~ 0.6	~~2.0~~ 1.2	~~3.0~~ 1.8	
Time (Min.)	1645	1649	1652	
Temperature (C°)	10.8	11.9	12.0	
pH (Units)	6.74	6.66	6.68	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	1.17	1.34	1.35	

Total Volume Purged 1.8 gallons
Water Appearance (describe color, clarity odor:) BROWN, OPAQUE, NO ODOR

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse; bottom-emptying device for VOC samples
Sample Water Appearance (color, clarity, odor): BROWN, TRANSLUCENT, NO ODOR

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	Y (N)	(Y) N
metals	6010	1x500-ml poly		HNO_3	(Y) N	(Y) N
CN⁻	9012	1x1-L AP		NaOH	Y (N)	(Y) N
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print): JOHN PANCO
SIGNATURE: John P. Panco II

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: S5
Sample Date: 12/20/96
Sample Time: 1820

SITE/SAMPLE LOCATION

Site Name: Allied Signal South Bend — Project No.: 9822-00
Personnel Present: P. Kaczor, J. Panico
Activity Start: 1645 — Activity End: 1845
Weather: 10°, windy, snowy, wind chill advisory
Well Type and Location: Stick up

WATER LEVEL/WELL DATA

Well Depth: 32.92 feet using Solinst (measuring device) (from top of well casing)
Water Depth: 13.00 feet using Solinst (measuring device) (from top of well casing)
Historical Well Depth: ____ feet (from ground surface)
Protective Casing Stickup: ____ feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: —— feet using —— (measuring device)
Well Condition (see Note 1): Okay, locked
Measuring Device Contamination Procedures: Liquinox + distilled water
PI Meter ID: Toxi Rae, Ambient Air: 0 ppm, Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column 19.92 feet X (PK) ~~(X)~~ .16 gal/ft (2 in) (X) .65 gal/ft (4 in) ( ) ____ gal/ft (____ in) x 3 casing volumes = ~~9.6~~ 39 (PK) gallons to purge

Purge Method (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse

Purge Vol. (gal)	(PK) ~~3.2~~ 13	(PK) ~~6.4~~ 26	(PK) ~~9.6~~ 39	
Time (Min.)	1719	1753	1809	
Temperature (C°)	9.0	8.7	8.2	
pH (Units)	6.91	6.74	6.59	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	1.05	1.41	1.49	

Total Volume Purged ____ gallons
Water Appearance (describe color, clarity odor:) dark brownish gray, opaque, silty

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): Teflon bailer, Liquinox + distilled water decon, distilled water rinse, bottom-emptying device for VOC samples
Sample Water Appearance (color, clarity, odor): same as purge

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2x40-ml		HCl	N	Y
metals	6010	1x500-ml poly		HNO_3	Y	Y
CN⁻	9012	1x1-L AP		NaOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print) Peter Kaczor
SIGNATURE: [signature]

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

ABB ENVIRONMENTAL SERVICES, INC.
GROUNDWATER SAMPLE RECORD

Sample No.: S6
Sample Date: 12-19-96
Sample Time: 1110

SITE/SAMPLE LOCATION

Site Name: ALLIED SIGNAL S.B.
Project No.: 9822-00
Personnel Present: J. PANCO, P. KACZOR
Activity Start: 1018
Activity End: 1132
Weather: MOSTLY CLOUDY, MEDIUM WIND, 10°
Well Type and Location: STICK UP

WATER LEVEL/WELL DATA

Well Depth: 30.49 feet using SOLINST (measuring device) (from top of well casing)
Water Depth: 19.41 feet using SOLINST (measuring device) (from top of well casing)
Historical Well Depth: ____ feet (from ground surface)
Protective Casing Stickup: ____ feet (for above-ground surface)
Protect. Casing Well Casing Difference: ____ feet
Floating Product Thickness: — feet using ____ (measuring device)
Well Condition (see Note 1): OK, locked
Measuring Device Contamination Procedures: LIQUINOX WASH, DI WATER RINSE
PI Meter ID: TOX RAE
Ambient Air: 0 ppm
Well Mouth: 0 ppm

PURGING PROCEDURES

Height of Water Column 11.08 feet X ( ) .16 gal/ft (2 in) / (X) .65 gal/ft (4 in) / ( ) ____ gal/ft (____ in) X 3 casing volumes = 21.6 gallons to purge

Purge Method (see Note 2): TEFLON BAILER; LIQUINOX WASH FOLLOWED BY DI WATER RINSE.

Purge Vol. (gal)	7.2	14.4	21.6	
Time (Min.)	1038	1050	1105	
Temperature (C°)	11.7	10.5	11.0	
pH (Units)	6.94	6.93	6.88	
Conductivity at 25°C ~~(umhos/cm)~~ mS/cm	0.94	0.98	0.97	

Total Volume Purged ____ gallons
Water Appearance (describe color, clarity odor:) BLACK, SUSPENDED PARTICULATES, NO ODOR

SAMPLING PROCEDURES

Sampling Procedure (see Note 2): SAME AS PURGE

Sample Water Appearance (color, clarity, odor): BLACK, SEMI-TRANSLUCENT, NO ODOR

ANALYTICAL PARAMETERS

Analysis	Method	No. of Bottles Volume, Type	Bottle Lot	Preservative/ Volume	Field Filtered?	Cool to 4°C?
VOC	8260	2X40ml		HCL	N	Y
METALS	6010	1X 500ml poly		HNO3	Y	Y
CN⁻	9012	1X1L AP		NAOH	N	Y
					Y N	Y N
					Y N	Y N

OTHER OBSERVATIONS

NAME (Print): JOHN PANCO
SIGNATURE: John P. Panco II

Notes: (1) Described whether well was locked and the condition of the protective casing and concrete collar.
(2) Describe sequence of purging/sampling including equipment type and decontamination method.

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
01CPT001	2,345,356.14	3,168,450.50	713.01
01CPT002	2,345,318.72	3,165,912.19	714.21
01CPT003	2,345,055.23	3,167,511.89	712.38
01CPT004	2,344,819.01	3,165,848.27	718.14
01CPT005	2,344,836.94	3,165,654.15	718.14
01CPT006	2,344,534.47	3,166,870.30	714.84
01CPT007	2,343,867.93	3,168,602.52	712.91
01CPT008	2,344,720.01	3,168,091.12	712.31
01CPT009	2,345,526.09	3,166,958.39	713.98
01CPT010	2,345,512.84	3,167,851.79	713.01
01CPT011	2,344,249.48	3,169,469.12	713.70
01CPT012	2,344,260.97	3,168,956.94	712.80
01CPT013	2,344,267.82	3,169,078.33	713.50
01CPT014	2,345,525.70	3,165,972.14	719.00
01CPT015	2,345,528.70	3,166,462.32	719.50
01CPT016	2,344,948.56	3,167,944.57	713.00
01CPT017	2,344,862.95	3,165,910.50	718.10
01GP001	2,344,066.87	3,168,362.74	712.91
01GP002	2,344,354.40	3,167,870.85	712.86
01GP003	2,344,107.97	3,169,198.64	712.93
01GP004	2,345,381.87	3,167,045.70	713.98
01GP005	2,345,069.26	3,167,513.45	712.38
02GP001	2,344,621.00	3,168,377.22	712.31
02GP002	2,344,600.73	3,168,311.74	712.31
03GP001	2,344,876.95	3,165,910.34	718.06
03GP002	2,344,823.29	3,166,071.77	718.42
03GP003	2,344,982.01	3,165,979.52	713.93
03GP004	2,344,773.72	3,165,975.55	718.56
03GP005	2,344,819.01	3,165,844.27	718.35
03GP006	2,344,766.40	3,166,067.77	721.75
03GP007	2,344,976.07	3,165,907.65	716.86
03GP008	2,344,824.16	3,166,250.24	713.60
03GP009	2,344,878.69	3,166,252.48	711.85
03GP010	2,344,933.25	3,166,251.27	711.93
03GP011	2,344,764.96	3,166,146.49	722.80
03GP012	2,344,873.23	3,166,153.03	723.34
03GP013	2,344,908.07	3,166,078.48	719.28
03GP014	2,344,906.48	3,165,980.55	719.03
03GP015	2,344,828.12	3,165,977.04	719.23
03GP016	2,344,776.22	3,165,912.48	719.06
03GP017	2,344,941.65	3,165,837.20	717.82
03GP018	2,344,735.29	3,165,952.99	718.14
03GP019	2,344,713.89	3,166,059.44	719.47
03GP020	2,344,704.89	3,166,192.44	719.00
03GP021	2,345,120.43	3,165,934.82	713.51
03GP022	2,344,872.84	3,165,766.54	717.49
03GP023	2,345,000.96	3,165,774.68	717.37
03GP024	2,344,957.42	3,165,695.49	717.49

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
03GP025	2,344,987.98	3,165,395.94	718.29
03GP026	2,345,115.87	3,165,632.40	717.73
03GP027	2,345,227.92	3,165,584.85	717.53
03GP028	2,345,163.08	3,165,835.94	717.60
03GP029	2,344,943.90	3,165,542.90	718.30
03GP030	2,344,819.90	3,165,557.90	718.10
03GP031	2,344,819.90	3,165,493.90	718.00
03GP032	2,344,819.90	3,165,430.90	718.20
03GP033	2,344,820.00	3,165,740.90	718.50
03GP034	2,344,990.96	3,165,200.90	718.31
03GP035	2,344,889.90	3,165,543.90	718.20
03GP036	2,344,851.00	3,165,651.90	718.00
03GP037	2,344,879.80	3,165,740.90	717.60
03GP038	2,344,922.80	3,165,662.90	717.60
03GP039	2,344,989.80	3,165,669.40	717.50
03GP040	2,344,870.94	3,165,612.15	718.20
03GP041	2,345,225.97	3,165,574.85	717.53
03GP042	2,344,876.95	3,165,910.34	718.06
03GP043	2,344,876.95	3,165,939.34	718.90
03GP044	2,344,891.95	3,165,911.34	718.20
03GP045	2,344,841.95	3,165,912.34	718.90
03GP046	2,344,931.65	3,165,838.20	717.82
03GP047	2,344,816.95	3,165,909.34	718.80
03GP048	2,344,862.95	3,165,885.50	718.10
03GP049	2,344,887.95	3,165,883.50	717.90
03GP050	2,344,990.95	3,165,882.50	716.70
03GP051	2,344,825.95	3,165,884.50	718.80
03GP052	2,344,805.95	3,165,883.50	719.00
03HA053	2,344,934.95	3,165,888.50	717.00
03HA054	2,344,974.95	3,165,905.50	716.90
03HA055	2,344,792.95	3,165,918.50	719.00
03HA056	2,344,944.01	3,165,951.52	715.00
03HA057	2,344,969.07	3,165,895.65	716.80
04GP001	2,344,303.58	3,167,771.43	712.92
04GP002	2,344,386.28	3,167,716.63	712.92
04GP003	2,344,533.70	3,167,516.72	712.91
04GP004	2,344,552.00	3,167,734.32	712.91
04GP005	2,344,437.00	3,167,735.22	712.91
05GP001	2,344,795.11	3,168,027.07	712.81
05GP002	2,344,778.21	3,168,028.97	712.81
05GP003	2,344,793.11	3,168,030.47	712.81
05GP004	2,344,845.11	3,168,077.87	712.81
05GP005	2,344,847.61	3,168,087.87	712.81
05GP006	2,344,783.61	3,168,078.37	712.81
05GP007	2,344,762.71	3,168,076.27	712.81
05GP008	2,344,732.52	3,168,157.49	712.31
05GP009	2,344,731.32	3,168,190.89	712.31
05GP010	2,344,722.82	3,168,225.19	712.31

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
05GP011	2,344,747.02	3,168,213.07	712.61
05GP012	2,344,958.27	3,168,261.24	713.01
05GP013	2,344,969.97	3,168,257.84	713.01
05GP014	2,343,792.31	3,169,122.50	712.97
05GP015	2,343,728.38	3,169,025.05	712.97
05GP016	2,343,732.28	3,168,988.41	712.97
05GP017	2,343,788.41	3,168,958.01	712.97
05GP018	2,343,788.41	3,168,900.32	712.97
05GP019	2,344,897.30	3,166,624.91	714.21
05GP020	2,344,916.40	3,166,625.01	714.21
05GP021	2,344,921.80	3,166,646.11	714.21
05GP022	2,344,901.90	3,166,643.21	714.21
05GP023	2,344,927.90	3,166,671.21	714.21
05GP024	2,344,949.48	3,166,765.64	713.82
05GP025	2,344,888.57	3,166,798.80	713.97
05GP026	2,344,710.52	3,166,683.47	713.97
05GP027	2,345,022.67	3,168,194.84	713.01
05GP028	2,345,022.77	3,168,207.34	713.01
05GP029	2,345,000.27	3,168,171.84	713.01
05GP030	2,345,000.17	3,168,082.84	713.01
05GP031	2,344,998.97	3,168,041.64	713.01
05GP032	2,345,022.97	3,168,048.44	713.01
05GP033	2,345,033.01	3,167,990.02	712.38
05GP034	2,344,893.27	3,167,943.16	711.09
05GP035	2,344,641.18	3,167,302.43	713.33
05GP036	2,344,635.98	3,167,194.33	713.33
05GP037	2,344,636.88	3,167,217.53	713.33
05GP038	2,344,477.06	3,167,096.61	714.84
05GP039	2,344,642.58	3,167,092.43	713.33
05GP040	2,344,543.51	3,167,330.50	714.38
05GP041	2,344,542.31	3,167,352.30	714.38
05GP042	2,344,440.61	3,167,368.50	714.38
05GP043	2,344,514.11	3,167,320.80	714.38
05GP046	2,344,662.92	3,168,252.19	712.31
05GP047	2,344,923.92	3,168,239.07	712.61
05GP048	2,345,040.47	3,167,891.76	711.09
05GP049	2,344,807.05	3,167,942.43	712.81
05GP050	2,344,753.75	3,167,864.33	712.81
05GP051	2,344,762.25	3,167,966.83	712.81
05GP052	2,344,721.41	3,168,063.37	712.91
05GP053	2,344,737.52	3,168,169.57	712.61
05GP054	2,344,871.97	3,166,816.60	713.97
05GP055	2,345,001.30	3,166,691.81	714.21
05GP056	2,344,934.50	3,166,557.16	713.83
05GP057	2,344,801.02	3,166,591.17	713.97
05GP058	2,344,823.52	3,166,691.07	713.97
05GP059	2,344,490.91	3,167,351.40	714.38
05GP060	2,344,429.11	3,167,313.10	714.38

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
05GP061	2,344,253.82	3,170,152.33	712.93
05GP062	2,345,028.72	3,168,289.13	713.01
05GP063	2,345,081.73	3,167,965.60	713.01
05GP064	2,345,067.70	3,168,154.26	713.01
05GP065	2,344,693.50	3,166,839.89	713.33
05GP066	2,344,697.40	3,167,178.23	713.33
05GP067	2,344,727.80	3,167,324.79	713.33
05GP068	2,344,645.17	3,167,350.52	713.33
05GP069	2,344,674.79	3,167,635.06	713.33
05GP070	2,343,705.77	3,169,234.76	712.97
05GP071	2,343,905.35	3,169,407.83	712.93
05GP072	2,344,205.48	3,169,488.12	712.93
05HA044	2,344,709.87	3,167,477.59	713.33
05HA045	2,344,740.28	3,167,467.81	713.33
06GP001	2,344,764.61	3,167,082.92	713.98
06GP002	2,344,808.11	3,167,082.92	713.98
06GP003	2,344,910.61	3,167,214.32	713.98
06GP004	2,344,844.61	3,166,989.52	713.98
06GP005	2,344,843.61	3,167,162.12	713.98
06GP006	2,344,861.11	3,167,077.92	713.98
06GP007	2,344,894.63	3,167,865.04	711.09
06GP008	2,344,809.66	3,167,864.26	711.09
07GP001	2,344,302.61	3,167,853.43	712.86
07GP002	2,344,317.31	3,167,893.63	712.86
07GP003	2,344,304.31	3,167,928.13	712.86
07GP004	2,344,708.45	3,167,876.63	712.81
07GP005	2,344,719.45	3,167,855.43	712.81
07GP006	2,344,238.23	3,170,181.95	712.93
07GP007	2,344,246.80	3,170,195.98	712.93
07GP008	2,345,081.73	3,167,648.32	712.93
07GP009	2,344,624.12	3,167,646.76	713.33
08GP001	2,344,040.39	3,168,357.94	712.04
08GP002	2,344,055.39	3,168,361.44	712.04
08GP003	2,344,075.29	3,168,293.94	712.04
08GP004	2,344,758.77	3,166,250.65	721.36
08GP005	2,344,132.22	3,168,212.74	712.31
08GP006	2,344,186.92	3,168,075.74	712.31
08GP007	2,344,203.52	3,168,009.34	712.31
08GP008	2,344,772.63	3,166,465.63	717.92
08GP009	2,344,366.08	3,167,551.23	712.92
08GP010	2,344,314.01	3,167,799.53	712.86
08GP011	2,344,272.41	3,167,739.13	712.86
08GP012	2,344,328.88	3,167,643.73	712.92
08SD001	2,344,820.57	3,166,386.96	713.98
08SD002	2,344,819.79	3,166,298.86	713.98
09GP001	2,345,099.66	3,168,155.04	713.01
09GP002	2,345,105.90	3,168,117.62	713.01
09GP003	2,345,105.90	3,168,115.62	713.01

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
09GP004	2,345,287.73	3,168,028.32	713.01
09GP005	2,345,104.73	3,167,894.32	713.01
09GP006	2,345,084.73	3,165,752.32	713.01
09GP007	2,345,352.73	3,165,725.32	713.00
09GP008	2,344,935.73	3,167,903.32	713.01
09HA001	2,345,029.73	3,167,900.32	710.00
10GP001	2,344,622.08	3,167,060.03	713.33
10GP002	2,344,618.48	3,167,080.73	713.33
11GP001	2,344,984.03	3,166,075.87	713.92
11GP002	2,344,985.77	3,166,155.66	713.87
11GP003	2,345,280.70	3,165,985.14	714.57
11GP004	2,345,289.70	3,166,135.32	713.61
11GP005	2,344,987.94	3,166,255.72	713.88
11GP006	2,345,190.87	3,166,072.79	714.00
11GP007	2,345,259.93	3,165,897.50	716.10
11GP008	2,345,195.55	3,166,204.53	714.00
11GP009	2,345,104.34	3,166,181.93	714.21
11GP010	2,345,102.60	3,166,112.54	714.21
12GP001	2,344,974.61	3,167,038.82	713.98
12GP002	2,345,014.61	3,167,082.32	713.98
12GP003	2,344,997.61	3,166,975.82	713.98
13GP001	2,344,491.20	3,167,973.35	712.86
13GP002	2,344,425.00	3,167,974.65	712.86
13GP003	2,343,842.09	3,169,256.37	712.97
13GP004	2,343,833.29	3,169,154.17	712.97
13GP005	2,343,699.79	3,169,357.17	712.97
13GP006	2,343,699.79	3,169,269.17	712.97
13GP007	2,343,636.79	3,169,216.17	713.00
14GP001	2,344,303.10	3,168,164.35	712.86
14GP002	2,344,303.20	3,168,258.25	712.86
14GP003	2,344,341.80	3,168,260.55	712.86
14GP004	2,344,094.97	3,168,891.94	712.91
14GP005	2,344,074.07	3,168,890.44	712.91
14GP006	2,344,033.57	3,168,893.44	712.91
14GP007	2,343,882.59	3,169,113.37	712.91
14GP008	2,343,902.29	3,169,112.67	712.91
14GP009	2,343,930.39	3,169,112.87	712.91
14GP010	2,343,971.87	3,168,830.44	712.91
14GP011	2,343,922.87	3,168,848.44	712.91
14GP012	2,344,005.77	3,169,479.44	712.93
14GP013	2,344,006.77	3,169,449.44	712.93
14GP014	2,344,036.77	3,169,437.44	712.93
14GP015	2,344,033.77	3,169,484.44	712.93
14GP016	2,344,073.77	3,169,455.04	712.93
14GP017	2,344,380.70	3,168,260.35	712.86
14GP018	2,344,360.50	3,168,223.35	712.86
14GP019	2,344,060.87	3,168,652.44	712.80
14GP020	2,344,130.77	3,169,453.44	712.93

SURVEY DATA
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

Boring ID	*Corrected Northing*	*Corrected Easting*	*Ground Surface Elevation*
14GP021	2,344,117.39	3,169,622.99	712.93
14GP022	2,344,110.95	3,169,458.25	712.93
14GP023	2,344,009.03	3,168,921.37	712.91
14GP024	2,344,095.56	3,168,731.93	712.91
14GP025	2,344,406.62	3,168,235.34	712.86
14GP026	2,344,293.58	3,168,319.53	712.86
14GP027	2,344,228.87	3,168,227.54	712.86
14GP028	2,344,325.54	3,168,126.98	712.86
14GP029	2,344,028.57	3,168,923.44	712.86
14GP030	2,344,003.57	3,168,924.44	712.86
14GP031	2,343,959.03	3,168,923.37	712.86
14GP032	2,344,004.03	3,168,869.37	712.86
15GP001	2,344,038.67	3,168,536.84	712.91
15GP002	2,344,033.87	3,168,665.44	712.91
15GP003	2,343,985.87	3,168,815.44	712.91
15GP004	2,344,019.87	3,168,815.44	712.91
15GP005	2,344,077.47	3,168,398.94	712.91
15GP006	2,344,089.77	3,168,526.74	712.91
15GP007	2,344,139.67	3,168,666.44	712.91
15GP008	2,343,993.87	3,168,662.64	712.91
15GP009	2,344,108.27	3,168,435.44	712.91
15GP010	2,344,092.47	3,168,817.44	712.91
15GP011	2,344,087.77	3,168,637.64	712.91
15GP012	2,344,100.56	3,167,779.16	712.91
15GP013	2,344,092.77	3,168,651.64	712.91
16GP001	2,344,394.48	3,167,458.83	712.92
16GP002	2,344,376.78	3,167,493.93	712.92
16GP003	2,344,425.40	3,167,493.82	712.91
16GP004	2,344,350.78	3,167,643.63	712.92
16GP005	2,344,296.98	3,167,695.43	712.92
17GP001	2,344,993.71	3,168,000.52	713.00
17GP002	2,344,958.56	3,167,997.57	712.38
17GP003	2,344,843.96	3,168,217.41	712.61
18HA001	2,344,594.49	3,167,672.48	713.33
18HA002	2,344,791.00	3,167,739.00	712.81
18HA003	2,344,791.00	3,167,773.00	712.81
EW-1	2,344,238.48	3,169,261.12	713.00
EW-2	2,344,240.97	3,168,908.96	712.30
EW-3	2,344,267.82	3,169,063.33	713.30
MW - 1	2,344,802.21	3,165,541.14	717.00
MW - 2	2,344,984.16	3,166,077.16	714.00
MW - 3	2,345,132.57	3,166,722.01	713.50
MW - 4	2,344,834.99	3,167,372.42	713.00
MW - 5	2,344,639.13	3,167,685.06	713.77
MW - 6	2,345,038.86	3,167,890.78	710.50
MW - 7	2,344,439.20	3,168,240.95	713.00
MW - 8	2,344,097.56	3,168,754.16	713.00
MW - 9	2,345,487.08	3,168,707.56	711.50

APPENDIX I

DEVELOPMENT OF RBSLS FOR FUEL CONSTITUENTS

MEMORANDUM

DATE: November 22, 1996

TO: Don Walsh

FROM: Anna Jackson and Susan Davis

SUBJECT: RBSLs for AlliedSignal South Bend, Indiana

Risk-based screening levels (RBSLs) for soil were developed for 2-methylnaphthalene, isopropylbenzene, and n-propylbenzene. The RBSLs for 2-methylnaphthalene, isopropylbenzene, and n-propylbenzene are 130 milligrams per kilogram (mg/kg), 3270 mg/kg, and 3270 mg/kg, respectively. The RBSLs were calculated based on IDEM draft guidance (1996a; 1996b) to be protective of groundwater ingestion in the commercial and industrial setting.

Because Federal maximum contaminant levels (MCLs) were not available for these analytes, the following equation was used to calculate the target groundwater level based on commercial/industrial exposure and noncarcinogenic effects (IDEM, 1996a):

$$C_{GWIN} = \frac{THQ \times BW_A \times AT_N \times 365 \ days/year}{EF_I \times ED_I \ (\frac{1}{RFD_O} \times IR_{AIW})}$$

Default values are provided in draft IDEM guidance (1996a).

C_{GWIN} =	acceptable risk based groundwater concentration (milligrams per liter)
THQ =	target hazard quotient (1; unitless)
BW_A =	adult body weight (70 kilograms)
AT_N =	averaging time for noncarcinogenic effects (25 years)
EF_I =	exposure frequency, industrial/commercial (250 days/years)
ED_I =	exposure duration, industrial/commercial (25 years)
RfD_O =	chronic oral reference dose (mg/kg-day). The naphthalene RfD_o was used as a surrogate value for 2-methylnaphthalene (USEPA, 1996). The xylene RfD_o was used as a surrogate value for isopropylbenzene and n-propylbenzene (USEPA, 1996).
IR_{AIW} =	groundwater ingestion rate for adult commercial/industrial worker (1.0 liter/day).

Groundwater RBSL for 2-methylnaphthalene = 4.1 mg/L
Groundwater RBSL for isopropylbenzene and n-propylbenzene = 204.4 mg/L

Soil concentrations were developed based on the acceptable risk-based groundwater concentrations, which were adjusted by a dilution attenuation factor (DAF) of 20. The following equation was used to solve for the screening levels in soil (IDEM, 1996b):

$$C_t = C_{GWIN}(K_{oc} \times f_{oc} + \frac{O_W + O_a \times H'}{P_b})$$

Default values are presented in draft IDEM guidance (1996b).

C_t = screening level in soil (mg/kg)
C_{GWIN} = target groundwater level (x 20 DAF, milligrams per liter)
K_{oc} = soil organic carbon-water partition coefficient (liters per kilogram). K_{oc} for xylene was used as a surrogate value for isopropylbenzene and n-propylbenzene (MADEP, 1994). K_{oc} for 2-methylnaphthalene available from MADEP, 1994.
f_{oc} = organic carbon fraction of soil (0.002, dimensionless)
O_W = water-filled soil porosity (0.3 liters water/liters soil)
O_a = air-filled soil porosity (0.13 liters air/liters soil)
H' = Henry's Law constant (dimensionless). Henry's Law constant for xylene was used as a surrogate value for isopropylbenzene and n-propylbenzene. Henry's Law constant for 2-methylnaphthalene available from MADEP, 1994.
P_b = dry soil bulk density (1.5 kilograms per liter)

References:

Indiana Department of Environmental Management (IDEM), 1996a. Office memorandum Tier I Equations and Exposure Assumptions; prepared by Interoffice Risk Management Team RBCA Tier Technical Action Group (TAG) Indianapolis ID, October 15.

IDEM 1996b, Tier TAG Recommendation for Migration to Groundwater Model for Organic; prepared by Internal Risk Management Team (IRMT), Indianapolis ID, October 8.

Massachusetts Department of Environmental Protection (MADEP), 1994, Background Documentation for the Development of the MCP Numerical Standards, Bureau of Waste Site Cleanup and Office of Research and Standards, April, 1994.

Unites States Environmental Protection Agency, 1996, Integrated Risk Information System (IRIS): on-line database search, October.

MEMORANDUM

DATE: November 10, 1996

TO: Donald A. Walsh

FROM: Gregory A. Beumel

SUBJECT: Calculation of Acceptable Risk-Based TPH Values for Jet Fuel in Soil

Acceptable risk-based TPH levels were calculated for jet fuel in soil. These calculations were performed using the methodology developed by the Massachusetts Department of Environmental Protection Office (1994)[1] and assumed an excavation worker exposure scenario. This scenario assumes 30 days of exposure during one year and no future exposure. Based on these calculations, three risk-based TPH values were determined. The first is for jet fuel that has been "weathered" (i.e., the release occurred sufficiently long ago that the volatile and most semi-volatile organic compounds, including benzene, toluene, ethylbenzene, and xylenes (BETX) have evaporated). The next two are for (1) JP5 or Jet A, and (2) JP4 that have been recently released and still contain the BTEX compounds and other volatile and semi-volatile organic compounds. The results are as follows:

Compound	Risk-Based Level (ppm)
Jet Fuel (weathered)	14,300
JP5 or Jet A	12,000
JP4	6,000

The spreadsheets used to perform the calculations are attached.

[1] Massachusetts Department of Environmental Protection, 1994. "Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter (August, 1994)".

ABB Environmental Services, Inc.
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Table 8

JP-4 Composition from USAir Force and ATSDR

Ref. Interim Final Petroleum Report: Development of Health-Based Alternative to the Total Petroleum Hydrocarbon (TPH) Parameter, (MADEP, August 1994)

Component	Wt %
C4-C8 Alkanes	34.70%
C9-C18 Alkanes	19.20%
Aromatics	7.57%
Benzene	0.50%
Toluene	1.33%
Ethylbenzene	0.37%
Xylenes	2.32%
Naphthalenes	2.90%

TABLE 9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
CONCENTRATION SOIL	CS	chemical-specific	chemical-specific	
INGESTION RATE	IR	480	mg/day	USEPA, 1991
FRACTION INGESTED	FI	100%	unitless	Assumption
ADHERENCE FACTOR	AF	1	mg/cm²-event	USEPA, 1992a
ABSORPTION FRACTION	ABS	chemical-specific	unitless	USEPA, 1992b
SURFACE AREA EXPOSED	SA	5,750	cm²	USEPA, 1992a
DOSE ABSORBED PER EVENT	DAevent	chemical-specific	mg/cm2-event	USEPA, 1992a
CONVERSION FACTOR	CF	1.00E-09	kg/ug	Organic conversion
CONVERSION FACTOR	CF	1.00E-06	kg/mg	Inorganic conversion
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE FREQUENCY	EF	30	days/year [1]	Assumption
EXPOSURE DURATION	ED	1	years	USEPA, 1991
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	1	years	USEPA, 1991

[1] Units for exposure frequency are events/year in the calculation of the dermally absorbed dose.

USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors"; OSWER Directive 9285.6-03.

USEPA, 1992a. Dermal Exposure Assessment: Principles and Applications; EPA/600/8-91/011B; January 1992.

USEPA, 1992b. USEPA Region IV Guidance Memorandum; February 10, 1992.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x CANCER SLOPE FACTOR (mg/kg-day)-1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / REFERENCE DOSE (mg/kg-day)

$$\text{INTAKE-INGESTION} = \frac{CS \times IR \times FI \times CF \times EF \times ED}{BW \times AT \times 365\ \text{days/yr}}$$

$$\text{INTAKE-DERMAL} = \frac{DAevent \times SA \times EF \times ED}{BW \times AT \times 365\ \text{days/year}}$$

Where:

$$DAevent = CS \times AF \times ABS \times CF$$

Notes: For noncarcinogenic effects, AT = ED

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TABLE 9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL CSF (mg/kg-day)^-1	CANCER RISK INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL CSF [2] (mg/kg-day)^-1	CANCER RISK DERMAL	TOTAL CANCER RISK
TPH Concentration	o	6,000,000	ug/kg	4.8E-05			0.01	5.8E-06			
Aromatics/Alkenes (9.66%)	o	579,600	ug/kg	4.7E-06			0.01	5.6E-07			
Alkanes	o										
C4-C8 (34.70%)	o	2,082,000	ug/kg	1.7E-05			0.01	2.0E-06			
C9-C18 (19.20%)	o	1,152,000	ug/kg	9.3E-06			0.01	1.1E-06			
C19-C36 (0%)	o	0									
Benzene (0.50%)	o	30,000	ug/kg	2.4E-07	0.029	7.0E-09	0.01	2.9E-08	0.029	8.4E-10	7.8E-09
Toluene (1.33%)	o	79,800	ug/kg	6.4E-07			0.01	7.7E-08			
Ethylbenzene (0.37%)	o	22,200	ug/kg	1.8E-07			0.01	2.1E-08			
Xylenes (2.32%)	o	139,200	ug/kg	1.1E-06			0.01	1.3E-07			
	o										
	o										
SUMMARY CANCER RISK						7E-09				8E-10	8E-09

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (February 10, 1992).
[2] Calculated from Oral CSFs.
NE = not evaluated.

TABLE 9

DIRECT CONTACT WITH AND INCIDENTAL INGESTION OF SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	INTAKE INGESTION (mg/kg-day)	ORAL RfD (mg/kg-day)	HAZARD QUOTIENT INGESTION	DERMAL ABS [1]	INTAKE DERMAL (mg/kg-day)	DERMAL RfD [2] (mg/kg-day)	HAZARD QUOTIENT DERMAL	TOTAL HAZARD QUOTIENT
TPH Concentration	o	6,000,000	ug/kg	3.4E-03			0.01	4.1E-04			
Aromatics/Alkenes (9.66%)	o	579,600	ug/kg	3.3E-04	0.03	1.1E-02	0.01	3.9E-05	0.03	1.3E-03	1.2E-02
Alkanes	o										
C4-C8 (34.70%)	o	2,082,000	ug/kg	1.2E-03	0.06	2.0E-02	0.01	1.4E-04	0.06	2.3E-03	2.2E-02
C9-C18 (19.20%)	o	1,152,000	ug/kg	6.5E-04	0.6	1.1E-03	0.01	7.8E-05	0.6	1.3E-04	1.2E-03
C19-C36 (0%)	o	0			6				6		
Benzene (0.50%)	o	30,000	ug/kg	1.7E-05	0.0003	5.6E-02	0.01	2.0E-06	0.0003	6.8E-03	6.3E-02
Toluene (1.33%)	o	79,800	ug/kg	4.5E-05	2	2.2E-05	0.01	5.4E-06	2	2.7E-06	2.5E-05
Ethylbenzene (0.37%)	o	22,200	ug/kg	1.3E-05	0.01	1.3E-03	0.01	1.5E-06	0.082	1.8E-05	1.3E-03
Xylenes (2.32%)	o	139,200	ug/kg	7.8E-05	2	3.9E-05	0.01	9.4E-06	2	4.7E-06	4.4E-05
SUMMARY HAZARD INDEX						9E-02				1E-02	1.0E-01

[1] USEPA Region IV guidance specifies absorption factors of 1% for organics and 0.1% for inorganics (February 10, 1992).
[2] Calculated from Oral RfDs.
ND = no data available.

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TABLE 10

INHALATION OF PARTICULATES - SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
SOIL CONCENTRATION	C	chemical-specific	chemical-specific	
PART. EMISSION FACTOR	PEF	5.00E+07	m^3/kg	[1]
CONCENTRATION AIR	CA	chemical-specific	mg/m^3	
INHALATION RATE	IR	2.5	$m^3/hour$	USEPA, 1995
BODY WEIGHT	BW	70	kg	USEPA, 1991
EXPOSURE TIME	ET	8	hours/day	Assumption
EXPOSURE FREQUENCY	EF	30	days/year	Assumption
EXPOSURE DURATION	ED	1	years	Assumption
CONVERSION FACTOR	CF	0.001	mg/ug	Organics only
AVERAGING TIME				
CANCER	AT	70	years	USEPA, 1991
NONCANCER	AT	1	years	USEPA, 1991

[1] PEF has been derived in Appendix A to this report.
USEPA, 1991. Human Health Evaluation Manual, Supplemental Guidance:
"Standard Default Exposure Factors"; OSWER Directive 9285.6-03.
USEPA, 1995. Supplemental Guidance to RAGS : Region IV, Human Health Risk Assessment Bulletin No. 3.

EQUATIONS

CANCER RISK = INTAKE (mg/kg-day) x INHALATION CANCER SLOPE FACTOR (mg/kg-day) -1

HAZARD QUOTIENT = INTAKE (mg/kg-day) / INHALATION REFERENCE DOSE (mg/kg-day)

$$INTAKE = \frac{CA \times IR \times ET \times EF \times ED}{BW \times AT \times 365\ days/yr}$$

Where:

$CA = C \times CF \times (1/PEF)$

Note: For noncarcinogenic effects, AT = ED

TABLE 10

INHALATION OF PARTICULATES - SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

CARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION [1]	UNITS	AIR CONCENTRATION (mg/m³)	INTAKE (mg/kg-day)	INHALATION CSF (mg/kg-day)^-1	CANCER RISK
TPH Concentration	O	6,000,000	ug/kg	1.20E-04	4.0E-08		
Aromatics/Alkenes (9.66%)	O	579,600	ug/kg	1.16E-05	3.9E-09		
Alkanes	O						
C4-C8 (34.70%)	O	2,082,000	ug/kg	4.16E-05	1.4E-08		
C9-C18 (19.20%)	O	1,152,000	ug/kg	2.30E-05	7.7E-09		
C19-C36 (0%)	O	0					
Benzene (0.50%)	O	30,000	ug/kg	6.00E-07	2.0E-10	0.029	5.8E-12
Toluene (1.33%)	O	79,800	ug/kg	1.60E-06	5.4E-10		
Ethylbenzene (0.37%)	O	22,200	ug/kg	4.44E-07	1.5E-10		
Xylenes (2.32%)	O	139,200	ug/kg	2.78E-06	9.3E-10		
NE = not evaluated.				SUMMARY CANCER RISK			6E-12

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TABLE 10

INHALATION OF PARTICULATES - SUBSURFACE SOIL
EXCAVATION WORKER
ALLIED
SOUTH BEND, IN
CALCULATION OF RISK-BASED TPH LEVELS FOR JP-4 (based on Air Force/ATSDR composition)

NONCARCINOGENIC EFFECTS

COMPOUND	INORGANIC OR ORGANIC I/O	SOIL CONCENTRATION	UNITS	AIR CONCENTRATION (mg/m^3)	INTAKE (mg/kg-day)	INHALATION RfD (mg/kg-day)	HAZARD QUOTIENT
TPH Concentration	O	6,000,000	ug/kg	1.20E-04	2.8E-06		
Aromatics/Alkenes (9.66%)	O	579,600	ug/kg	1.16E-05	2.7E-07	400	6.8E-10
Alkanes	O						
C4-C8 (34.70%)	O	2,082,000	ug/kg	4.16E-05	9.8E-07		
C9-C18 (19.20%)	O	1,152,000	ug/kg	2.30E-05	5.4E-07		
Benzene (0.50%)	O	30,000	ug/kg	6.00E-07	1.4E-08		
Toluene (1.33%)	O	79,800	ug/kg	1.60E-06	3.7E-08	400	9.4E-11
Ethylbenzene (0.37%)	O	22,200	ug/kg	4.44E-07	1.0E-08	1000	1.0E-11
Xylenes (2.32%)	O	139,200	ug/kg	2.78E-06	6.5E-08		
				SUMMARY HAZARD INDEX			8E-10

ND = no data available.

ABB M E M O R A N D U M

DATE: 1/24/97

TO: Don Walsh

FROM: A. J. Lonergan

SUBJECT: Background Metals and Cyanide
Voluntary Site Investigation, AlliedSignal Industrial Complex
South Bend, Indiana

This memorandum summarizes the actions taken to develop background concentrations for metals and cyanide in soils at the AlliedSignal Industrial Complex, South Bend, Indiana. A summary of the background data is presented in Table 4-6 of the Voluntary Site Investigation (VSI) report.

In selecting locations for background soil sample collection, facility history and aerial photographs were reviewed. The majority of the facility's available property is currently or has been used for manufacturing operations in the past. Areas which have not been used for manufacturing or associated operations are located primarily along the facility's southern perimeter and in the northwestern portion of the property. Locations along the southern perimeter were not selected as background sampling locations because of proximity to the railroad. The area chosen for background soil sample collection was located in the northwestern part of the AlliedSignal facility, north of the Carbon Brake building. The area was formerly used as a baseball field until it was covered by a parking lot during expansion of the Carbon Brake building (see Figure 5-6 in the VSI report).

A total of seven soil samples were collected from the area north of the Carbon Brake building. The collected samples consisted primarily of sands. The collection of background samples representative of the variability in soil types observed during the VSI (i.e., sands, silty sands, and clayey silts) could not be obtained because of the limited number of locations available for background soil sampling. Background soil sample collection was performed in accordance with the project's Quality Assurance Project Plan (QAPP). Soil samples were submitted for Level 3 laboratory analysis of inorganics in accordance with the QAPP.

Laboratory analytical results for the selected background soil samples are presented in Table 1 (attached to this memorandum). Descriptive statistics were developed for each of the inorganic analytes. These statistics are presented in Attachment I to this memorandum. Four metals (cadmium, lead, mercury, and selenium) were not detected in the background soil samples. For these metals, the detection limit was used in the site-specific column for soil on Table 4-6 of the VSI report. For the remaining analytes, the standard deviation of the constituent was multiplied by three (3) and then added to the mean of the constituent to calculate the maximum background value. This value was used in the site-specific column for soil on Table 4-6 of the VSI.

Calculation of maximum background values using the above method assumes that the population is normally distributed; therefore, further statistical analysis was completed on the data to evaluate the distributions of detected analytes. This analysis consisted of completing histograms and box and whisker plots. These outputs are provided in Attachment II. As can be seen from the histograms, nickel's distribution most closely approximates a normal distribution, but none of data are normally distributed. The box and whisker plots indicate that some outside values are present for arsenic and chromium. These values are within the expected typical background for the soil types present at the facility, and it was

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therefore concluded that their identification as outside values resulted for the limited size of the data set and the limited variance among the other detected concentrations.

In general, as can be seen in Table 4-6 of the VSI, the site-specific background values for inorganics in soils are much lower (an order of magnitude in several cases) than those typically expected for the types of soils present at the facility. It is probable that the lower site-specific numbers are the result of a limited amount of fines in the soil samples used in the background data set. Samples designated as background were collected from an area were the soils samples were relatively sandy. Soils at the facility are more variable than those included in the background data set, typically containing a greater percentage of fine sediments (i.e., silts and clays). Fine sediments generally have a higher amount of metals.

Table 1
Background Soil Sampling Results - Inorganics
Voluntary Site Investigation
AlliedSignal Industrial Complex, South Bend, Indiana

CONSTITUENENT: (Units in mg/kg)	SITE: DATE: DEPTH (ft):	11GP003 10/4/96 4	11GP003 10/4/96 8	11GP003 10/4/96 12	11GP004 10/4/96 4	11GP004 10/4/96 9	11GP007 10/5/96 8	11GP007 10/5/96 12	11GP007 10/5/96 15
Arsenic, Total		1.6	0.4	2.5	1	0.7	<0.25	0.92	1.5
Barium, Total		5.3	3	10	4.4	7.9	3.7	6.6	5.9
Cadmium, Total		<1	<1	<1	<1	<1	<1	<1	<1
Chromium, Total		<5	<5	5.5	5	19	<5	<5	<5
Copper, Total		3.8	3	6.4	5.3	5	2.4	6	4.2
Lead, Total		<5	<5	<5	<5	<5	<5	<5	<5
Mercury, Total		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel, Total		4.4	2.7	6.9	4.4	4.5	2.9	4.6	4.6
Selenium, Total		<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver, Total		<1	<1	2.2	<1	<1	<1	<1	<1
Zinc, Total		12	6.9	22	13	15	8	16	18

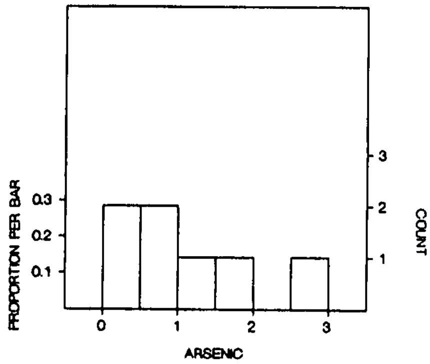
TOTAL OBSERVATIONS: 7

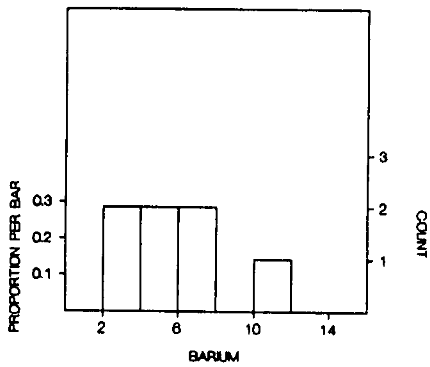
	ARSENIC	BARIUM	CADMIUM	CHROMIUM	COPPER
N OF CASES	7	7	7	7	7
MINIMUM	0.125	3.000	0.500	2.500	2.400
MAXIMUM	2.500	10.000	0.500	19.000	6.400
RANGE	2.375	7.000	0.000	16.500	4.000
MEAN	1.035	5.843	0.500	5.286	4.557
VARIANCE	0.637	6.190	0.000	37.821	2.313
STANDARD DEV	0.798	2.488	0.000	6.150	1.521
STD. ERROR	0.302	0.940	0.000	2.324	0.575
SKEWNESS(G1)	0.805	0.526	0.000	1.913	-0.230
KURTOSIS(G2)	-0.333	-0.931	0.000	1.849	-1.398
SUM	7.245	40.900	3.500	37.000	31.900
C.V.	0.771	0.426	0.000	1.163	0.334
MEDIAN	0.920	5.300	0.500	2.500	5.000
Nof BDL	1	0	7	5	0
Max Background	3.429	13.307	ALL BDL	23.736	9.12

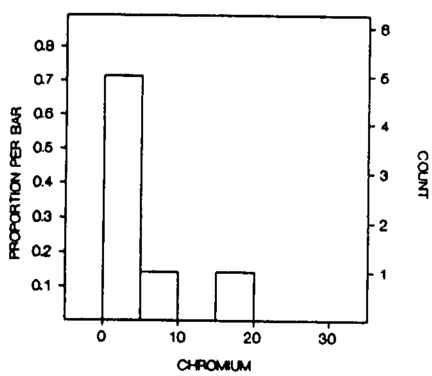
	LEAD	MERCURY	NICKEL	SELENIUM	SILVER
N OF CASES	7	7	7	7	7
MINIMUM	2.500	0.050	2.700	0.250	0.500
MAXIMUM	2.500	0.050	6.900	0.250	2.200
RANGE	0.000	0.000	4.200	0.000	1.700
MEAN	2.500	0.050	4.343	0.250	0.743
VARIANCE	0.000	0.000	1.903	0.000	0.413
STANDARD DEV	0.000	0.000	1.379	0.000	0.643
STD. ERROR	0.000	0.000	0.521	0.000	0.243
SKEWNESS(G1)	0.000	0.000	0.638	0.000	2.041
KURTOSIS(G2)	0.000	0.000	-0.080	0.000	2.167
SUM	17.500	0.350	30.400	1.750	5.200
C.V.	0.000	0.000	0.318	0.000	0.865
MEDIAN	2.500	0.050	4.400	0.250	0.500
Nof BDL	7	7	0	7	6
Max Background	ALL BDL	ALL BDL	8.48	ALL BDL	2.672

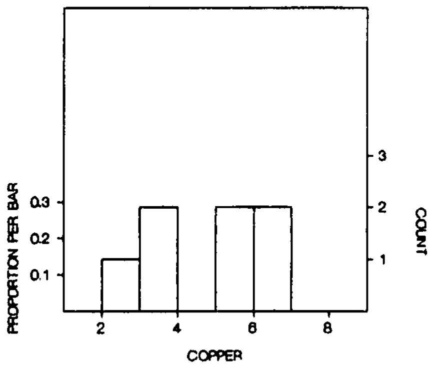
	ZINC
N OF CASES	7
MINIMUM	6.900
MAXIMUM	22.000
RANGE	15.100
MEAN	13.271
VARIANCE	26.116
STANDARD DEV	5.110
STD. ERROR	1.932
SKEWNESS(G1)	0.382
KURTOSIS(G2)	-0.636
SUM	92.900
C.V.	0.385
Nof BDL	0
Max Background	28.601

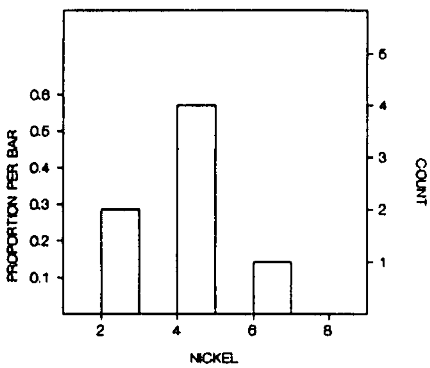
Distribution of values:

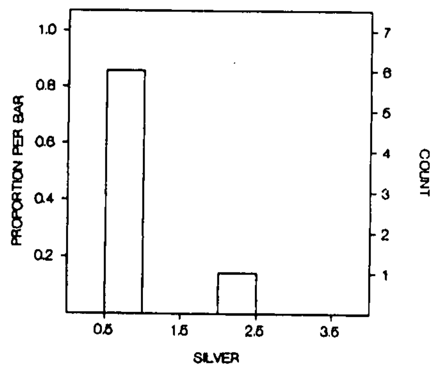




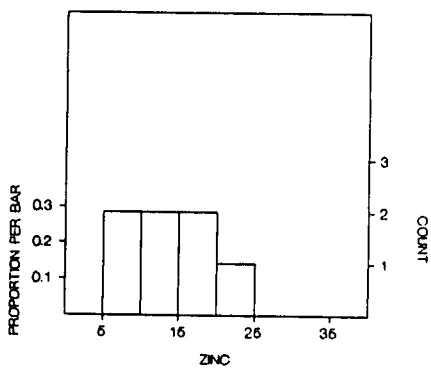



PROPORTION PER BAR
0.1
0.2
0.3
COUNT
1
2
3
2
4
6
8
COPPER


PROPORTION PER BAR
0.1
0.2
0.3
0.4
0.5
0.6
COUNT
1
2
3
4
5
2
4
6
8
NICKEL

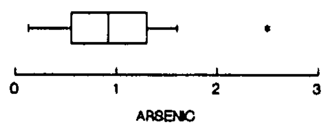


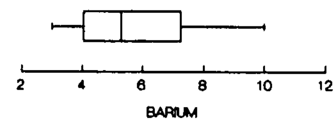
1.0
0.8
0.6
0.4
0.2
PROPORTION PER BAR
7
6
5
4
3
2
1
COUNT
0.5
1.5
2.5
3.5
SILVER



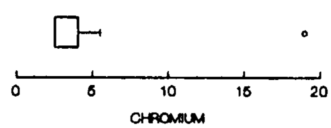
0.3
0.2
0.1
PROPORTION PER BAR
3
2
1
COUNT
5
15
25
35
ZINC

Distribution of arsenic values

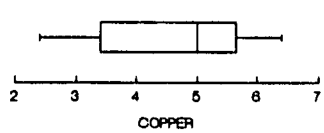




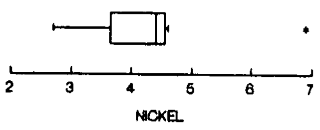
Distribution of barium values



Distribution of chromium values



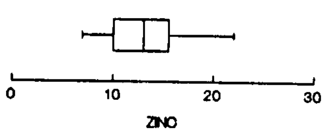
Distribution of copper values



Distribution of nickel values

only hit

Distribution of silver values

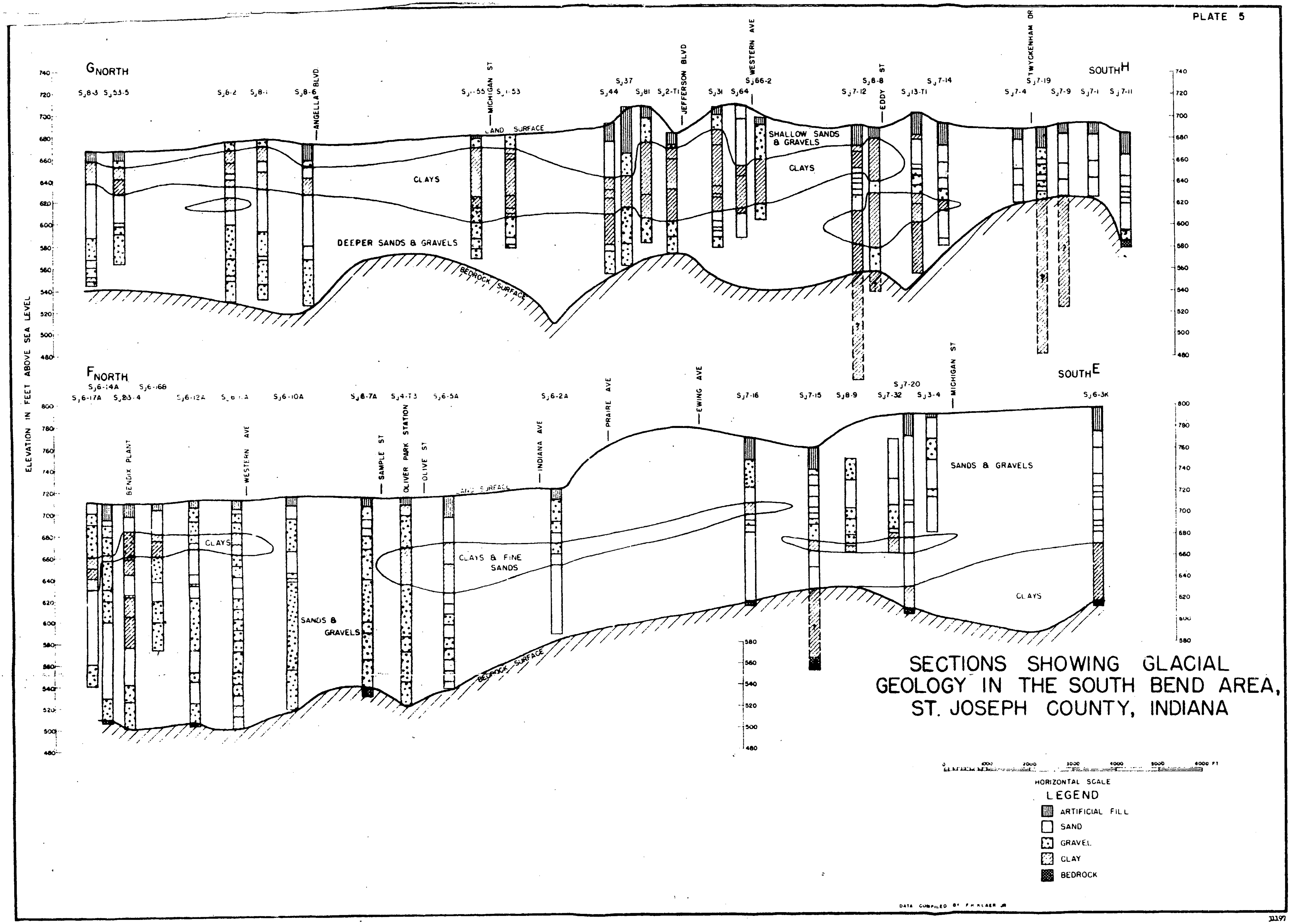


Distribution of zinc values

LABORATORY DATA QUALIFIERS
VOLUNTARY SITE INVESTIGATION
AlliedSignal Industrial Complex - South Bend, Indiana

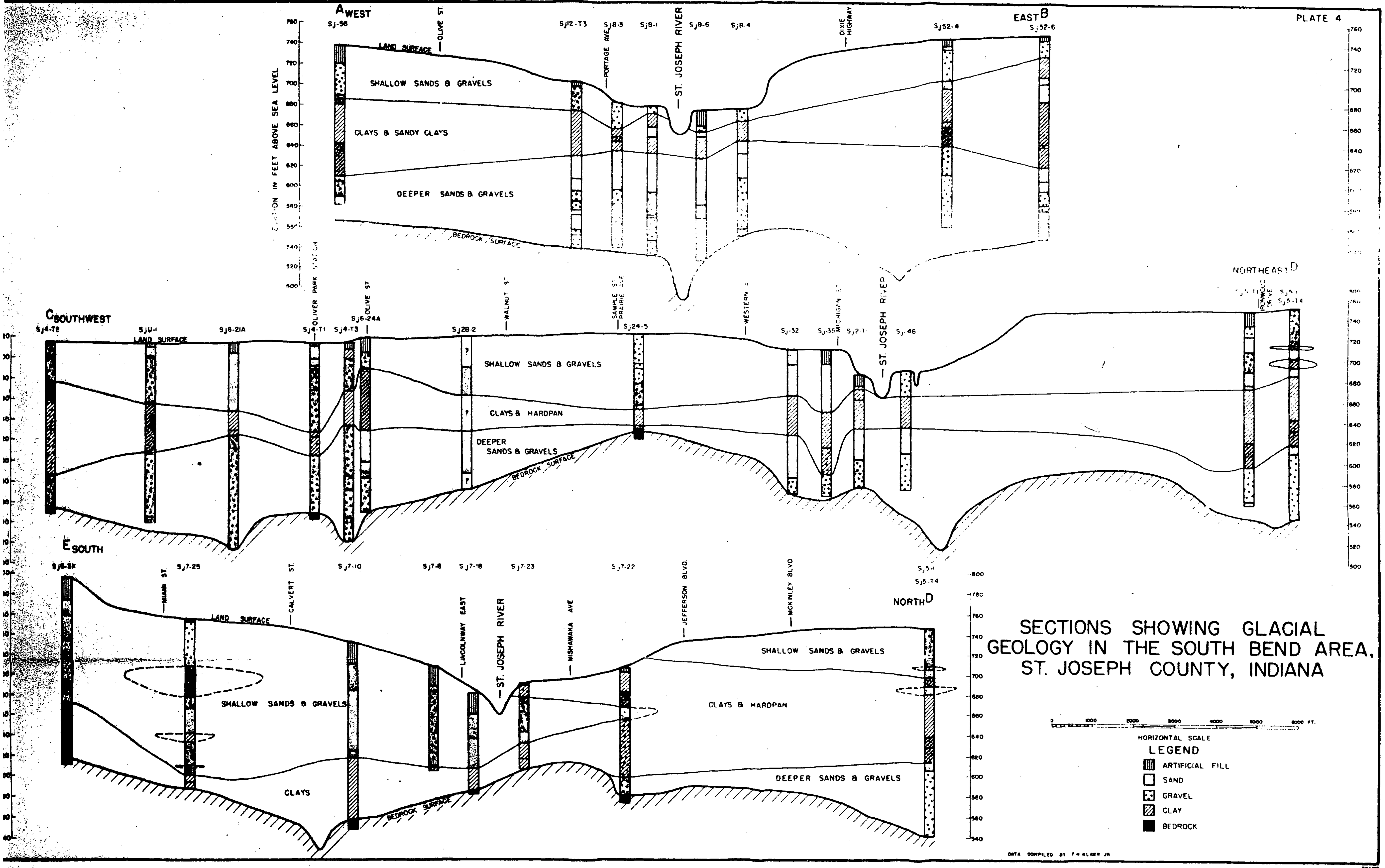
J	- Estimated value
P	- Possible interference may have affected the accuracy
I	- Interference resulted in elevated reporting limits
*	- Duplicate RPD not within control limits
E	- Approximate value

PLATE 5

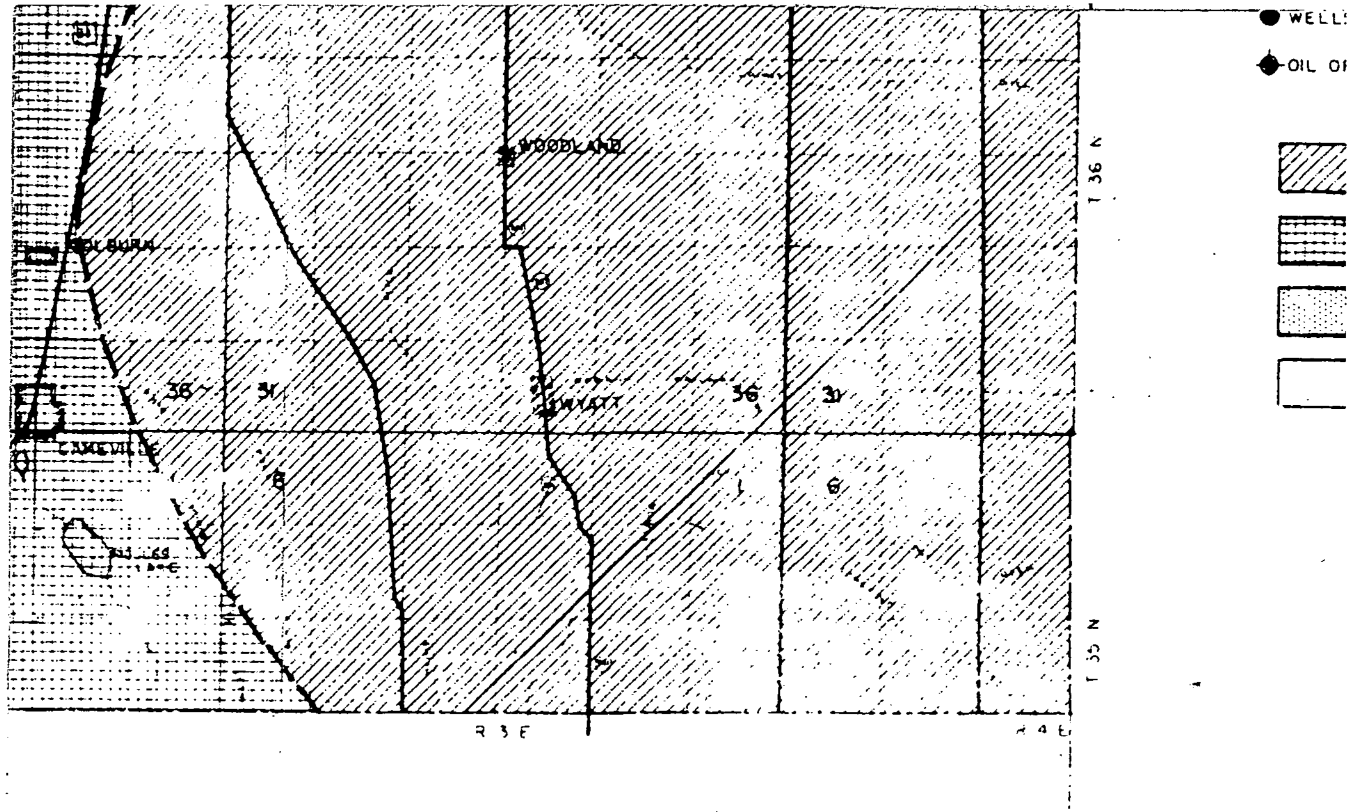


SECTIONS SHOWING GLACIAL GEOLOGY IN THE SOUTH BEND AREA, ST. JOSEPH COUNTY, INDIANA

PLATE 4



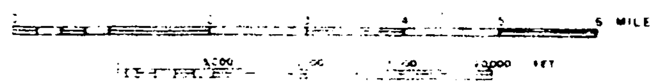
SECTIONS SHOWING GLACIAL GEOLOGY IN THE SOUTH BEND AREA, ST. JOSEPH COUNTY, INDIANA

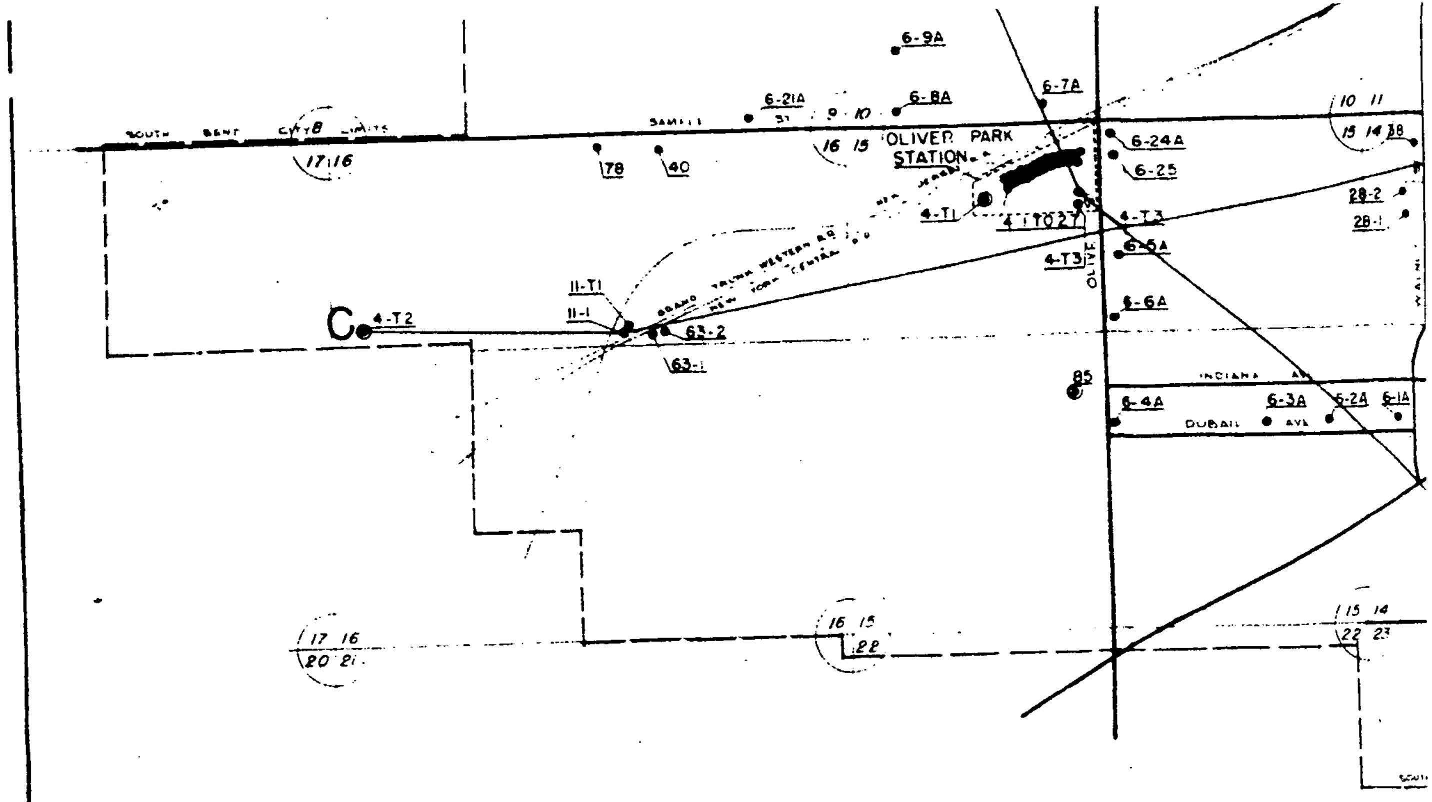


MAP OF

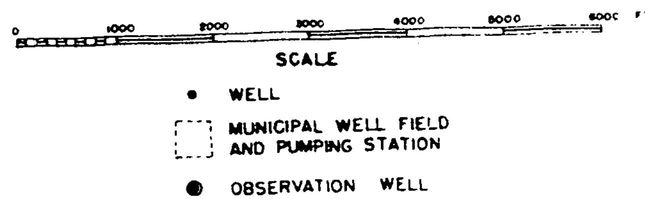
ST. JOSEPH COUNTY, INDIANA

SHOWING GLACIAL GEOLOGY AND LOCATIONS OF WELLS



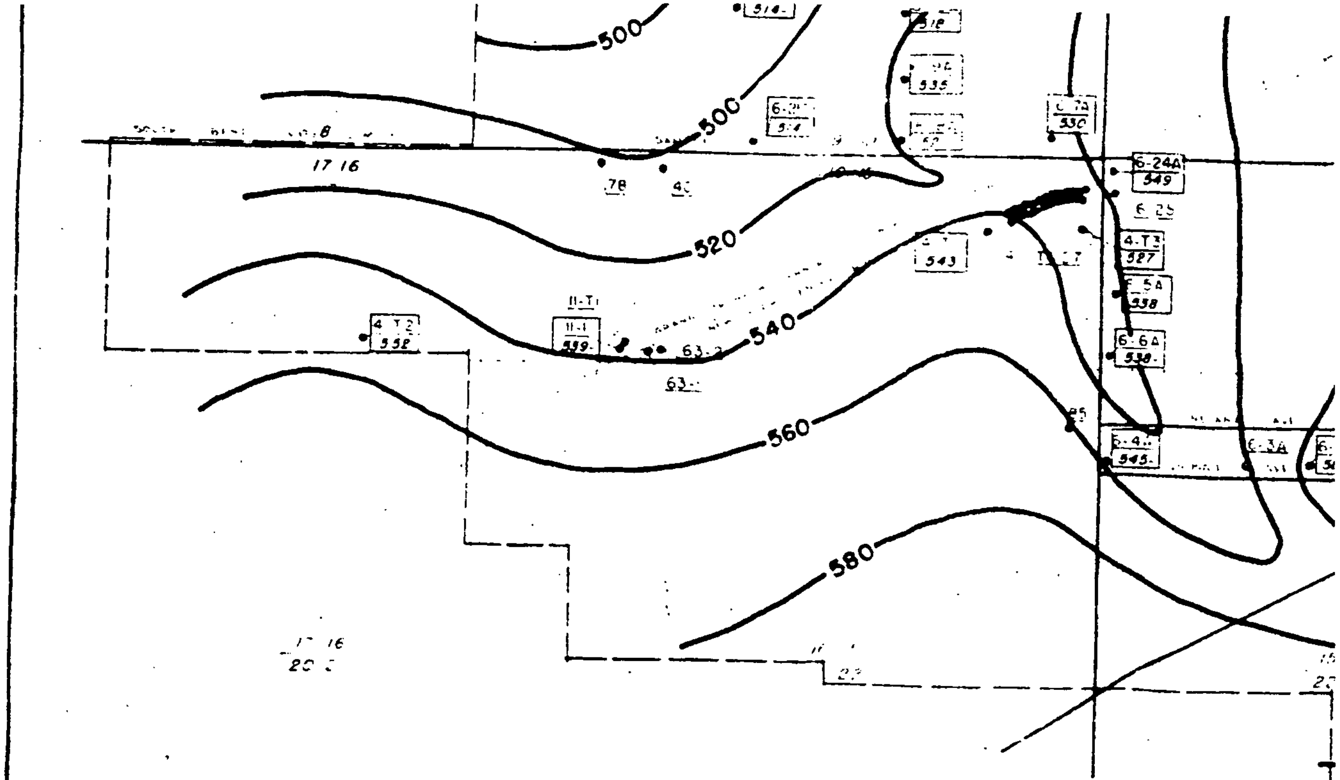


MAP OF
SOUTH BEND, ST. JOSEPH COUNTY, INDIANA
SHOWING LOCATIONS OF WELLS AND OF GEOLOGIC CROSS SECTIONS



22 23
27 26

BASE MAP FROM C.E WILLIAMS CITY ENGINEER 1942



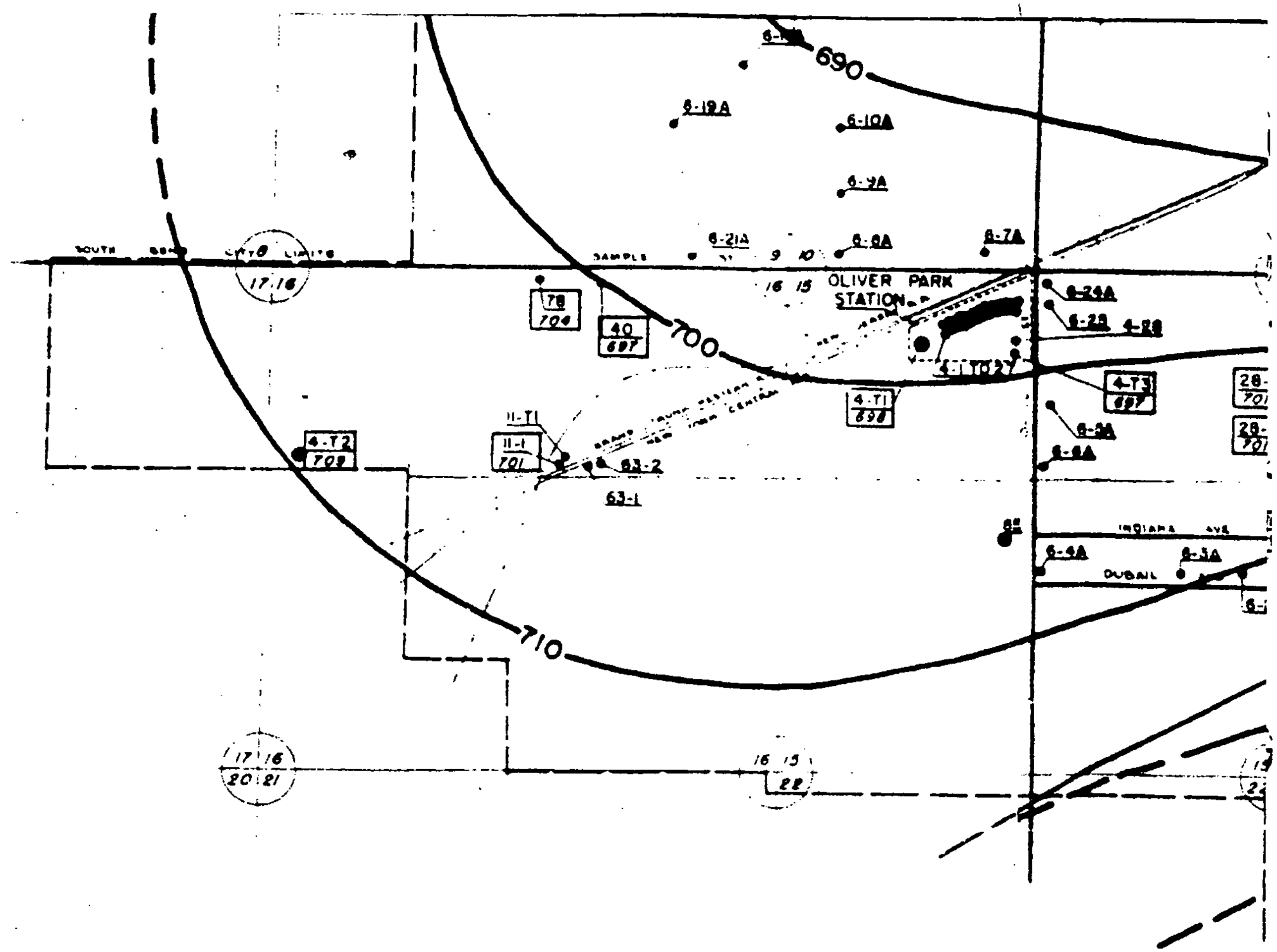
MAP OF

SOUTH BEND, ST. JOSEPH COUNTY, INDIANA

SHOWING CONTOURS OF THE BEDROCK SURFACE

SCALE

CONTOUR INTERVAL 20 FEET



MAP OF

SOUTH BEND, ST. JOSEPH COUNTY, INDIANA

SHOWING THE CONTOURS OF THE PIEZOMETRIC SURFACE -1945

0 1000 2000 3000 4000

SCALE

• WELL

MUNICIPAL WELL FIELD AND PUMPING STATION

● OBSERVATION WELL

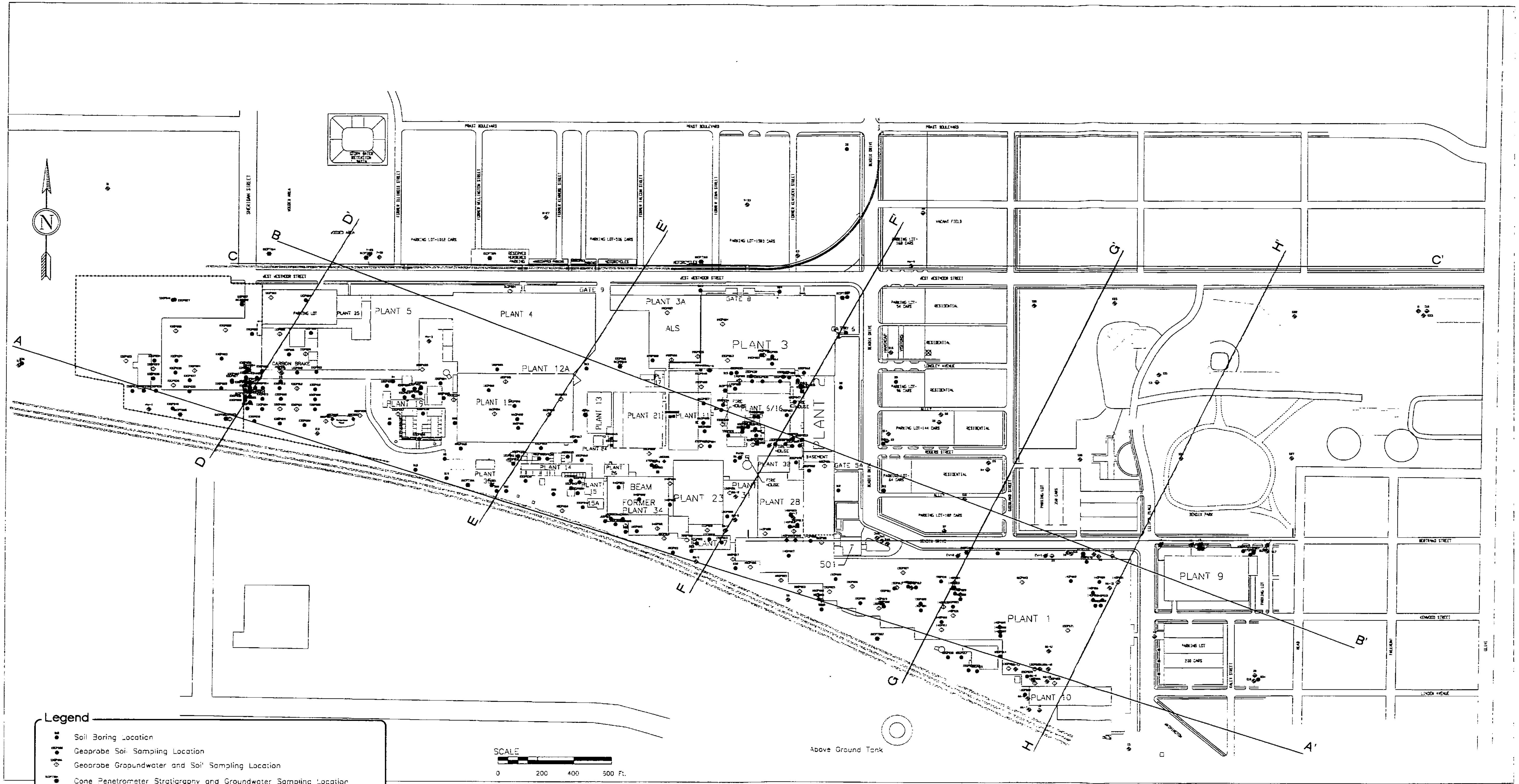
28-1 / 701 WELL NUMBER / ELEVATION OF THE WATER LEVEL

CONTOUR

LIMITS OF AREA OF DIVERSION WITHIN 700-FOOT CONTOUR

APPENDIX M

GEOLOGIC CROSS-SECTIONS

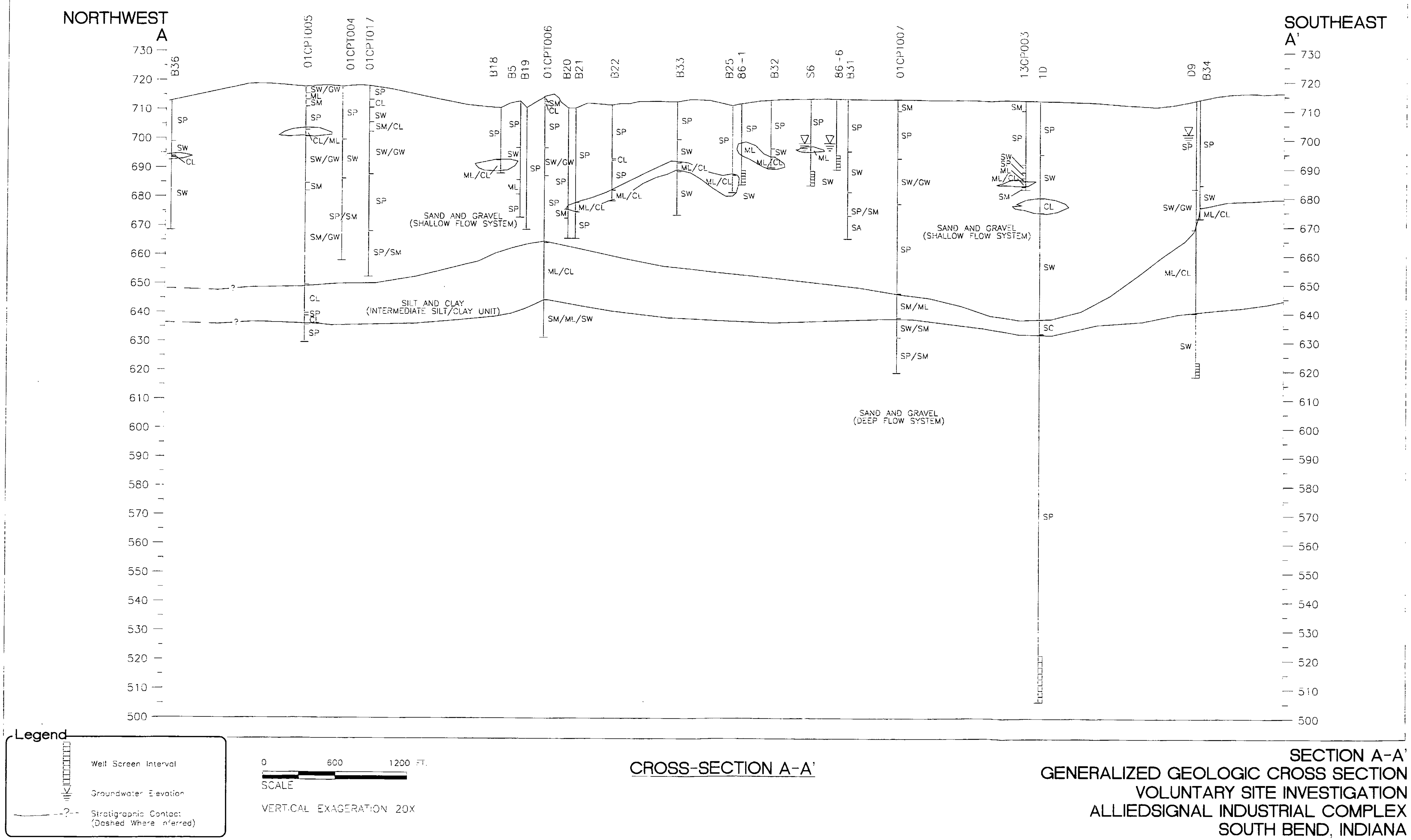


Legend
- Soil Boring Location
- Geoprobe Soil Sampling Location
- Geoprobe Groundwater and Soil Sampling Location
- Cone Penetrometer Stratigraphy and Groundwater Sampling Location
- Sediment Sampling Location
- Shallow Monitoring Well Location
- Intermediate Monitoring Well Location (50 to 100 feet, shallow flow system)
- Deep Monitoring Well Location
- Recovery Well Location
- A ____ A' Geologic Cross Section Location

GEOLOGIC CROSS SECTION LOCATION MAP
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

ABB Environmental Services, Inc.

C:\ALLIED\FIGS\9822F019.DWG



CROSS-SECTION A-A'

SECTION A-A'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
ABB Environmental Services, Inc.

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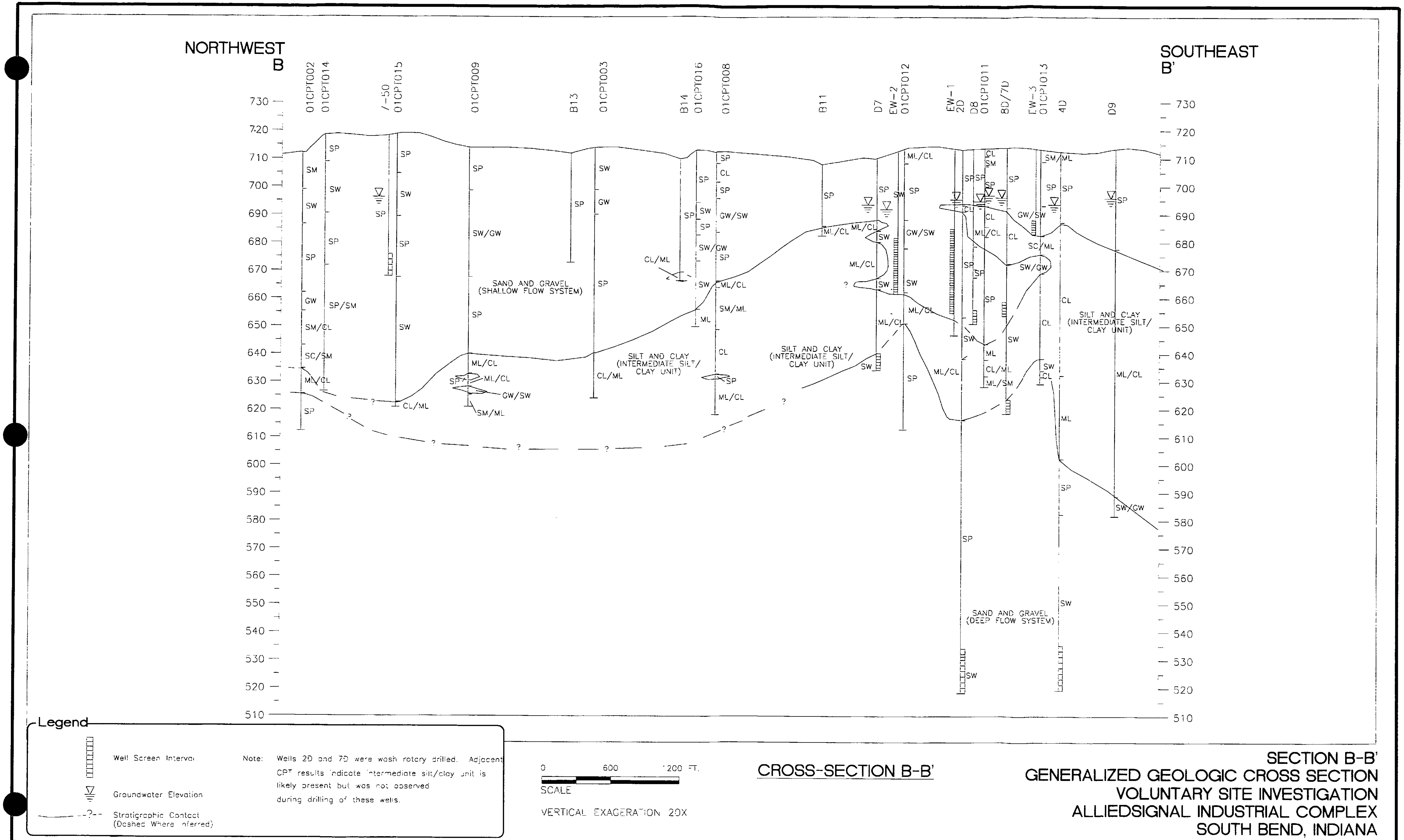
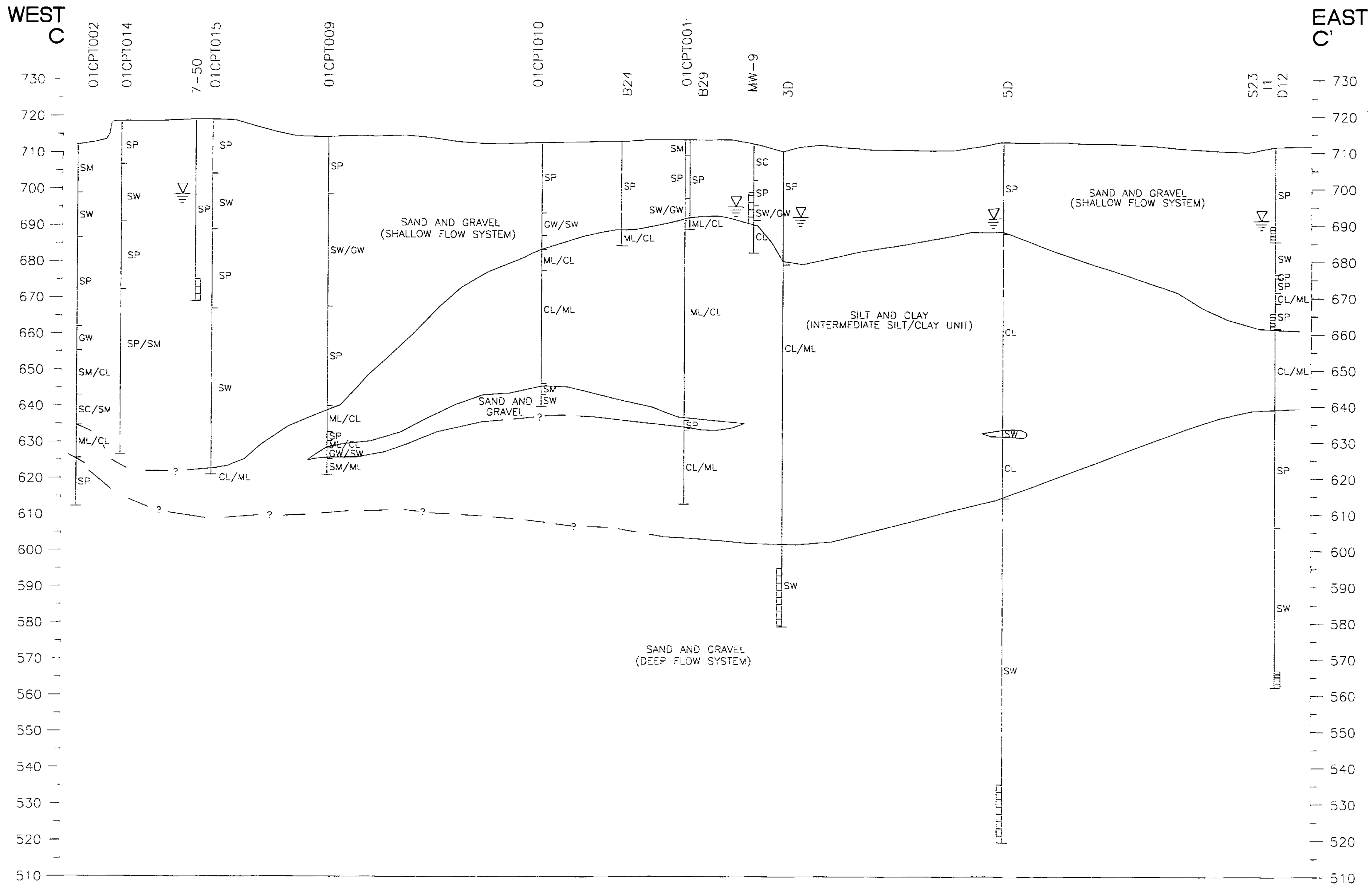


CROSS-SECTION B-B'

SECTION B-B'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTBB.DWG | Drawn: EJL | Rev: 11/3/97 Chk: SDM



Legend

Well Screen Interval

Groundwater Elevation

Stratigraphic Contact (Dashed Where Inferred)

0 500 1200 FT.

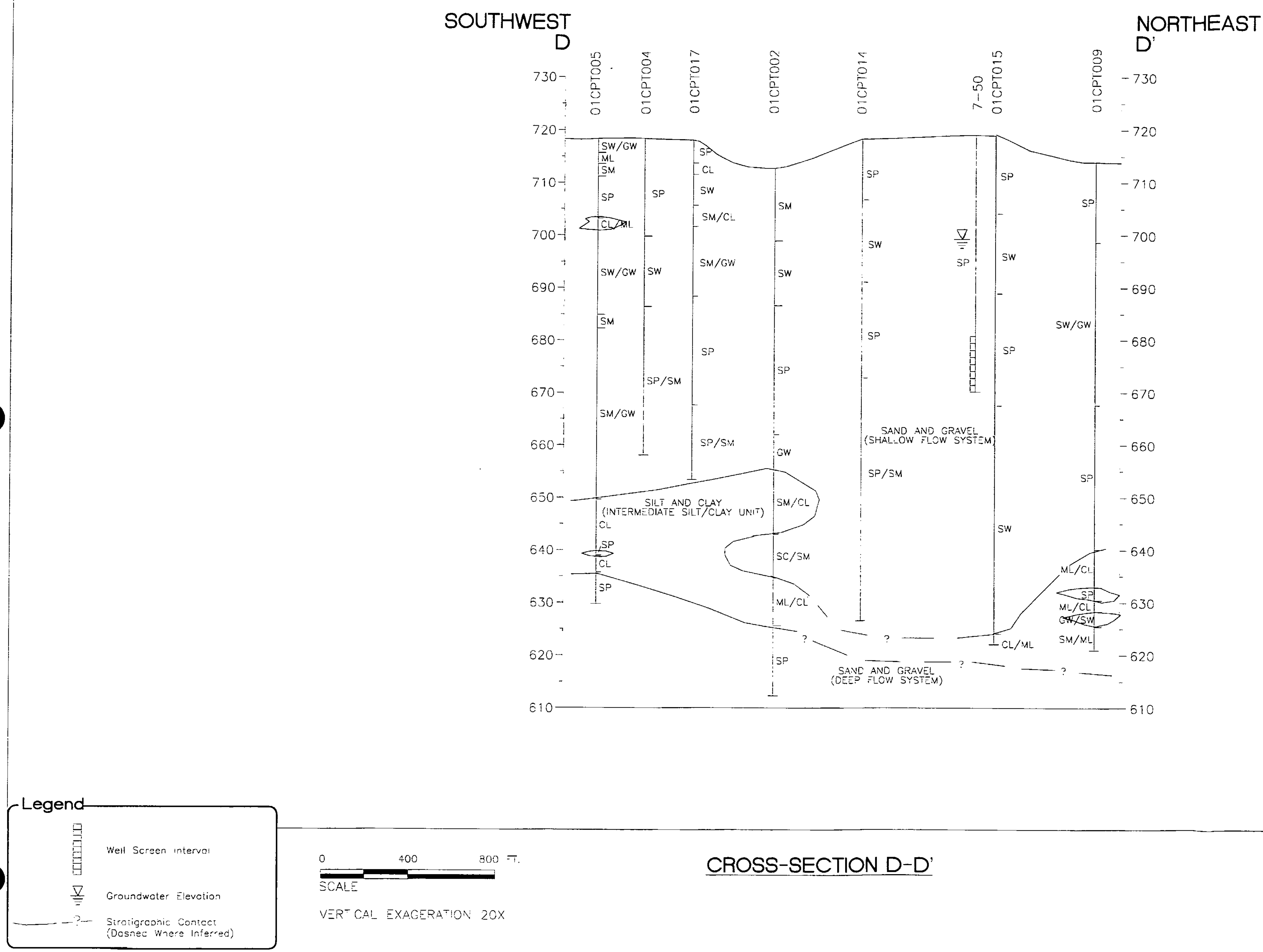
SCALE

VERTICAL EXAGERATION 20X

CROSS-SECTION C-C'

SECTIONC-C'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTCC.DWG Drawn: EJL Rev: 11/3/97 Chk: SDM



CROSS-SECTION D-D'

SECTION D-D'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTDD.DWG | Drawn: EJL | Rev: 11/3/97 | Chk: SDM

Legend

Stratigraphic Contact (Dashed Where Inferred)

0 300 600 FT
SCALE

VERTICAL EXAGERATION 20X

CROSS-SECTION E-E'

SECTION E-E'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

ABB Environmental Services, Inc.

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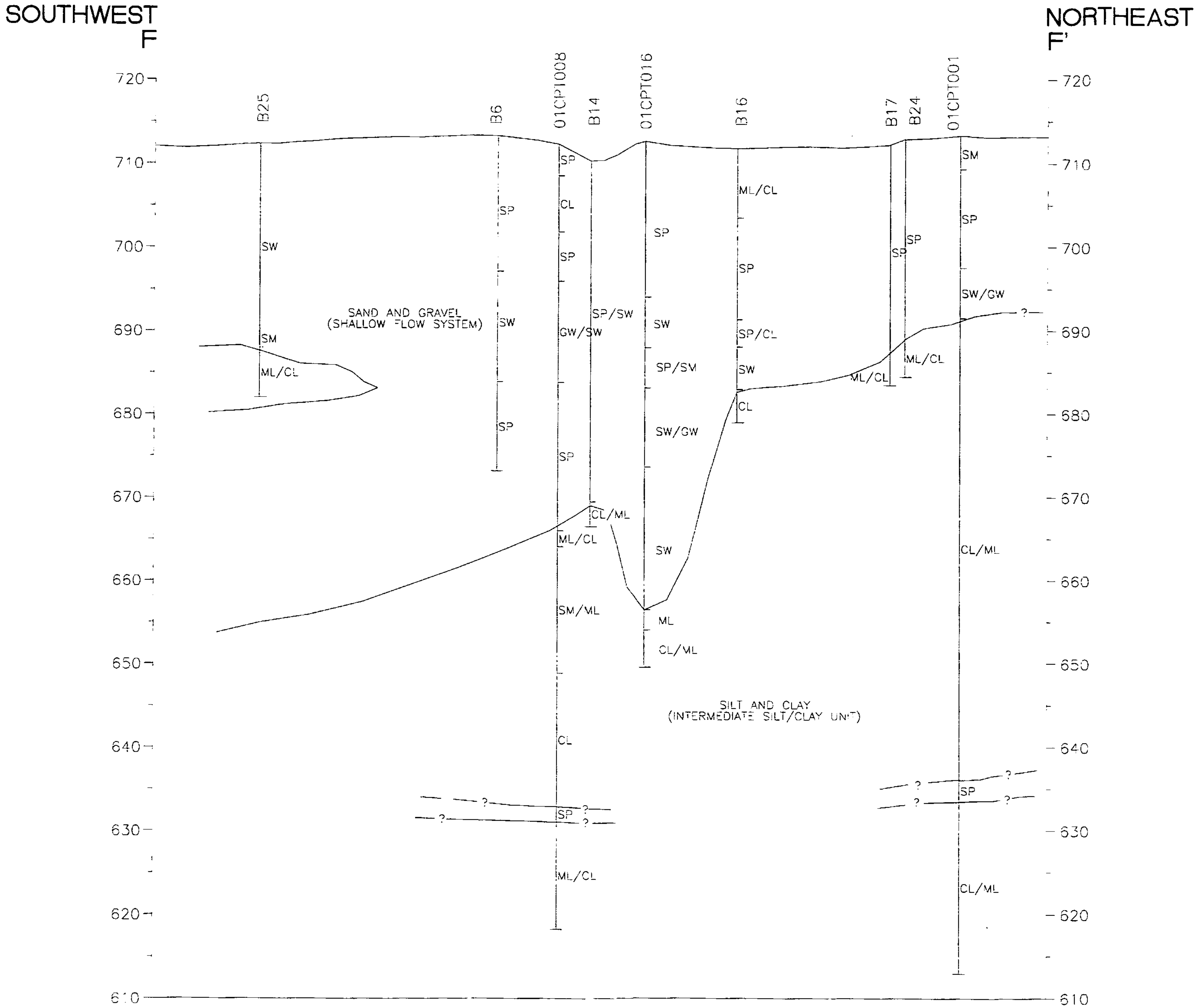


Legend

——— --?-- Stratigraphic Contact (Dashed Where Inferred)

0 600 1200 FT
SCALE

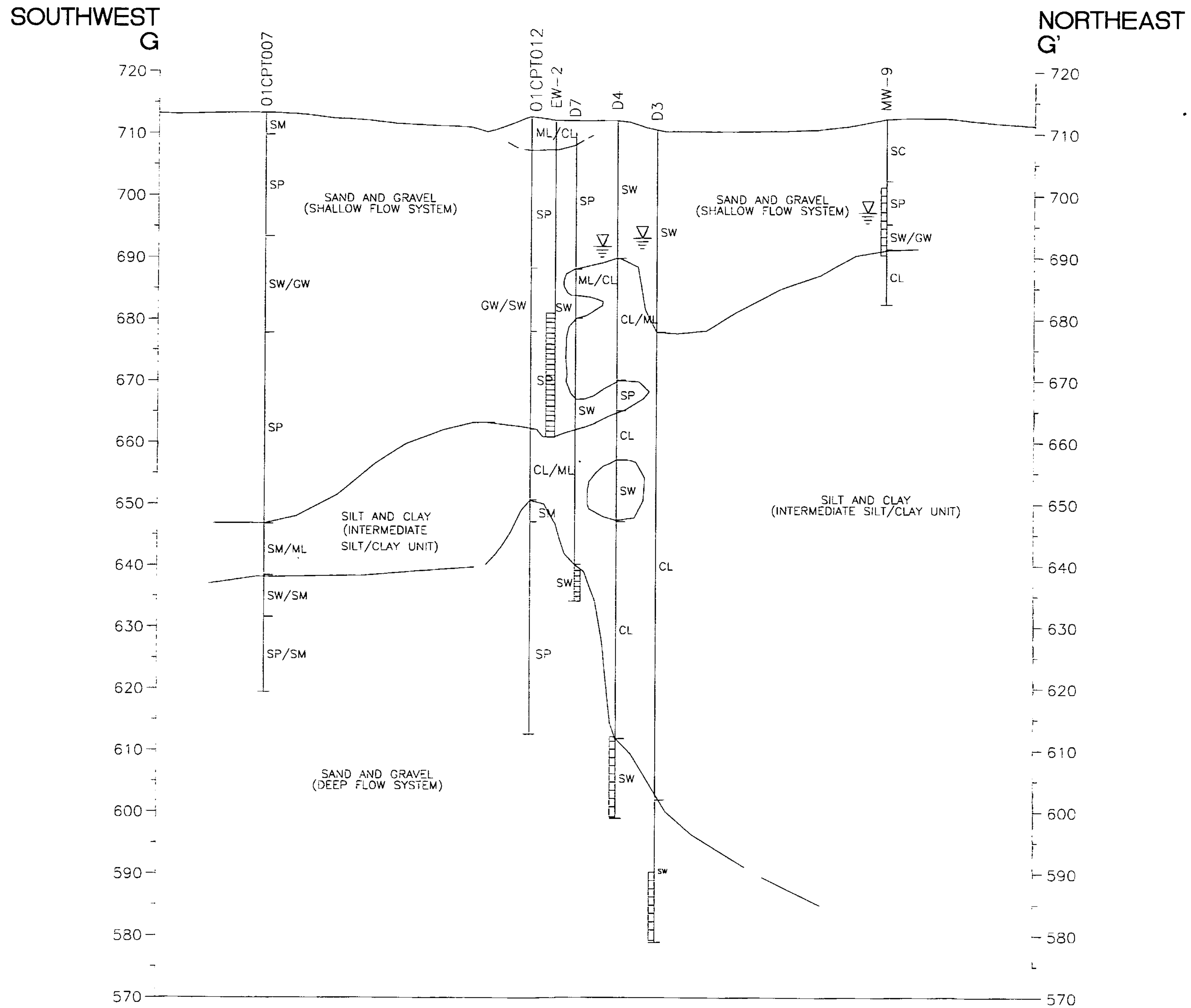
VERTICAL EXAGERATION 20X

CROSS-SECTION F-F'

CLAY UNIT EXTRAPOLATED BASED UPON GEOLOGIC CROSS-SECTION A-A'

SECTION F-F'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA
ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTFF.DWG | Drawn: EJL | Rev: 11/6/97 | Chk: SDM



Legend

Well Screen Interval

Groundwater Elevation

Stratigraphic Contact (Dashed Where Inferred)

0 600 1200 FT.

SCALE

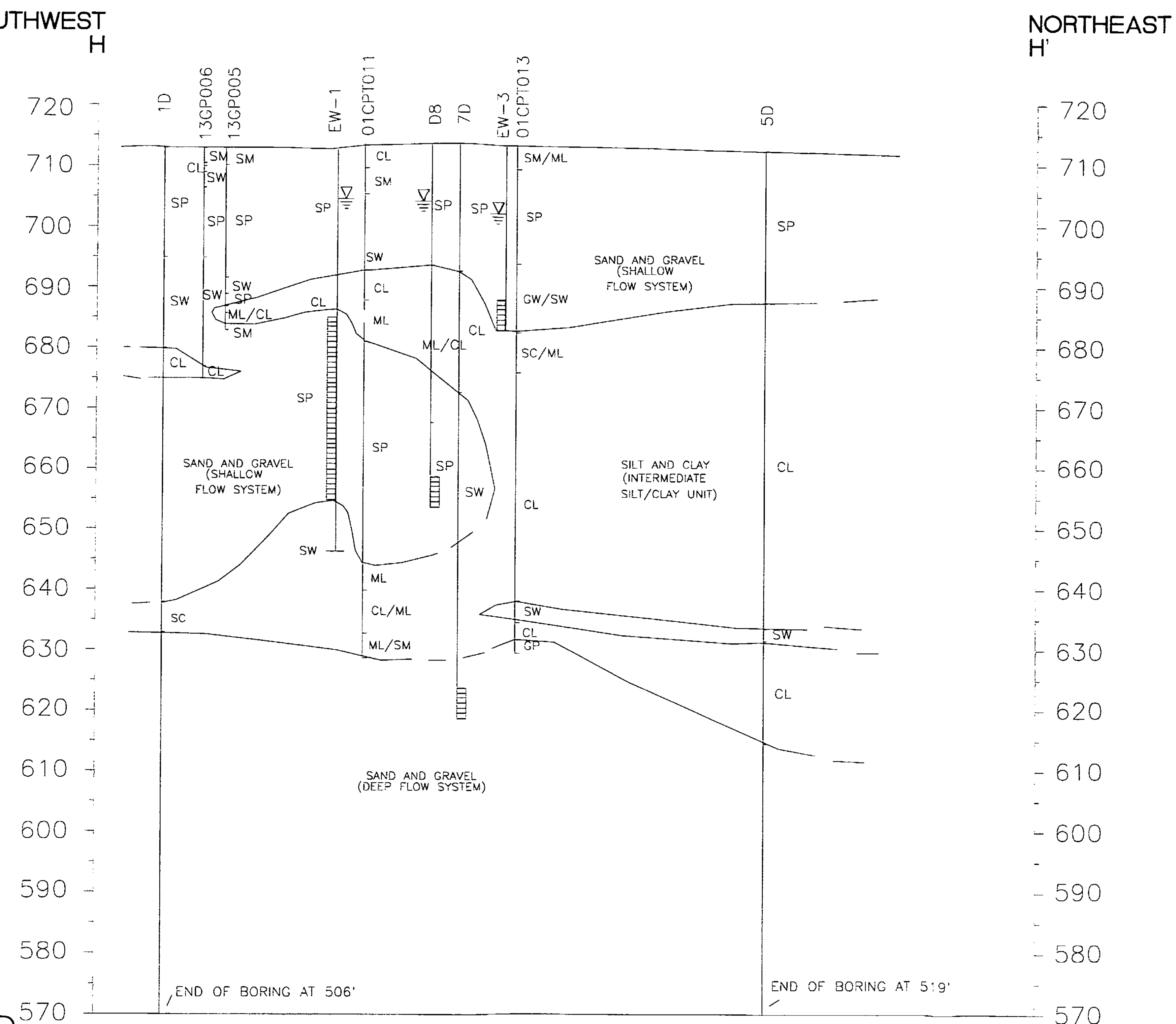
VERTICAL EXAGERATION 20X

CROSS-SECTION G-G'

SECTION G-G'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTGG.DWG | Drawn: EJL | Rev: 11/6/97 | Chk: SDM



Legend

Well Screen Interval

Groundwater Elevation

—?— Stratigraphic Contact (Dashed Where Inferred)

Well 7D was wash rotary drilled. Adjacent CPT results indicate intermediate silt/clay unit is likely present but was not during drilling of this well.

0 600 1200 FT.
SCALE

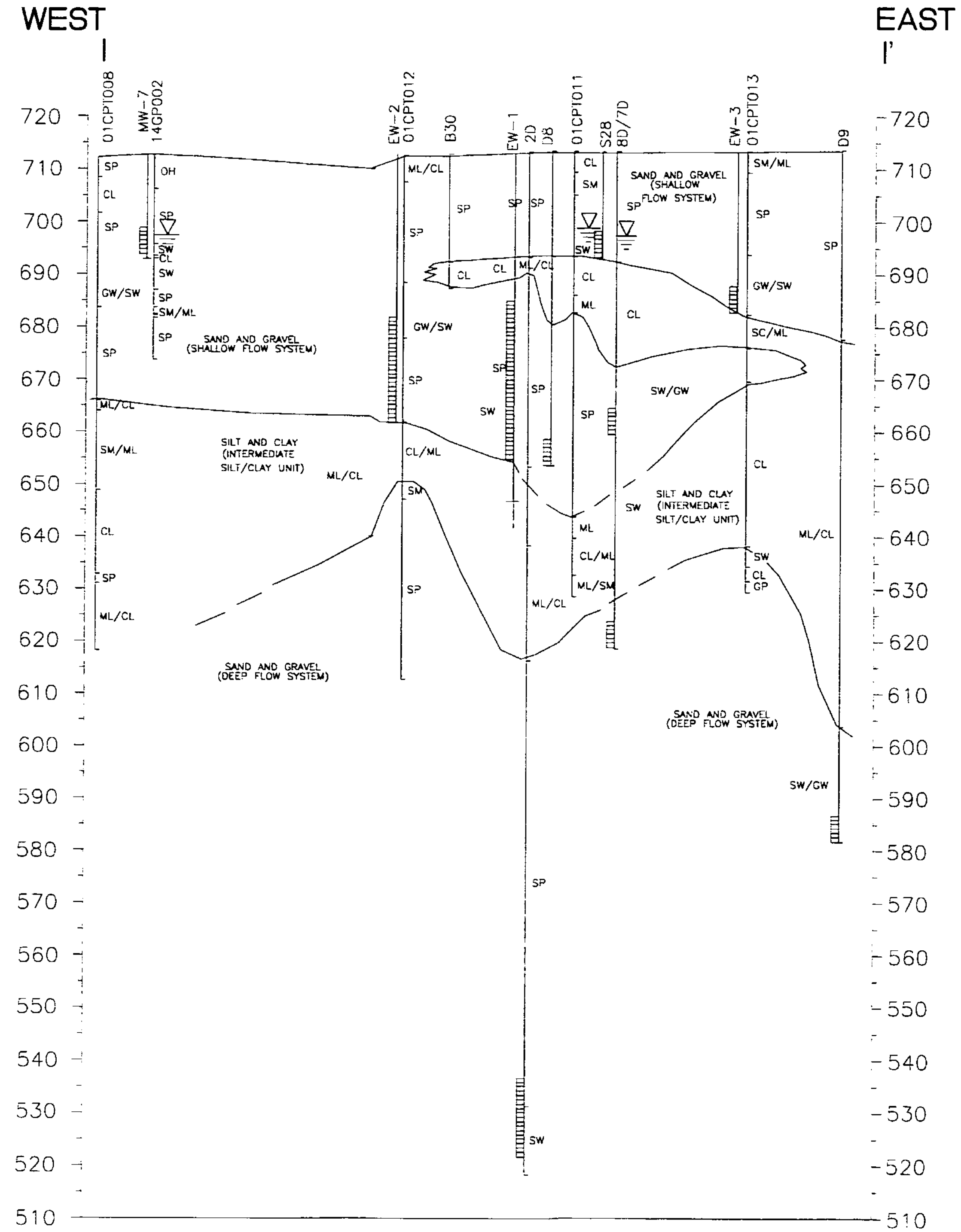
VERTICAL EXAGERATION 20X

CROSS-SECTION H-H'

SECTION H-H'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

ABB Environmental Services, Inc.

P:\ALLIED\09822-00\SECTHH.DWG Drawn: SDM Rev: 11/14/97 Chk: SDM



Legend

Well Screen Interval

Groundwater Elevation

--?-- Stratigraphic Contact (Dashed Where Inferred)

Wells 2D and 7D were wash rotary drilled. Adjacent CPT results indicate intermediate silt/clay unit is likely present but was not observed during the drilling on these wells

0 600 1200 FT.

SCALE

VERTICAL EXAGERATION 20X

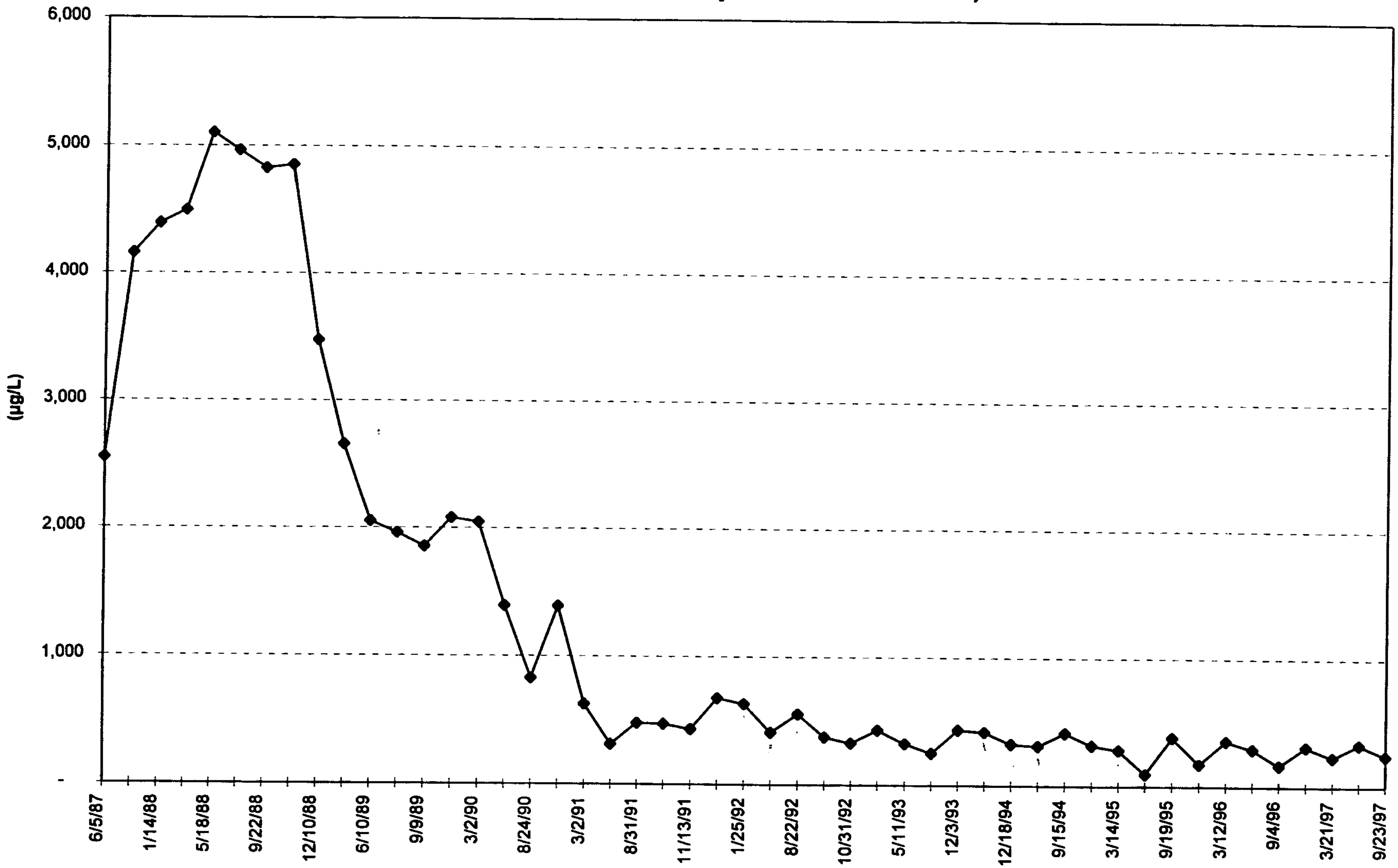
CROSS-SECTION I-I'

SECTION I-I'
GENERALIZED GEOLOGIC CROSS SECTION
VOLUNTARY SITE INVESTIGATION
ALLIEDSIGNAL INDUSTRIAL COMPLEX
SOUTH BEND, INDIANA

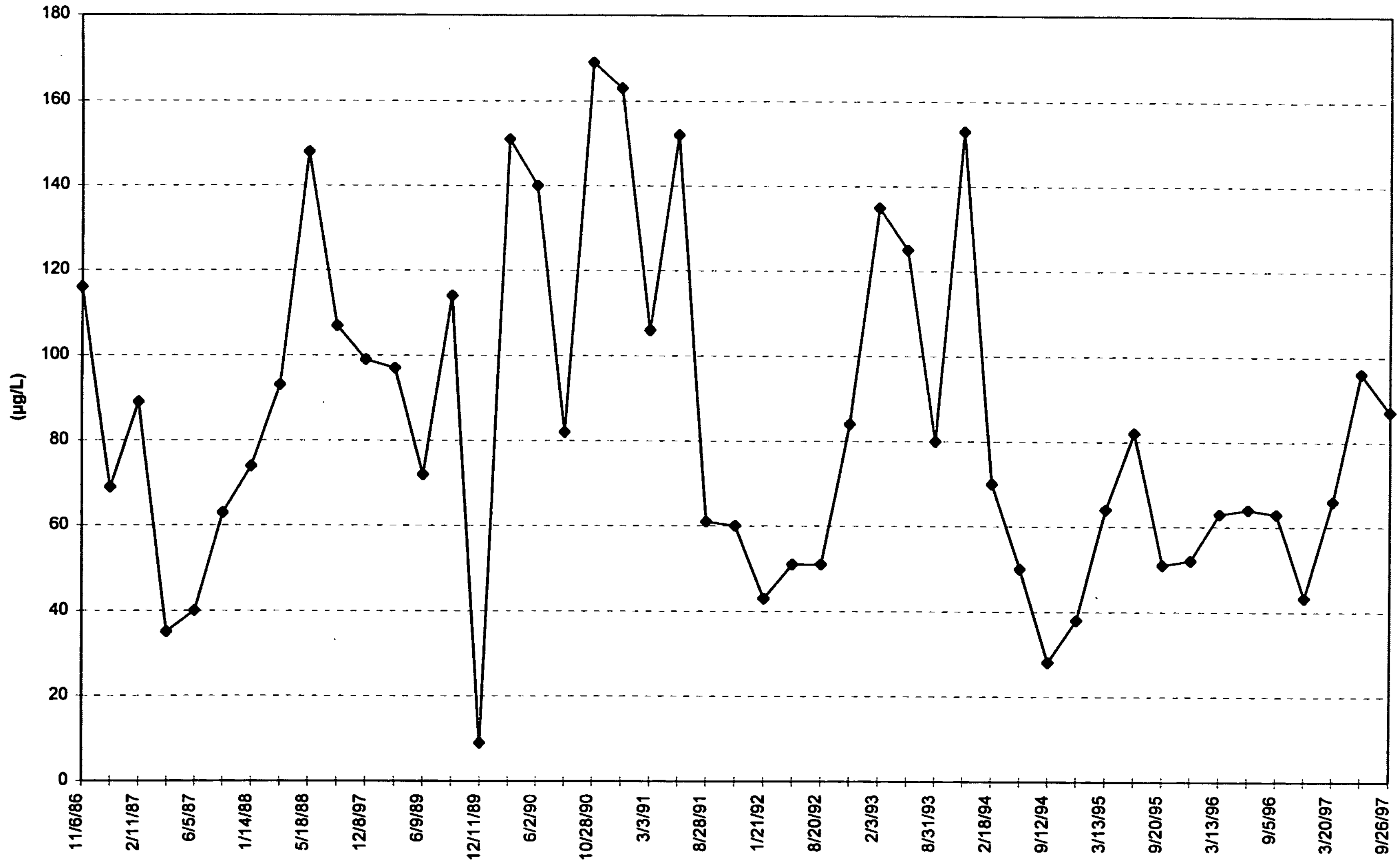
ABB Environmental Services, Inc.

P:\ALLIED\09822-00\DWG\SECTII.DWG

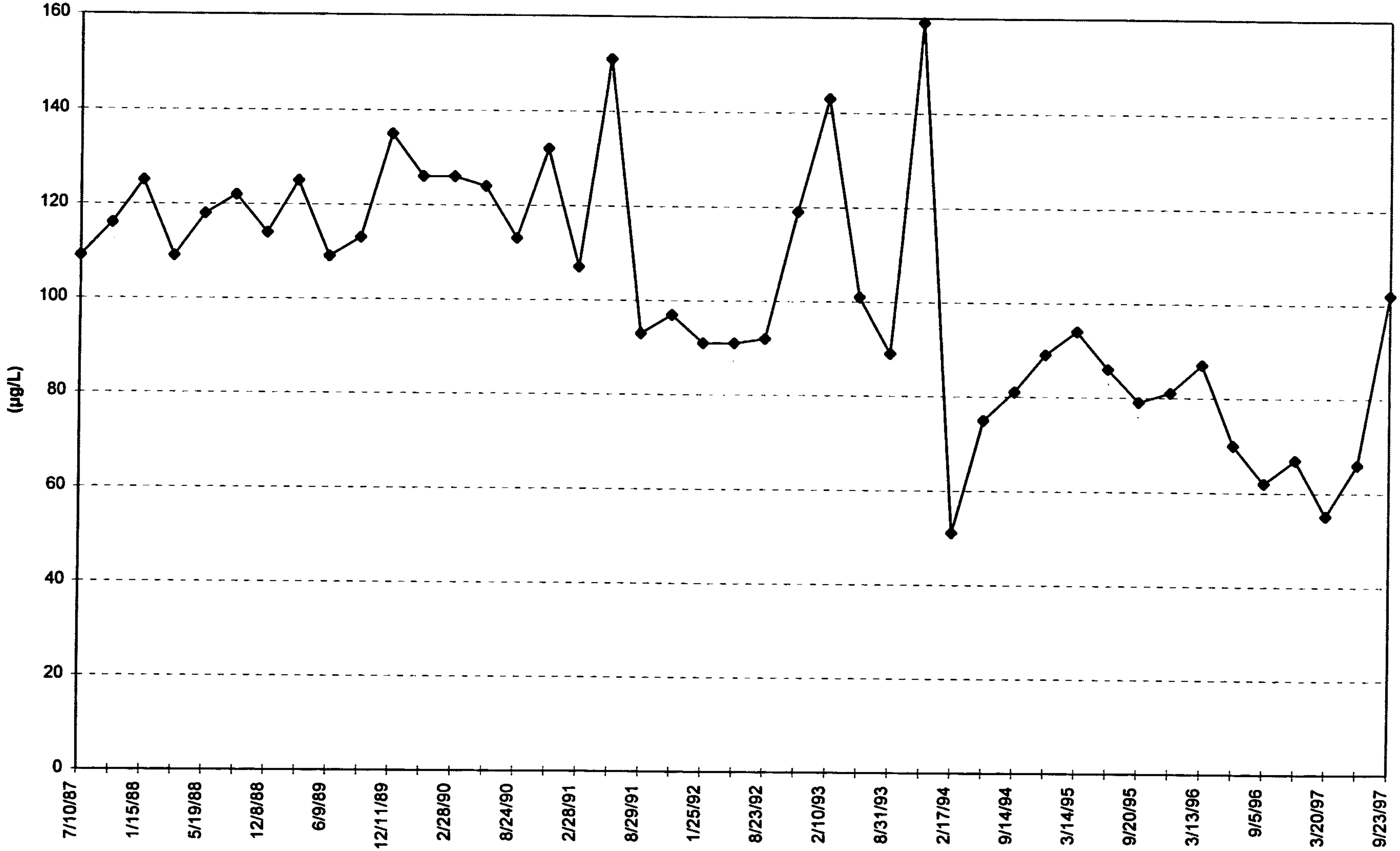
Shallow Monitoring Well S4A
Total VOCs Versus Time (µg/L)
Voluntary Site Investigation
AlliedSignal Industrial Complex - South Bend, Indiana



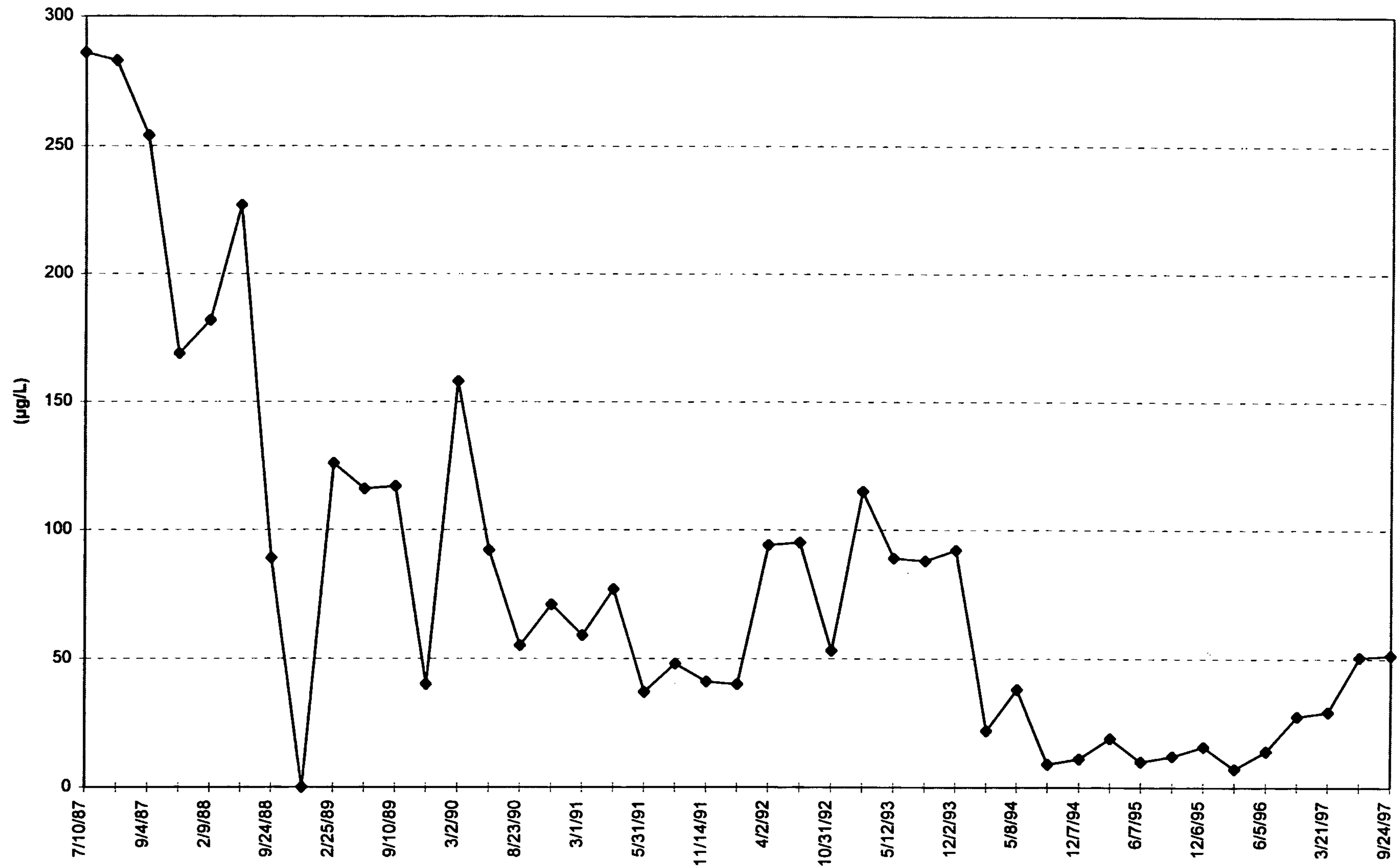
Shallow Monitoring Well S21
Total VOCs Versus Time (µg/L)
Voluntary Site Investigation
AlliedSignal Industrial Complex - South Bend, Indiana



Shallow Monitoring Well S27
Total VOCs Versus Time (µg/L)
Voluntary Site Investigation
AlliedSignal Industrial Complex - South Bend, Indiana



Deep Monitoring Well 7D
Total VOCs Versus Time (µg/L)
Voluntary Site Investigation
AlliedSignal Industrial Complex - South Bend, Indiana



APPENDIX O-1

RESULTS OF TIER I EVALUATION

TABLE O-1-1
TIER I EVALUATION
Area 311 - Former Disposal Area/Carbon Brake Expansion - SURFACE SOIL

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
ANTHRACENE	0.33	0.33	0.34	0.56	0.45	0.308	0.335	2/4	5.14E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
BENZO(A)ANTHRACENE	0.33	0.33	1.2	1.4	1.3	0.758	0.765	2/4	1.86E+01	No	No	1.37E+01	No	No	7.59E+02	No	No	NA	NA	NA
BENZO(A)PYRENE	0.33	0.33	0.41	0.92	0.66	0.415	0.37	2/4	8.16E+00	No	No	1.37E+00	No	No	7.59E+01	No	No	NA	NA	NA
BENZO(B&k)FLUORANTHENE	0.33	0.33	0.9	1.4	1.15	0.657	0.615	2/4	5.74E+01	No	No	1.37E+01	No	No	7.59E+02	No	No	NA	NA	NA
CHRYSENE	0.33	0.33	1	1.1	1.05	0.608	0.665	2/4	2.50E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
FLUORANTHENE	0.33	0.33	1.5	3.2	2.35	1.26	0.915	2/4	2.55E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
PHENANTHRENE	0.33	0.33	1.1	2	1.55	0.858	.715	2/4	5.68E+02	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
PYRENE	0.33	0.33	2.1	2.9	2.5	1.33	1.22	2/4	5.68E+02	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
2-METHYLNAPHTHALENE	0.33	0.33	0.48	0.81	0.64	0.405	0.405	2/4	2.58E+01	No	No	3.44E+02	No	No	1.00E+03	No	No	2.43E+02	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

location	sampdate
03GP00601	11/6/97
03GP01201	11/6/97
03GP01401	11/6/97

TABLE O-1-2
TIER II EVALUATION
AREA 13, PLANT 10, Former Electroplating Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.1	1.3	0.328	0.16	0.1	6/15	NA	NA	NA	NA	No	No
TRICHLOROETHYLENE	0.05	0.05	0.24	2.6	1.033	0.781	0.25	3/4	5.05E+00	No	No	1.33E+11	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP070	12/09/96
05GP071	12/09/96
13GP006	11/15/96
13GP007	12/09/96

TABLE O-1-3
TIER I EVALUATION
AREA 14 - PLANT 1 - Former Painting and Degreasing Operations (Central)

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0	0.1	0.066	1.3	0.447	0.09	0.1	4/31	1.93E+00	No	No	1.00E+03	No	No	1.00E+03	No	No	2.02E+01	No	No
1,1-DICHLOROETHANE	0	0.1	0.1	0.1	0.1	0.039	0.1	1/31	1.18E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	4.01E+01	No	No
2-METHYLNAPHTHALENE	0	0.5	0.69	4.1	2.395	0.298	0.5	2/31	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.19	0.19	0.19	0.079	0.220	1/30	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.077	0.077	0.077	0.073	0.077	1/31	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
CIS-1,2-DICHLOROETHYLENE	0	0.1	0.15	0.15	0.15	0.04	0.1	1/31	4.00E-01	No	No	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	No	No
ETHYLBENZENE	0	0.25	0.51	0.51	0.51	0.088	0.25	1/31	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0	0.25	0.28	1.4	0.84	0.125	0.25	2/31	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TETRACHLOROETHYLENE	0	0.1	0.12	0.51	0.315	0.055	0.1	2/31	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	No	No
TOLUENE	0	0.25	0.28	0.28	0.28	0.081	0.25	1/31	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
TRICHLOROETHYLENE	0	0.1	0.098	0.62	0.24	0.126	0.1	14/31	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	No	No
XYLENES	0	0.25	2	2	2	0.138	0.25	1/31	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
14GP004	10/29/96
14GP005	10/29/96
14GP006	10/29/96
14GP023	12/12/96
14GP029	7/15/97
14GP030	7/15/97
14GP031	7/15/97
14GP032	7/15/97
15GP010	11/8/96

TABLE O-1-4
TIER I EVALUATION
Area 14 - Plant 1 - Former Painting and Degreasing Operations (Eastern)

Analyte (mg/kg0	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
CIS-1,2-DICHLOROETHYLENE	0.1	0.22	0.12	1.4	0.364	0.11	0.1	5/29	4.00E-01	Yes	No	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	Yes	No
TRICHLOROETHYLENE	0.1	0.1	0.15	58	4.58	3.67	1.8	26/29	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	Yes	Yes

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
14GP012	10/31/96
14GP013	11/1/96
14GP014	11/1/96
14GP015	11/1/96
14GP016	11/3/96
14GP020	11/6/96
14GP021	12/9/96
14GP022	12/12/96

TABLE 0-1-5
TIER I EVALUATION
AREA 14, PLANT 1 - WEST - Painting and Degreasing Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	5.2	1.8	1.8	1.8	0.406	0.5	1/30	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE,1,2,4-TRIMETHYL	0.01	2.6	1.6	1.6	1.6	0.225	0.25	1/30	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE,1,3,5-TRIMETHYL	0.01	2.6	0.57	0.57	0.57	0.19	0.25	1/30	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE,1-METHYLMETHYL	0.01	2.6	1.7	1.7	1.7	0.228	0.25	1/30	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	0.13	0.15	0.2	0.175	0.058	0.1	2/30	4.00E-01	No	No	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	No	No
ETHYLBENZENE	0.05	2.6	0.32	0.32	0.32	0.184	0.25	1/30	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.01	2.6	0.29	0.29	0.29	0.181	0.25	1/30	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0.05	2.6	1.2	1.2	1.2	0.214	0.25	1/30	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TOLUENE	0.05	2.6	0.87	0.87	0.87	0.203	0.25	1/30	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
TRICHLOROETHYLENE	0.1	0.1	0.084	40	4.756	4.129	0.655	26/30	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	Yes	Yes
XYLENES	0.1	2.6	0.76	0.76	0.76	0.202	0.25	1/30	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
14GP001	10/24/96
14GP002	10/24/96
14GP002	11/01/96
14GP003	10/25/96
14GP017	11/04/96
14GP018	11/04/96
14GP025	12/13/96
14GP026	12/12/96
14GP027	12/12/96
14GP028	12/12/96

TABLE O-1-6
TIER I EVALUATION
Area 15 - Former Metal Stamping Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.75	2.2	1.313	0.161	0.1	3/33	1.93E+00	Yes	No	1.00E+03	No	No	1.00E+03	No	No	2.02E+01	No	No
2-METHYLNAPHTHALENE	0.1	0.5	12	12	12	0.564	0.5	1/33	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	0.1	0.14	0.53	0.277	0.067	0.1	3/33	4.00E-01	Yes	No	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	No	No
NAPHTHALENE	0.05	0.25	1.5	1.5	1.5	0.145	0.25	1/33	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TETRACHLOROETHYLENE	0.05	0.1	0.13	35	6.415	1.592	0.1	8/33	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	Yes	Yes
TOLUENE	0.05	0.25	0.093	0.093	0.093	0.103	0.25	1/33	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
TRICHLOROETHYLENE	0.05	0.1	0.35	5	1.52	0.27	0.1	5/33	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	Yes	Yes
XYLENES	0.05	0.25	0.43	1	0.667	0.16	0.25	3/33	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
14GP019	11/6/96
15GP001	11/4/96
15GP002	11/4/96
15GP003	11/4/96
15GP004	11/4/96
15GP006	11/5/96
15GP007	11/5/96
15GP008	11/5/96
15GP009	11/6/96
15GP012	7/15/97
15GP013	7/17/97

TABLE O-1-7
TIER I EVALUATION
Area 311 - Former Disposal Area/Carbon Brake Expansion

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.11	290	15.548	6.505	0.1	25/60	1.93E+00	Yes	Yes	1.00E+03	No	No	1.00E+03	No	No	2.02E+01	Yes	No
1,1-DICHLOROETHANE	0.05	7.2	0.16	2.2	0.74	0.175	0.1	6/60	1.18E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	4.01E+01	No	No
1,1-DICHLOROETHYLENE	0.05	7.2	0.15	6.9	2.54	0.231	0.1	3/60	5.79E-02	Yes	Yes	1.07E+00	Yes	Yes	1.36E+02	No	No	1.08E-02	Yes	Yes
1,2-DICHLOROETHANE	0.05	7.2	0.12	0.3	0.21	0.112	0.1	2/60	2.38E-02	Yes	Yes	5.84E+00	No	No	3.18E+02	No	No	6.12E-02	Yes	Yes
2-METHYLNAPHTHALENE	0.1	120	0.5	24	12.875	2.968	0.5	4/60	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE, 1,2,4-TRIMETHYL	0.01	60	0.29	88	13.604	2.665	0.250	7/60	1.34E+01	Yes	Yes	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
BENZENE, 1,3,5-TRIMETHYL	0.01	60	0.42	44	9.848	1.902	0.250	5/60	1.34E+01	Yes	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
BENZENE,1-METHYL METHYL	0.01	60	0.36	13	2.999	1.473	0.250	8/60	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
CHLOROBENZENE	0.05	7.2	0.12	0.12	0.12	0.107	0.1	1/60	1.30E+00	No	No	5.93E+02	No	No	6.81E+02	No	No	1.08E+01	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	0.1	0.12	56	7.32	2.107	0.1	17/60	4.00E-01	Yes	Yes	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	Yes	Yes
TRANS-1,2-DICHLOROETHENE	0.05	7.2	0.11	0.41	0.26	0.113	0.100	2/60	6.79E-01	No	No	2.29E+02	No	No	1.00E+03	No	No	1.52E+00	No	No
ETHYLBENZENE	0.05	60	0.53	74	11.144	2.559	0.25	8/60	1.34E+01	Yes	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.01	60	8.1	8.1	8.1	1.225	0.25	1/60	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
NAPHTHALENE	0.05	60	0.34	9	3.093	1.39	0.25	6/60	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TETRACHLOROETHYLENE	0.05	0.1	0.1	170	19.839	5.985	0.1	18/60	5.77E-02	Yes	Yes	1.07E+02	Yes	No	2.35E+02	No	No	9.43E-01	Yes	Yes
TOLUENE	0.05	7.2	0.28	150	22.646	5.112	0.25	13/60	1.17E+01	Yes	Yes	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	Yes	No
TRICHLOROETHYLENE	0.05	7.2	0.11	1500	67.238	37.06	0.21	33/60	5.70E-02	Yes	Yes	7.24E+01	Yes	No	5.49E+02	Yes	No	7.15E-01	Yes	Yes
VINYL CHLORIDE	0.1	24	0.67	0.67	0.67	0.504	0.100	1/60	1.35E-02	Yes	Yes	4.59E-01	Yes	Yes	5.64E+01	No	No	6.50E-03	Yes	Yes
XYLENES	0.05	60	0.31	160	20.057	4.668	0.25	11/60	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	Yes	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

location	sampdate
03GP001	9/30/96
03GP002	9/30/96
03GP003	9/30/96
03GP004	9/30/96
03GP005	10/1/96
03GP006	10/1/96
03GP006	11/6/97
03GP007	10/1/96
03GP009	10/2/96
03GP010	10/2/96
03GP011	10/2/96
03GP012	10/2/96
03GP012	11/6/97
03GP013	10/2/96
03GP014	10/3/96
03GP014	11/6/97
03GP015	10/3/96
03GP015	11/6/97
03GP016	10/3/96
03GP017	10/4/96
11GP001	10/3/96
11GP002	10/3/96
11GP005	10/4/96

TABLE O-1-8
TIER I EVALUATION
AREA 4/16 - Former I-Beam Building

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	0.5	0.73	1.5	1.077	0.322	0.5	3/26	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.12	2.7	1.44	0.268	0.25	3/26	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE, 1,3,5 -TRIMETHYL	0.01	0.25	0.88	0.88	0.88	0.141	0.25	1/26	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE, 1-METHYL METHYL	0.01	0.25	3.5	3.5	3.5	0.242	0.25	1/26	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
ETHYLBENZENE	0.05	0.25	1.2	3.3	2.25	0.277	0.25	2/26	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.01	0.25	0.34	0.34	0.34	0.12	0.25	1/26	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0.05	0.25	0.37	1.4	0.923	0.206	0.25	3/26	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TETRACHLOROETHYLENE	0.05	0.1	0.14	0.14	0.14	0.051	0.1	1/26	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	No	No
TOLUENE	0.05	0.25	0.31	0.31	0.31	0.121	0.25	1/26	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
TRICHLOROETHYLENE	0.05	0.1	0.19	0.19	0.19	0.053	0.1	1/26	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	No	No
XYLENES	0.05	0.25	1.4	7.5	4.45	0.448	0.25	2/26	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
04GP001	10/22/96
04GP004	10/23/96
04GP005	10/23/96
07GP006	11/15/96
08GP009	10/21/96
16GP004	10/21/96
16GP005	10/14/96
16GP005	10/21/96

TABLE O-1-9
TIER I EVALUATION
AREA 5, PLANT 14 - Former USTS

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	6.4	1.1	1.1	1.1	0.775	0.5	1/16	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE,1,2,4-TRIMETHYL	0.01	1.3	0.77	31	12.662	4 852	0.25	6/16	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE, 1,3,5-TRIMETHYL	0.01	1.3	0.81	30	13.253	3.465	0.25	4/16	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE, 1-METHYL METHYL	0.01	3.2	2	2	2	0.443	0.25	1/16	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
N-PROPYLBENZENE	0.01	3.2	20	20	20	1.568	0.25	1/16	1.34E+01	Yes	Yes	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0.05	3.2	0.63	0.63	0.63	0.391	0.25	1/16	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TOLUENE	0.05	3.2	2.2	2.2	2.2	0.457	0.25	1/16	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
XYLENES	0.1	0.25	0.69	24	7.87	3.509	0.25	7/16	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
05GP035	10/17/96
05GP036	10/17/96
05GP037	10/17/96
05GP040	10/17/96
05GP043	10/18/96

TABLE O-1-10
TIER I EVALUATION
AREA 5, PLANT 19 - Former USTS

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
BENZENE, 1,3,5-TRIMETHYL	0.13	2.8	2.9	6.7	4.825	2.127	1.5	4/10	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE, 1-METHYL METHYL	0.13	0.25	6	83	40.667	24.444	16	6/10	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
ETHYLBENZENE	0.13	0.25	1.8	84	32.633	19.624	9.4	6/10	1.34E+01	Yes	Yes	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
TRICHLOROETHYLENE	0.1	0.13	0.39	0.39	0.39	0.085	0.1	1/10	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
05GP019	10/14/96
05GP021	10/14/96
05GP023	10/15/96
05GP024	10/15/96

TABLE O-1-11
TIER I EVALUATION
AREA 5, PLANT 6-16, CENTRAL - Former USTs

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1-DICHLOROETHYLENE	0.05	13	0.17	0.17	0.17	0.199	0.1	1/43	5.79E-02	Yes	Yes	1.07E+00	No	No	1.36E+02	No	No	1.08E-02	Yes	Yes
2-METHYLNAPHTHALENE	0.1	54	0.91	0.91	0.91	2.019	0.5	1/43	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE	0.05	13	0.17	5	1.99	0.376	0.1	4/43	3.38E-02	Yes	Yes	1.30E+01	No	No	8.69E+02	No	No	1.04E-01	Yes	Yes
BENZENE,1,2,4-TRIMETHYL	0.01	27	0.32	59	13.826	5.946	0.320	17/43	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE,1,3,5-TRIMETHYL	0.01	27	0.67	81	37.918	4.348	0.250	4/43	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE,1-METHYL METHYL	0.01	13	0.64	150	37.873	22.203	1.600	25/43	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	Yes	No
CIS-1,2-DICHLOROETHYLENE	0.05	13	0.06	0.06	0.06	0.197	0.1	1/43	4.00E-01	No	No	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	No	No
ETHYLBENZENE	0.05	0.25	0.42	230	43.793	26.513	1.9	26/43	1.34E+01	Yes	Yes	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.01	27	0.36	23	6.972	1.652	0.25	5/43	1.34E+01	Yes	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0.05	27	0.84	2.8	1.82	1.116	0.25	2/43	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TOLUENE	0.05	27	0.36	0.36	0.36	1.075	0.25	1/43	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
XYLENES	0.05	27	0.25	58	15.469	3.682	0.25	8/43	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
05GP001	10/5/96
05GP001	11/6/97
05GP002	10/5/96
05GP003	10/5/96
05GP003	11/6/97
05GP004	10/5/96
05GP005	10/5/96
05GP005	11/6/97
05GP006	10/5/96
05GP007	10/5/96
05GP007	11/6/97
05GP008	10/6/96
05GP009	10/6/96
05GP011	10/6/96
05GP052	11/12/96
05GP053	11/12/96
17GP003	12/16/96

TABLE O-1-12
TIER I EVALUATION
AREA 5, PLANT 6-16, NORTH - Former USTs

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	58	19	19	19	3.876	0.5	1/17	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE	0.05	0.13	80	80	80	4.752	0.1	1/17	3.38E-02	Yes	Yes	1.30E+01	Yes	Yes	8.69E+02	No	No	1.04E-01	Yes	Yes
BENZENE,1,2,4-TRIMETHYL	0.01	29	0.77	280	55.921	27.221	0.77	8/17	2.01E+02	Yes	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	Yes	No
BENZENE,1,3,5-TRIMETHYL	0.01	29	0.37	81	26.553	10.33	0.37	6/17	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
BENZENE,1-METHYL METHYL	0.01	29	5.9	42	17.5	5.301	0.25	4/17	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
ETHYLBENZENE	0.05	0.25	0.63	280	50.804	23.964	0.25	8/17	1.34E+01	Yes	Yes	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.01	29	0.34	12	6.028	2.991	0.25	5/17	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
NAPHTHALENE	0.05	29	3.1	30	17.7	4.102	0.25	3/17	2.58E+01	Yes	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TOLUENE	0.05	7.8	3.8	700	159.76	47.297	0.25	5/17	1.17E+01	Yes	Yes	6.54E+02	Yes	No	6.54E+02	Yes	No	9.18E+01	Yes	Yes
XYLENES	0.1	0.25	0.5	720	127.844	67.737	0.5	9/17	2.01E+02	Yes	No	4.61E+02	Yes	No	4.61E+02	Yes	No	9.76E+01	Yes	Yes

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
05GP013	10/8/96
05GP028	1015/96
05GP029	10/16/96
05GP031	10/16/96
17GP001	11/12/96

TABLE O-1-13
TIER I EVALUATION
AREA 5, PLANT 6/16 - FORMER RAIL SUPPLY LINE

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	45	0.31	1.1	0.6	2.475	0.27	3/10	1.83E+00	No	No	1.00E+03	No	No	1.00E+03	No	No	2.02E+01	No	No
BENZENE, 1,2,4-TRIMETHYL	0.05	0.53	0.14	870	290.513	96.892	0.140	3/9	2.01E+02	Yes	Yes	4.61E+02	Yes	No	4.61E+02	Yes	No	9.76E+01	Yes	Yes
BENZENE, 1,3,5-TRIMETHYL	0.05	0.53	0.14	580	194.313	58.355	0.195	3/10	2.01E+02	Yes	No	4.61E+02	Yes	No	4.61E+02	Yes	No	9.76E+01	Yes	Yes
BENZENE, 1-METHYL METHYL	0.01	0.74	150	150	150	15.092	0.075	1/10	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	Yes	Yes
CIS-1,2-DICHLOROETHYLENE	0.05	0.21	0.1	190	29.781	20.865	0.24	7/10	4.00E-01	Yes	Yes	1.43E+02	Yes	No	7.47E+02	No	No	1.13E+00	Yes	Yes
ETHYLBENZENE	0.05	0.74	0.15	600	200.307	60.157	0.125	3/10	1.34E+01	Yes	Yes	3.95E+02	Yes	No	3.95E+02	Yes	No	4.08E+02	Yes	No
TETRACHLOROETHYLENE	0.05	45	0.15	0.23	0.18	2.342	0.155	3/10	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	No	No
TOLUENE	0.05	0.74	0.17	1200	400.39	120 189	0.21	3/10	1.17E+01	Yes	Yes	6.54E+02	Yes	No	6.54E+02	Yes	No	9.18E+01	Yes	Yes
TRICHLOROETHYLENE	0.05	45	0.14	7.6	2.704	4.156	1.11	7/10	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	Yes	Yes
XYLENES	0.05	2.5	0.6	2500	501.118	250.704	0.645	5/10	2.01E+02	Yes	Yes	4.61E+02	Yes	Yes	4.61E+02	Yes	Yes	9.76E+01	Yes	Yes

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
05GP048	11/11/96
09GP008	7/16/97
09HA001	7/25/97

TABLE O-1-14
TIER I EVALUATION
AREA 7, PLANT 7 - SWMU 19

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
TETRACHLOROETHYLENE	0.1	0.1	0.1	1.4	0.49	0.427	0.31	6/7	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	Yes	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
07GP002	10/22/96
07GP003	10/23/96

TABLE O-1-15
TIER I EVALUATION
AREA 8 - Former Stormwater Drainage System/Dry Wells

Analyte	Minimum	Maximum	Minimum	Maximum	Mean of	Mean of	Median	FOD	Residential			Industrial			Construction			Vapor Mig.		
(mg/kg)	SQL	SQL	Detect	Detect	Detects	all Samples			Sub. Soil	Max>?	Mean>?	Surf. Soil	Max>?	Mean>?	Soil	Max>?	Mean>?	Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.71	0.58	7.2	3.89	0.427	0.1	2/21	1.93E+00	Yes	Yes	1.00E+03	No	No	1.00E+03	No	No	2.02E+01	No	No
1,1-DICHLOROETHANE	0.05	0.71	0.14	57	28 57	2.777	0.1	2/21	1.18E+01	Yes	Yes	1.00E+03	No	No	1.00E+03	No	No	4.01E+01	Yes	No
2-METHYLNAPHTHALENE	0.1	1.1	0.52	6.5	3 68	0.894	0.5	4/21	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
BENZENE, 1,2,4	0.05	0.25	0.99	8.8	3 199	1.14	0.25	7/21	1.34E+01	No	No	3 95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
BENZENE, 1,3,5	0.05	2.6	0.64	6 7	3 67	0.515	0.25	2/21	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
BENZENE, 1-MM	0.05	2.6	2.8	3.8	3 367	0.653	0.25	3/21	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
CHLOROBENZENE	0.05	0.71	0.26	0.26	0.26	0.071	0.1	1/21	1.30E+00	No	No	5.93E+02	No	No	6.81E+02	No	No	1.08E+01	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	0.71	0.14	6.4	3 27	0.368	0.1	2/21	4.00E-01	Yes	Yes	1.43E+02	No	No	7.47E+02	No	No	1.13E+00	Yes	Yes
ETHYLBENZENE	0.05	2.6	2.4	3.3	2 9	0.586	0.25	3/21	1.34E+01	No	No	3.95E+02	No	No	3.95E+02	No	No	4.08E+02	No	No
N-PROPYLBENZENE	0.05	2.6	1.3	1.3	1 3	0.241	0.25	1/21	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No
NAPHTHALENE	0.05	0.71	0.36	2.8	1 385	0.369	0.25	4/21	2.58E+01	No	No	1.00E+03	No	No	1.00E+03	No	No	1.63E+03	No	No
TOLUENE	0.05	2.6	3.7	3.7	3 7	0.348	0.25	1/21	1.17E+01	No	No	6.54E+02	No	No	6.54E+02	No	No	9.18E+01	No	No
TRICHLOROETHYLENE	0.05	0.71	3 3	3.3	3 3	0 216	0.1	1/21	5 70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	Yes	Yes
XYLENES	0.05	2.6	0 57	2 8	1 59	0.392	0.25	3/21	2.01E+02	No	No	4.61E+02	No	No	4.61E+02	No	No	9.76E+01	No	No

Notes:

SQL = Sample Quantitation Limit

Mean of Detects = Arithmetic mean of results reported above the detection limit

Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.

FOD = Frequency of detection

All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.

Vapor migration values developed by ABB-ES.

Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
08GP001	10/7/96
08GP002	10/8/96
08GP003	10/8/96
08GP005	10/9/96
08GP007	10/9/96
08GP008	10/14/96
08GP010	10/21/96

TABLE O-1-16
TIER I EVALUATION
PLANT 3A

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
TETRACHLOROETHYLENE	N/A	N/A	0.11	0.78	0.377	0.377	0.24	3/3	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	9.43E-01	No	No
TRICHLOROETHYLENE	0.05	0.05	0.25	0.57	0.41	0.282	0.25	2/3	5.70E-02	Yes	Yes	7.24E+01	No	No	5.49E+02	No	No	7.15E-01	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
09GP004	7/16/97

TABLE O-1-17
TIER I EVALUATION
GROUNDWATER

Analyte (ug/L)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential GW			Vapor Mig. GW	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	1	5000	6.6	2700	272.603	93.08	5	32/147	2.00E+02	**YES**	NO	2.00E+05	NO	NO
1,1-DICHLOROETHANE	1	5000	5	2700	222.573	107.59	5	51/147	2.09E+03	**YES**	NO	6.93E+05	NO	NO
1,1-DICHLOROETHYLENE	1	5000	6.3	180	62.66	37.298	5	5/147	7.00E+00	**YES**	**YES**	7.11E+01	**YES**	NO
1,2-DICHLOROETHANE	1	5000	7.6	6300	1838.229	122.378	5	7/147	5.00E+00	**YES**	**YES**	8.95E+02	**YES**	NO
1,2-DICHLOROETHYLENE	1	2	230	240	235	59.438	2	2/8	1.02E+03	NO	NO	1.60E+04	NO	NO
1,2-DICHLOROPROPANE	1	500	150	160	155	15.752	5	2/109	5.00E+00	**YES**	**YES**	8.64E+02	NO	NO
2-METHYLNAPHTHALENE	10	10000	12	20	15	74.562	10	3/137	3.07E+02	NO	NO	2.43E+05	NO	NO
BENZENE	1	5000	5	15000	2906.133	265.514	5	12/147	5.00E+00	**YES**	**YES**	1.26E+03	**YES**	NO
BENZENE, 1,2,4-TRIMETHYL	1	20000	1.6	1500	277.647	198.44	5.000	17/125	7.00E+02	**YES**	NO	1.23E+06	NO	NO
BENZENE, 1,3,5-TRIMETHYL	1	5000	3.1	65	25.275	35.333	5.000	4/137	7.00E+02	NO	NO	1.23E+06	NO	NO
BENZENE, 1-MTEHYL METHYL	1	5000	14	280	106.857	39.657	5.000	7/137	7.00E+02	NO	NO	1.23E+06	NO	NO
CHLOROFORM	1	500	6.6	6.6	6.6	13.863	5	1/109	1.00E+02	NO	NO	1.23E+06	NO	NO
CIS-1,2-DICHLOROETHYLENE	5	1300	5.5	120000	3113.174	1763.742	17	7.00E-02	1.02E+03	**YES**	**YES**	16000	**YES**	NO
ETHYLBENZENE	1	5000	6.4	2900	964.59	91.448	5	10/147	7.00E+02	**YES**	NO	1.23E+06	NO	NO
MTBE	50	50000	130	130	130 000	374.672	50	1/137	NA	NO	NO	NA	NO	NO
N-PROPYLBENZENE	1	5000	9.5	170	76.875	36.646	5	4/137	1.00E+04	NO	NO	1.23E+06	NO	NO
NAPHTHALENE	5	5000	14	1700	365.6	49.904	5	5/125	3.07E+02	**YES**	NO	2.43E+05	NO	NO
TETRACHLOROETHYLENE	1	5000	7.7	35	18.567	36.005	5	3/147	5.00E+00	**YES**	**YES**	7.02E+03	NO	NO
TOLUENE	1	5000	17	17000	4393	239.391	5	7/147	1.00E+03	**YES**	NO	4.89E+05	NO	NO
TRICHLOROETHYLENE	1	1300	6	19000	905.781	364.194	5	57/147	5.00E+00	**YES**	**YES**	4.50E+03	**YES**	NO
VINYL CHLORIDE	1	2000	3.4	1300	109.157	43.956	10.000	35/147	2.00E+00	**YES**	**YES**	4.02E+01	**YES**	**YES**
XYLENES	3	5000	6.5	8700	2880.682	244.276	10	11/147	1.00E+04	NO	NO	2.58E+05	NO	NO

Notes:

SQL = Sample Quantitation Limit

Mean of Detects = Arithmetic mean of results reported above the detection limit.

Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.

FOD = Frequency of detection

All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.

Vapor migration values developed by ABB-ES.

Mean of detects is used as the mean concentration for comparison of Tier I values

APPENDIX O-2

RESULTS OF TIER II EVALUATION

TABLE O-2-1
TIER II EVALUATION
AREA 13, PLANT 10, Former Electroplating Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.1	1.3	0.328	0.16	0.1	6/15	NA	NA	NA	NA	No	No
TRICHLOROETHYLENE	0.05	0.05	0.24	2.6	1.033	0.781	0.25	3/4	5.05E+00	No	No	1.33E+11	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP070	12/09/96
05GP071	12/09/96
13GP006	11/15/96
13GP007	12/09/96

TABLE O-2-2
TIER II EVALUATION
AREA 14 - PLANT 1 - Former Painting and Degreasing Operations (Central)

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0	0.1	0.066	1.3	0.447	0.09	0.1	4/31	NA	NA	NA
1,1-DICHLOROETHANE	0	0.1	0.1	0.1	0.1	0.039	0.1	1/31	NA	NA	NA
2-METHYLNAPHTHALENE	0	0.5	0.69	4.1	2.395	0.296	0.5	2/31	NA	NA	NA
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.19	0.19	0.19	0.079	0.220	1/30	NA	NA	NA
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.077	0.077	0.077	0.073	0.077	1/31	NA	NA	NA
CIS-1,2-DICHLOROETHYLENE	0	0.1	0.15	0.15	0.15	0.04	0.1	1/31	NA	NA	NA
ETHYLBENZENE	0	0.25	0.51	0.51	0.51	0.088	0.25	1/31	NA	NA	NA
NAPHTHALENE	0	0.25	0.28	1.4	0.84	0.125	0.25	2/31	NA	NA	NA
TETRACHLOROETHYLENE	0	0.1	0.12	0.51	0.315	0.055	0.1	2/31	7.99E+11	No	No
TOLUENE	0	0.25	0.28	0.28	0.28	0.081	0.25	1/31	NA	NA	NA
TRICHLOROETHYLENE	0	0.1	0.098	0.62	0.24	0.126	0.1	14/31	1.33E+11	No	No
XYLENES	0	0.25	2	2	2	0.138	0.25	1/31	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
14GP004	10/29/96
14GP005	10/29/96
14GP006	10/29/96
14GP023	12/12/96
14GP029	7/15/97
14GP030	7/15/97
14GP031	7/15/97
14GP032	7/15/97
15GP010	11/6/96

TABLE O-2-3
TIER II EVALUATION
Area 14 - Plant 1 - Former Painting and Degreasing Operations (Eastern)

Analyte (mg/kg0	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
CIS-1,2-DICHLOROETHYLENE	0.1	0.22	0.12	1.4	0.364	0.11	0.1	4/25	2.35E+09	No	No	3.57E+00	No	No
TRICHLOROETHYLENE	0.1	0.1	0.15	58	4.58	3.67	1.8	24/25	3.54E+00	Yes	Yes	2.42E+00	Yes	Yes

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/97.
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
14GP012	10/31/96
14GP013	11/1/96
14GP014	11/1/96
14GP015	11/1/96
14GP016	11/3/96
14GP020	11/6/96
14GP021	12/9/96
14GP022	12/12/96

TABLE O-2-4
TIER II EVALUATION
AREA 14, PLANT 1 - WEST - Painting and Degreasing Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	5.2	1.8	1.8	1.8	0.406	0.5	1/30	NA	NA	NA	NA	NA	NA
BENZENE,1,2,4-TRIMETHYL	0.01	2.6	1.6	1.6	1.6	0.225	0.25	1/30	NA	NA	NA	NA	NA	NA
BENZENE,1,3,5-TRIMETHYL	0.01	2.6	0.57	0.57	0.57	0.19	0.25	1/30	NA	NA	NA	NA	NA	NA
BENZENE,1-METHYLMETHYL	0.01	2.6	1.7	1.7	1.7	0.228	0.25	1/30	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHYLENE	0.05	0.13	0.15	0.2	0.175	0.058	0.1	2/30	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.05	2.6	0.32	0.32	0.32	0.184	0.25	1/30	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	0.01	2.6	0.29	0.29	0.29	0.181	0.25	1/30	NA	NA	NA	NA	NA	NA
NAPHTHALENE	0.05	2.6	1.2	1.2	1.2	0.214	0.25	1/30	NA	NA	NA	NA	NA	NA
TOLUENE	0.05	2.6	0.87	0.87	0.87	0.203	0.25	1/30	NA	NA	NA	NA	NA	NA
TRICHLOROETHYLENE	0.1	0.1	0.084	40	4.756	4.129	0.655	26/30	1.17E+01	Yes	No	2.42E+00	Yes	Yes
XYLENES	0.1	2.6	0.76	0.76	0.76	0.202	0.25	1/30	NA	NA	NA	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
14GP001	10/24/96
14GP002	10/24/96
14GP002	11/01/96
14GP003	10/25/96
14GP017	11/04/96
14GP018	11/04/96
14GP025	12/13/96
14GP026	12/12/96
14GP027	12/12/96
14GP028	12/12/96

TABLE O-2-5
TIER II EVALUATION
Area 15 - Former Metal Stamping Operations

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.75	2.2	1.313	0.161	0.1	3/33	2.41E+03	No	No	NA	NA	NA
2-METHYLNAPHTHALENE	0.1	0.5	12	12	12	0.564	0.5	1/33	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHYLENE	0.05	0.1	0.14	0.53	0.277	0.067	0.1	3/33	1.24E+00	No	No	NA	NA	NA
NAPHTHALENE	0.05	0.25	1.5	1.5	1.5	0.145	0.25	1/33	NA	NA	NA	NA	NA	NA
TETRACHLOROETHYLENE	0.05	0.1	0.13	35	6.415	1.592	0.1	8/33	9.46E+03	No	No	7.99E+11	No	No
TOLUENE	0.05	0.25	0.093	0.093	0.093	0.103	0.25	1/33	NA	NA	NA	NA	NA	NA
TRICHLOROETHYLENE	0.05	0.1	0.35	5	1.52	0.27	0.1	5/33	2.04E+00	Yes	No	1.33E+11	No	No
XYLENES	0.05	0.25	0.43	1	0.667	0.16	0.25	3/33	NA	NA	NA	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
14GP019	11/6/96
15GP001	11/4/96
15GP002	11/4/96
15GP003	11/4/96
15GP004	11/4/96
15GP006	11/5/96
15GP007	11/5/96
15GP008	11/5/96
15GP009	11/6/96
15GP012	7/15/97
15GP013	7/17/97

TABLE O-2-6
TIER II EVALUATION
Area 3/11 - Former Disposal Area/Carbon Brake Expansion

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.1	0.11	290	15.548	6.505	0.1	25/60	7.25E+06	No	No	1.00E+03	No	No	1.00E+03	No	No	1.87E+01	Yes	No
1,1-DICHLOROETHANE	0.05	7.2	0.16	2.2	0.74	0.175	0.1	6/60	NA	NA	NA	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
1,1-DICHLOROETHYLENE	0.05	7.2	0.15	6.9	2.54	0.231	0.1	3/60	1.08E+10	No	No	1.07E+00	Yes	Yes	1.36E+02	No	No	1.60E-02	Yes	Yes
1,2-DICHLOROETHANE	0.05	7.2	0.12	0.3	0.21	0.112	0.1	2/60	6.88E+02	No	No	5.84E+00	No	No	3.18E+02	No	No	2.50E-01	Yes	No
2-METHYLNAPHTHALENE	0.1	120	0.5	24	12.875	2.968	0.5	4/60	NA	NA	NA	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
BENZENE, 1,2,4-TRIMETHYL	0.01	60	0.29	88	13.604	2.665	0.250	7/60	8.38E+44	No	No	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
BENZENE, 1,3,5-TRIMETHYL	0.01	60	0.42	44	9.848	1.902	0.250	5/60	3.02E+58	No	NA	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
BENZENE,1-METHYL METHYL	0.01	60	0.36	13	2.999	1.473	0.250	8/60	NA	NA	NA	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
CHLOROBENZENE	0.05	7.2	0.12	0.12	0.12	0.107	0.1	1/60	NA	NA	NA	5.93E+02	No	No	6.81E+02	No	No	NA	NA	NA
CIS-1,2-DICHLOROETHYLENE	0.05	0.1	0.12	56	7.32	2.107	0.1	17/60	1.97E+01	Yes	No	1.43E+02	No	No	7.47E+02	No	No	3.57E+00	Yes	No
TRANS-1,2-DICHLOROETHENE	0.05	7.2	0.11	0.41	0.26	0.113	0.100	2/60	NA	NA	NA	2.29E+02	No	No	1.00E+03	No	No	NA	NA	NA
ETHYLBENZENE	0.05	60	0.53	74	11.144	2.559	0.25	8/60	1.93E+19	No	NA	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
N-PROPYLBENZENE	0.01	60	8.1	8.1	8.1	1.225	0.25	1/60	NA	NA	NA	4.61E+02	No	No	4.61E+02	No	No	NA	NA	NA
NAPHTHALENE	0.05	60	0.34	9	3.093	1.39	0.25	6/60	NA	NA	NA	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
TETRACHLOROETHYLENE	0.05	0.1	0.1	170	19.839	5.985	0.1	18/60	6.33E+08	No	No	1.07E+02	Yes	No	2.35E+02	No	No	2.89E+00	Yes	Yes
TOLUENE	0.05	7.2	0.28	150	22.646	5.112	0.25	13/60	3.16E+40	No	No	6.54E+02	No	No	6.54E+02	No	No	3.38E+02	No	No
TRICHLOROETHYLENE	0.05	7.2	0.11	1500	67.238	37.06	0.21	33/60	3.15E+02	Yes	No	7.24E+01	Yes	No	5.49E+02	Yes	No	2.42E+00	Yes	Yes
VINYL CHLORIDE	0.1	24	0.67	0.67	0.67	0.504	0.100	1/60	4.10E-01	Yes	Yes	4.59E-01	Yes	Yes	5.64E+01	No	No	5.00E-03	Yes	Yes
XYLENES	0.05	60	0.31	160	20.057	4.668	0.25	11/60	NA	NA	NA	4.61E+02	No	No	4.61E+02	No	No	3.43E+02	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

location	sampdate
03GP001	9/30/96
03GP002	9/30/96
03GP003	9/30/96
03GP004	9/30/96
03GP005	10/1/96
03GP006	10/1/96
03GP006	11/6/97
03GP007	10/1/96
03GP009	10/2/96
03GP010	10/2/96
03GP011	10/2/96
03GP012	10/2/96
03GP012	11/6/97
03GP013	10/2/96
03GP014	10/3/96
03GP014	11/6/97
03GP015	10/3/96
03GP015	11/6/97
03GP016	10/3/96
03GP017	10/4/96
11GP001	10/3/96
11GP002	10/3/96
11GP005	10/4/96

TABLE O-2-7
TIER II EVALUATION
AREA 4/16 - Former I-Beam Building

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	0.5	0.73	1.5	1.077	0.322	0.5	3/26	NA	NA	NA
BENZENE, 1,2,4-TRIMETHYL	0.01	0.25	0.12	2.7	1.44	0.268	0.25	3/26	NA	NA	NA
BENZENE, 1,3,5 -TRIMETHYL	0.01	0.25	0.88	0.88	0.88	0.141	0.25	1/26	NA	NA	NA
BENZENE, 1-METHYL METHYL	0.01	0.25	3.5	3.5	3.5	0.242	0.25	1/26	NA	NA	NA
ETHYLBENZENE	0.05	0.25	1.2	3.3	2.25	0.277	0.25	2/26	NA	NA	NA
N-PROPYLBENZENE	0.01	0.25	0.34	0.34	0.34	0.12	0.25	1/26	NA	NA	NA
NAPHTHALENE	0.05	0.25	0.37	1.4	0.923	0.206	0.25	3/26	NA	NA	NA
TETRACHLOROETHYLENE	0.05	0.1	0.14	0.14	0.14	0.051	0.1	1/26	5.49E+05	No	No
TOLUENE	0.05	0.25	0.31	0.31	0.31	0.121	0.25	1/26	NA	NA	NA
TRICHLOROETHYLENE	0.05	0.1	0.19	0.19	0.19	0.053	0.1	1/26	1.44E+01	No	No
XYLENES	0.05	0.25	1.4	7.5	4.45	0.448	0.25	2/26	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
04GP001	10/22/96
04GP004	10/23/96
04GP005	10/23/96
07GP006	11/15/96
08GP009	10/21/96
16GP004	10/21/96
16GP005	10/14/96
16GP005	10/21/96

TABLE O-2-8
TIER II EVALUATION
AREA 5, PLANT 14 - Former USTS

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	6.4	1.1	1.1	1.1	0.775	0.5	1/16	NA	NA	NA
BENZENE,1,2,4-TRIMETHYL	0.01	1.3	0.77	31	12.662	4.852	0.25	6/16	NA	NA	NA
BENZENE, 1,3,5-TRIMETHYL	0.01	1.3	0.81	30	13.253	3.465	0.25	4/16	NA	NA	NA
BENZENE, 1-METHYL METHYL	0.01	3.2	2	2	2	0.443	0.25	1/16	NA	NA	NA
N-PROPYLBENZENE	0.01	3.2	20	20	20	1.568	0.25	1/16	1.09E+15	No	No
NAPHTHALENE	0.05	3.2	0.63	0.63	0.63	0.391	0.25	1/16	NA	NA	NA
TOLUENE	0.05	3.2	2.2	2.2	2.2	0.457	0.25	1/16	NA	NA	NA
XYLENES	0.1	0.25	0.69	24	7.87	3.509	0.25	7/16	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP035	10/17/96
05GP036	10/17/96
05GP037	10/17/96
05GP040	10/17/96
05GP043	10/18/96

TABLE O-2-9
TIER II EVALUATION
AREA 5, PLANT 19 - Former USTS

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?
BENZENE, 1,2,4-TRIMETHYL	0.13	2.8	2.9	6.7	4.825	2.127	1.525	4/10	NA	NA	NA
BENZENE, 1-METHYL METHYL	0.13	0.25	6	83	40.667	24.444	16.000	6/10	NA	NA	NA
ETHYLBENZENE	0.13	0.25	1.8	84	32.633	19.624	9.4	6/10	4.73E+17	No	No
TRICHLOROETHYLENE	0.1	0.13	0.39	0.39	0.39	0.085	0.1	1/10	1.67E+02	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP019	10/14/96
05GP021	10/14/96
05GP023	10/15/96
05GP024	10/15/96

TABLE O-2-10
TIER II EVALUATION
AREA 5, PLANT 6-16, CENTRAL - Former USTs

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1-DICHLOROETHYLENE	0.05	13	0.17	0.17	0.17	0.199	0.1	1/43	6.40E+04	No	No	1.60E-02	Yes	Yes
2-METHYLNAPHTHALENE	0.1	54	0.91	0.91	0.91	2.019	0.5	1/43	NA	NA	NA	NA	NA	NA
BENZENE	0.05	13	0.17	5	1.99	0.37	0.1	4/43	3.85E+00	Yes	No	3.70E-01	Yes	No
BENZENE,1,2,4-TRIMETHYL	0.01	27	0.32	59	13.826	5.946	0.320	17/43	NA	NA	NA	NA	NA	NA
BENZENE,1,3,5-TRIMETHYL	0.01	27	0.67	81	37.918	4.348	0.250	4/43	NA	NA	NA	NA	NA	NA
BENZENE,1-METHYL METHYL	0.01	13	0.64	150	37.873	22.203	1.600	25/43	NA	NA	NA	3.43E+02	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	13	0.06	0.06	0.06	0.197	0.1	1/43	NA	NA	NA	NA	NA	NA
ETHYLBENZENE	0.05	0.25	0.42	230	43.793	26.513	1.9	26/43	2.28E+11	No	No	NA	NA	NA
N-PROPYLBENZENE	0.01	27	0.36	23	6.972	1.652	0.25	5/43	1.22E+10	No	No	NA	NA	NA
NAPHTHALENE	0.05	27	0.84	2.8	1.82	1.116	0.25	2/43	NA	NA	NA	NA	NA	NA
TOLUENE	0.05	27	0.36	0.36	0.36	1.075	0.25	1/43	NA	NA	NA	NA	NA	NA
XYLENES	0.05	27	0.25	58	15.469	3.682	0.25	8/43	NA	NA	NA	NA	NA	NA

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP001	10/5/96
05GP001	11/6/97
05GP002	10/5/96
05GP003	10/5/96
05GP003	11/6/97
05GP004	10/5/96
05GP005	10/5/96
05GP005	11/6/97
05GP006	10/5/96
05GP007	10/5/96
05GP007	11/6/97
05GP008	10/6/96
05GP009	10/6/96
05GP011	10/6/96
05GP052	11/12/96
05GP053	11/12/96
17GP003	12/16/96

TABLE O-2-11
TIER II EVALUATION
AREA 5, PLANT 6-16, NORTH - Former USTs

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Industrial Surf. Soil	Max>?	Mean>?	Construction Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
2-METHYLNAPHTHALENE	0.1	58	19	19	19	3.876	0.5	1/17	NA	NA	NA	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
BENZENE	0.05	0.13	80	80	80	4.752	0.1	1/17	1.34E+00	Yes	Yes	1.30E+01	Yes	Yes	8.69E+02	No	No	3.67E-01	Yes	Yes
BENZENE,1,2,4-TRIMETHYL	0.01	29	0.77	280	55.921	27.221	0.77	8/17	2.15E+24	No	NA	4.61E+02	No	No	4.61E+02	No	No	3.43E+02	No	No
BENZENE,1,3,5-TRIMETHYL	0.01	29	0.37	81	26.553	10.33	0.37	6/17	NA	NA	NA	4.61E+02	No	No	4.61E+02	No	No	NA	NA	NA
BENZENE,1-METHYL METHYL	0.01	29	5.9	42	17.5	5.301	0.25	4/17	NA	NA	NA	4.61E+02	No	No	4.61E+02	No	No	NA	NA	NA
ETHYLBENZENE	0.05	0.25	0.63	280	50.804	23.964	0.25	8/17	9.40E+09	No	No	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
N-PROPYLBENZENE	0.01	29	0.34	12	6.028	2.991	0.25	5/17	NA	NA	NA	3.95E+02	No	No	3.95E+02	No	No	NA	NA	NA
NAPHTHALENE	0.05	29	3.1	30	17.7	4.102	0.25	3/17	3.01E+17	No	No	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
TOLUENE	0.05	7.8	3.8	700	159.76	47.297	0.25	5/17	2.04E+21	No	No	6.54E+02	Yes	No	6.54E+02	Yes	No	3.38E+02	Yes	No
XYLENES	0.1	0.25	0.5	720	127.844	67.737	0.5	9/17	1.02E+09	No	No	4.61E+02	Yes	No	4.61E+02	Yes	No	3.43E+02	Yes	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP013	10/6/96
05GP028	1015/96
05GP029	10/16/96
05GP031	10/16/96
17GP001	11/12/96

TABLE O-2-12
TIER II EVALUATION
AREA 5, PLANT 6/16 - FORMER RAIL SUPPLY LINE

Analyte	Minimum	Maximum	Minimum	Maximum	Mean of	Mean of	Median	FOD	Residential			Industrial			Construction			Vapor Mig.		
(mg/kg)	SQL	SQL	Detect	Detect	Detects	all Samples			Sub. Soil	Max>?	Mean>?	Surf. Soil	Max>?	Mean>?	Soil	Max>?	Mean>?	Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	45	0.31	1.1	0.6	2.475	0.27	3/10	NA	NA	NA	1.00E+03	No	No	1.00E+03	No	No	NA	NA	NA
BENZENE, 1,2,4-TRIMETHYL	0.05	0.53	0.14	870	290.513	96.892	0.140	3/9	6.00E+28	No	No	4.61E+02	Yes	No	4.61E+02	Yes	No	3.43E+02	Yes	No
BENZENE, 1,3,5-TRIMETHYL	0.05	0.53	0.14	580	194.313	58.355	0.195	3/10	2.12E+37	No	NA	4.61E+02	Yes	No	4.61E+02	Yes	No	3.43E+02	Yes	No
BENZENE, 1-METHYL METHYL	0.01	0.74	150	150	150	15.092	0.075	1/10	NA	NA	NA	4.61E+02	No	No	4.61E+02	No	No	3.43E+02	No	No
CIS-1,2-DICHLOROETHYLENE	0.05	0.21	0.1	190	29.781	20.865	0.24	7/10	8.43E+00	Yes	Yes	1.43E+02	Yes	No	7.47E+02	No	No	3.57E+00	Yes	Yes
ETHYLBENZENE	0.05	0.74	0.15	600	200.307	60.157	0.125	3/10	2.27E+12	No	No	3.95E+02	Yes	No	3.95E+02	Yes	No	1.39E+03	No	NA
TETRACHLOROETHYLENE	0.05	45	0.15	0.23	0.18	2.342	0.155	3/10	5.77E-02	Yes	Yes	1.07E+02	No	No	2.35E+02	No	No	NA	NA	NA
TOLUENE	0.05	0.74	0.17	1200	400.39	120.189	0.21	3/10	1.24E+05	No	No	6.54E+02	Yes	No	6.54E+02	Yes	No	3.38E+02	Yes	No
TRICHLOROETHYLENE	0.05	45	0.14	7.6	2.704	4.156	1.11	7/10	1.65E+01	No	No	7.24E+01	No	No	5.49E+02	No	No	2.42E+00	Yes	Yes
XYLENES	0.05	2.5	0.8	2500	501.118	250.704	0.645	5/10	1.11E+11	No	No	4.61E+02	Yes	Yes	4.61E+02	Yes	Yes	3.43E+02	Yes	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
05GP048	11/11/96
09GP008	7/18/97
09HA001	7/25/97

TABLE O-2-13
TIER II EVALUATION
AREA 7, PLANT 7 - SWMU 19

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
TETRACHLOROETHYLENE	0.1	0.1	0.1	1.4	0.49	0.427	0.31	6/7	5.28E+05	No	No	2.89E+00	No	No

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier II value sources and comparisons are described in text.
NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
07GP002	10/22/96
07GP003	10/23/96

TABLE O-2-14
TIER II EVALUATION
AREA 8 - Former Stormwater Drainage System/Dry Wells

Analyte (mg/kg)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Residential Sub. Soil	Max>?	Mean>?	Vapor Mig. Sub. Soil	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	0.05	0.71	0.58	7.2	3.89	0.427	0.1	2/21	1.78E+04	No	No	NA	NA	NA
1,1-DICHLOROETHANE	0.05	0.71	0.14	57	28.57	2.777	0.1	2/21	2.37E+06	No	No	1.23E+02	No	No
2-METHYLNAPHTHALENE	0.1	1.1	0.52	6.5	3.68	0.894	0.5	4/21	NA	NA	NA	NA	NA	NA
BENZENE, 1,2,4	0.05	0.25	0.99	8.8	3.199	1.14	0.25	7/21	NA	NA	NA	NA	NA	NA
BENZENE, 1,3,5	0.05	2.6	0.64	6.7	3.67	0.515	0.25	2/21	NA	NA	NA	NA	NA	NA
BENZENE, 1-MM	0.05	2.6	2.8	3.8	3.367	0.653	0.25	3/21	NA	NA	NA	NA	NA	NA
CHLOROBENZENE	0.05	0.71	0.26	0.26	0.26	0.071	0.1	1/21	NA	NA	NA	NA	NA	NA
CIS-1,2-DICHLOROETHYLENE	0.05	0.71	0.14	6.4	3.27	0.368	0.1	2/21	1.51E+00	Yes	No	3.57E+00	Yes	No
ETHYLBENZENE	0.05	2.6	2.4	3.3	2.9	0.586	0.25	3/21	NA	NA	NA	NA	NA	NA
N-PROPYLBENZENE	0.05	2.6	1.3	1.3	1.3	0.241	0.25	1/21	NA	NA	NA	NA	NA	NA
NAPHTHALENE	0.05	0.71	0.36	2.8	1.385	0.369	0.25	4/21	NA	NA	NA	NA	NA	NA
TOLUENE	0.05	2.6	3.7	3.7	3.7	0.348	0.25	1/21	NA	NA	NA	NA	NA	NA
TRICHLOROETHYLENE	0.05	0.71	3.3	3.3	3.3	0.216	0.1	1/21	5.38E+00	No	No	2.42E+00	Yes	No
XYLENES	0.05	2.6	0.57	2.8	1.59	0.392	0.25	3/21	NA	NA	NA	NA	NA	NA

Notes:

SQL = Sample Quantitation Limit

Mean of Detects = Arithmetic mean of results reported above the detection limit.

Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.

FOD = Frequency of detection

All Tier II value sources and comparisons are described in text.

NA = maximum concentration did not exceed Tier I criterion.

Samples included:

location	sampdate
08GP001	10/7/96
08GP002	10/8/96
08GP003	10/8/96
08GP005	10/9/96
08GP007	10/9/96
08GP008	10/14/96
08GP010	10/21/96

TABLE O-2-15
TIER II EVALUATION
ON-SITE GROUNDWATER

Analyte (ug/L)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	Median	FOD	Vapor Mig. GW	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	1	5000	6.6	2700	272.603	93.08	5	32/147	4.52E+13	NO	NO
1,1-DICHLOROETHANE	1	5000	5	2700	222.573	107.59	5	51/147	3.68E+14	NO	NO
1,1-DICHLOROETHYLENE	1	5000	6.3	180	62.66	37.298	5	5/147	3.40E+11	NO	NO
1,2-DICHLOROETHANE	1	5000	7.6	6300	1838.229	122.378	5	7/147	1.34E+03	YES	NO
1,2-DICHLOROETHYLENE	1	2	230	240	235	59.438	2	2/8	2.65E+13	NO	NO
1,2-DICHLOROPROPANE	1	500	150	160	155	15.752	5	2/109	7.00E+02	NO	NO
2-METHYLNAPHTHALENE	10	10000	12	20	15	74.562	10	3/137	3.81E+05	NO	NO
BENZENE	1	5000	5	15000	2906.133	265.514	5	12/147	8.30E+02	YES	NO
BENZENE, 1,2,4-TRIMETHYL	1	20000	1.6	1500	277.647	198.44	5.000	17/125	1.48E+05	NO	NO
BENZENE, 1,3,5-TRIMETHYL	1	5000	3.1	65	25.275	35.333	5.000	4/137	1.48E+05	NO	NO
BENZENE, 1-MTEHYL METHYL	1	5000	14	280	106.857	39.657	5.000	7/137	1.48E+05	NO	NO
CHLOROFORM	1	500	6.6	6.6	6.6	13.863	5	1/109	4.20E+02	NO	NO
CIS-1,2-DICHLOROETHYLENE	5	1300	5.5	120000	3113.174	1763.742	17	7.00E-02	2.65E+13	NO	NO
ETHYLBENZENE	1	5000	6.4	2900	964.59	91.448	5	10/147	6.44E+05	NO	NO
MTBE	50	50000	130	130	130.000	374.672	50	1/137	NA	NO	NO
N-PROPYLBENZENE	1	5000	9.5	170	76.875	36.646	5	4/137	6.44E+05	NO	NO
NAPHTHALENE	5	5000	14	1700	365.6	49.904	5	5/125	3.81E+05	NO	NO
TETRACHLOROETHYLENE	1	5000	7.7	35	18.567	36.005	5	3/147	5.30E+14	NO	NO
TOLUENE	1	5000	17	17000	4393	239.391	5	7/147	2.93E+05	NO	NO
TRICHLOROETHYLENE	1	1300	6	19000	905.781	364.194	5	57/147	5.88E+13	NO	NO
VINYL CHLORIDE	1	2000	3.4	1300	109.157	43.956	10.000	35/147	7.24E+12	NO	NO
XYLENES	3	5000	6.5	8700	2880.682	244.276	10	11/147	1.48E+05	NO	NO

Notes:

SQL = Sample Quantitation Limit

Mean of Detects = Arithmetic mean of results reported above the detection limit.

Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.

FOD = Frequency of detection

All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Response. 10/21/

Vapor migration values developed by ABB-ES.

Mean of detects is used as the mean concentration for comparison of Tier I values

TABLE O-2-16
TIER II EVALUATION
OFF-SITE GROUNDWATER

Analyte (ug/L)	Minimum SQL	Maximum SQL	Minimum Detect	Maximum Detect	Mean of Detects	Mean of all Samples	FOD	Vapor Mig. GW	Max>?	Mean>?
1,1,1-TRICHLOROETHANE	5	5	35	35	35	13	1/3	6.31E+05	NO	NO
1,1-DICHLOROETHANE	5	5	14	44	29	20	2/3	2.84E+06	NO	NO
1,1-DICHLOROETHYLENE	5	5	6.3	6.3	6.3	3.8	1/3	1.84E+02	NO	NO
1,2-DICHLOROETHANE	5	5	11	190	100.5	68	2/3	6.56E+03	NO	NO
1,2-DICHLOROETHYLENE	NA	NA	28	117	235	68.4	3/3	7.36E+04	NO	NO
TRICHLOROETHYLENE	5	5	64	64	64	23	1/3	1.32E+04	NO	NO
VINYL CHLORIDE	2	2	31.5	31.5	31.5	11	1/3	1.06E+02	NO	NO

Notes:
SQL = Sample Quantitation Limit
Mean of Detects = Arithmetic mean of results reported above the detection limit.
Mean of all Samples = Arithmetic mean of all results, using 1/2 the SQL as the value for results reported as not-detected.
FOD = Frequency of detection
All Tier I values except vapor migration values are from "Risk-Integrated System of Cleanups" Indiana Department of Environmental Management Office of Environmental Resp
Vapor migration values developed by ABB-ES.
Mean of detects is used as the mean concentration for comparison of Tier I values

Samples included:

location	sampdate
S-9	9/14/97
S-14	9/14/97
S-15	9/14/97

TABLE O-2-17
TIER II EVALUATION
OFF-SITE GROUNDWATER AT COMPLIANCE POINTS

Analyte (ug/L)	Maximum Detect	FOD	Residential GW	Max>?
1,2-DICHLOROETHYLENE, CIS	64	1/9	7.00E+01	NO
1,2-DICHLOROETHYLENE, TRANS	97	1/9	1.00E+02	NO

Notes:

Samples included: All data from sampling in Sept. 1997

location		
7-25	MW-9	S-22
7-50	S-20	S-23
9-33	S-25	5D

APPENDIX O-3

VAPOR MIGRATION MODELING

ABB TECHNICAL MEMORANDUM

SUBJECT: Vapor Migration Modeling

PROJECT: AlliedSignal Industrial Complex, South Bend, Indiana

PREPARED BY: Ron Lewis, ABB Environmental Services, Inc.

DATE: February 13, 1998

INTRODUCTION

This document presents the vapor migration model used to estimate volatile emissions from subsurface soil and groundwater sources to indoor air, the risk-based screening levels used to derive acceptable VOC concentrations in indoor air, and the final soil screening levels selected for each VOC. Soil screening levels (i.e., Tier I and II criteria) were developed using a three-step process. The first step used a fate and transport model to estimate VOC migration from subsurface soil and groundwater to indoor air. The output from the model is a volatilization factor (VF) which relates the amount of VOC in soil to the estimated indoor air concentration. The second step was to calculate risk-based screening levels for inhalation exposures to air. The product of this step is an air concentration that corresponds to a fixed level of acceptable risk (i.e., a threshold air concentration). The final step in this process was to combine the VF from the model with the RBSLs to calculate target soil and groundwater concentrations. The target soil and groundwater concentrations represent VOC concentrations in those media that do not pose unacceptable risk to receptors exposed to air in a building overlying the soil or groundwater source area.

CONCEPTUAL MODEL

The following paragraphs provide additional detail describing the modeling approach.

Step 1 - Calculate soil and groundwater volatilization factors

The Johnson-Ettinger model, as recommended in USEPA's Soil Screening Guidance (USEPA, 1996), is the fate and transport model used in this evaluation. Two models are presented in the USEPA guidance document: one for infinite source areas, and one for finite source areas. The model for finite source areas has been used in this evaluation because it is assumed that chemicals in soil and groundwater will degrade

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over time, rather than remain at a steady concentration (the potential degradation of VOCs is demonstrated in the soil leaching model, presented in Appendix O-5), and because the depth to soil sources is known.

The equations and theory supporting the model development are provided as an attachment to this document. This information was excerpted from Appendix H of the Soil Screening Guidance document (USEPA, 1996). The equations included in this attachment are specific to soil sources, and do not provide the equations used to derive the VF factor or the effective diffusion variables (used only in the *chi* parameter).

<u>Groundwater modifications:</u> To calculate migration from groundwater, the Csource variable for soil was substituted with a Csource value for groundwater. The Csource value for groundwater is equal to the Henry's Law constant multiplied by the Cgw (average contaminant level in groundwater). The Cgw was set equal to 1 g/cm^3, consistent with the Cr for soil (1 g/g). The Cgw value was substituted for the Cr value used in the soil equations.

<u>Diffusion variables:</u> The equations used to derive the effective diffusion variables are presented in ASTM's Standard Guide for Risk-Based Corrective Action at Petroleum Release Sites (ASTM, 1995). These equations are also presented in the attachment to this document.

<u>Volatilization factors:</u> The VF equations are presented below:

For both soil and groundwater:

VF = 1 / Cbuilding

Cbuilding is dependent upon the relationship between the exposure time (T) and the degradation time (TD):

If T > TD, Cbuilding = $\langle E \rangle$ */ Qbuilding*

If T < TD, Cbuilding = a x Csource x 1000 $cm^3 * kg/m^3 * g$

<u>Model input parameters:</u> The chemical-physical inputs to the model are both chemical- and site-specific. Chemical constants such as Henry's Law values and soil/water partition coefficients were obtained from IDEM draft RISC guidance (IDEM, 1997). Variables not presented in IDEM guidance were obtained

from the USEPA SSL guidance (USEPA, 1996). Site-specific inputs to the model included soil bulk density, water content and air content in vadose zone soils, depth to soil and groundwater sources, thickness of soil and groundwater source areas, soil porosity, vadose zone thickness, and organic carbon content. In both the Tier I and Tier II models, it was conservatively assumed that the soil gas source was located directly below the foundation. The basis of all input variables are provided in Tables O-3-1a through O-3-4a. All output variables are also provided in the pages accompanying those tables. The Tier I model is presented in Tables O-3-1a.

Tier II modifications Tier II vapor migration criteria were calculated using the Tier I fate and transport model. However, the following modifications were made to the model:

- The basement area was based on the dimensions for Plant 13, an average small-sized building at the Facility.
- The building ventilation rate was adjusted to reflect the minimum exchange rate that would be required by ASHRAE standards. This value is 8 liters per person per second, and it was assumed that the building would be staffed by a minimum of 20 workers.
- The area of cracks in the building foundation as a function of the total foundation area was modified from 1% to 0.01% based on empirical measurements cited in the literature and confirmatory engineering calculations cited in MDEQ's user manual for "Risk-Based Screening Levels for Soil and Groundwater Volatilization to Indoor Air" (MDEQ, 1998).
- The vapor infiltration rate was recalculated based on the revised building size.
- The detected soil gas concentrations and associated soil and groundwater concentrations from among soil gas sample locations at three AOCs were used in place of the Csource, CR, and Cgw values that the Tier I model calculates and/or assumes. These data are summarized in Table O-3-3d; the sampling rationale, methods, and analytical results are presented in Appendix O-5.
- Vapor migration from groundwater was also calculated for a residential scenario. Residential parameters for building-specific values were used in the fate and transport model (e.g., basement area, building air exchange rate). These values are provided in MDEQ (1998). Documentation of these calculations are provided in Appendix O-3-4a.

Selection of soil-gas sample results for use in the Tier II model was based on a conservative approach that incorporated knowledge of fate and transport properties and professional judgment. In general, for each

COC detected in soil gas, the soil gas and associated bulk soil result that yielded the highest soil gas:soil concentration ratio were selected for use in the model. Locations with detections in soil gas and soil, but not groundwater, were selected preferentially. This approach was used because it provides the assumptions that a) the measured soil gas concentrations result entirely from COCs in soil (as opposed to soil and groundwater), and b) the soil gas:soil ratio represents the largest amount of VOCs that occur in soil gas from a given concentration in soil. Likewise, for groundwater, the locations with the highest soil gas:groundwater concentrations where VOCs were detected in both soil gas and groundwater (but not soil) were preferentially selected for use in the groundwater portion of the fate and transport model. For locations where a given COC was detected in soil gas, soil, and groundwater, professional judgment was exercised for determining the appropriate association. For example, at a location where a high soil gas concentration, low soil concentration, and high groundwater concentration were recorded, it was assumed that the soil gas result reflected groundwater, not soil, as the source. The soil gas, soil, and groundwater concentrations selected for use in the fate and transport model are indicated in Table O-3-3d.

The Tier II model which does not incorporate measured soil gas concentrations is presented in Table O-3-2a. The Tier II model which incorporates soil gas concentrations is presented in Table O-3-3a. The residential fate and transport model is presented in Table O-3-4a.

Step 2 - Calculate RBSLs

RBSLs were calculated for commercial/industrial worker inhalation exposures to air and residential exposures to air. The RBSLs are based on the commercial/industrial worker and residential exposure parameters and cancer and non-cancer inhalation dose-response values presented in Appendix 1 of the IDEM draft RISC guidance (IDEM, 1997). The equations used to calculate the RBSLs, in addition to all input variables and calculated values, are presented in the RBSL spreadsheets included in Table O-3-1b (commercial/industrial) and Table O-3-4b (residential). Because Tier I commercial/industrial RBSLs were not modified for Tier II analyses, the RBSL calculations are not presented in Tables O-3-2 and O-3-3.

Step 3 - Calculate soil and groundwater Tier values

Tier values for soil and groundwater were calculated by multiplying the VF values by the RBSLs. Because RBSLs for some VOCs may be based on carcinogenic and non-carcinogenic effects, it is necessary to use the lower of the values based on these two endpoints in order to be protective of both types of effects.

Therefore, for chemicals with Tier values based on both carcinogenic and non-carcinogenic endpoints, the lesser of the two Tier values was selected as the final Tier value for comparison to analytical data. The calculations are documented in Tables O-3-1b and O-3-4b. Final Tier I, Tier II (non-soil gas), Tier II (soil gas), and Tier II (residential) values are presented in Tables O-3-1c, O-3-2c, O-3-3c and O-3-4c, respectively.

TABLE O-3-1a

PARAMETERS FOR CALCULATION OF VOLATILIZATION FROM SUBSURFACE SOIL AND GROUNDWATER TO INDOOR AIR

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
HENRY'S LAW CONSTANT	H	chemical-specific	dimensionless	IDEM, 1997
SOIL BULK DENSITY	ρ_b	1.66E+00	g-soil/cm3-soil	Site-specific (1)
WATER CONTENT VADOSE ZONE SOILS	θ_W	0.12	cm3-water/cm3-soil	Site-specific (1)
AIR CONTENT VADOSE ZONE SOILS	θ_A	0.26	cm3-air/cm3-soil	Site-specific (1)
SOIL-WATER PARTITION COEFFICIENT	Kd	chemical-specific	cm3-water/g-soil	IDEM, 1997
SOURCE-BUILDING SEPARATION AT t=0; SOIL	$L_T^0{}_{-SOIL}$	15	cm	Assumption (5)
SOURCE-BUILDING SEPARATION AT t=0; GROUNDWATER	$L_T^0{}_{-GW}$	122	cm	Assumption (6)
AREA OF BASEMENT	A_B	1380000	cm2	USEPA, 1996
AREA OF CRACKS IN BASEMENT	A_{CRACK}	13800	cm2	USEPA, 1996
BUILDING VENTILATION RATE	$Q_{BUILDING}$	63480	cm3/sec	ASTM, 1995
AVERAGE VAPOR FLOW RATE INTO BUILDING	Q_{SOIL}	2.59	cm3/sec	USEPA, 1996
ENCLOSED SPACE WALL THICKNESS	L_{CRACK}	15	cm	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN SOIL	$D_{eff-SOIL}$	chemical-specific	cm2/sec	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN GROUNDWATER	D_{eff-GW}	chemical-specific	cm2/sec	ASTM, 1995
EFFECTIVE DIFFUSION COEFFICIENT THROUGH CRACKS	$D_{eff-CRACK}$	chemical-specific	cm2/sec	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN SOIL	Cs	1	g/g	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN GROUNDWATER	Cgw	1	g/cm3	USEPA, 1996
THICKNESS OF SOURCE AREA - SOIL	H_{C-SOIL}	365.76	cm	Assumption (7)
THICKNESS OF SOURCE AREA - GROUNDWATER	H_{C-GW}	2133.6	cm	Assumption (7)
DIFFUSION COEFFICIENT IN AIR	Di_a	chemical-specific	cm2/sec	IDEM, 1997
DIFFUSION COEFFICIENT IN WATER	Di_w	chemical-specific	cm2/sec	IDEM, 1997
SOIL POROSITY IN IMPACTED ZONE	θ_T	0.39	cm3/cm3	Site-specific (1)
THICKNESS OF CAPILLARY FRINGE	hcap	60.96	cm	Assumption (8)
THICKNESS OF VADOSE ZONE	hv	365.76	cm	Assumption (5)
EFFECTIVE DIFFUSION THROUGH CAPILLARY FRINGE	$D_{eff-CAP}$	chemical-specific	cm3/cm3	ASTM, 1995
AIR CONTENT CAPILLARY FRINGE	θ_{A-CAP}	0.038	cm3-air/cm3-soil	ASTM, 1995
WATER CONTENT CAPILLARY FRINGE	θ_{W-CAP}	0.342	cm3-water/cm3-soil	ASTM, 1995
AIR CONTENT IN WALL CRACKS	$\theta_{A-CRACK}$	0.26	cm3-air/cm3-tot.vol.	Assumption (3)
WATER CONTENT WALL CRACKS	$\theta_{W-CRACK}$	0.12	cm3-water/cm3-tot.vol.	Assumption (3)
AVERAGING TIME FOR VAPOR FLUX	T	1.80E+08	sec	IDEM, 1997 (4)
AIR CONCENTRATION - INDOOR AIR	$C_{BUILDING}$	chemical-specific	kg/m3	USEPA, 1996
VOLATILIZATION FACTOR - SUBSURFACE SOIL:INDOOR AIR	VF_{SOIL}	chemical-specific	m3/kg	USEPA, 1996
VOLATILIZATION FACTOR - GROUNDWATER:INDOOR AIR	VF_{GW}	chemical-specific	m3/kg	USEPA, 1996
FRACTION ORGANIC CARBON IN SOIL	foc	0.0066	unitless	Site-specific (2)
CONVERSION FACTOR 1	CF1	1.0E+03	cm3-kg/m3-g	USEPA, 1996
SOIL GAS CONCENTRATION	C_{SOURCE}	chemical-specific	g/cm3	Calculated in model

NOTES:

USEPA, 1996. Soil Screening Guidance: Technical Background Document. Appendix H. EPA/540/R-95/128

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM Standard E1739-95)

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management, Office of Response. October, 1997

(1) Site-specific values determined through measurements taken at 5 site locations (MW-5, 4-6; MW-5, 6-8; MW-9, 14-16; MW-4, 10-12; MW-3, 2-4); geometric mean of measured values used as input parameter in this model.

(2) Site-specific values determined through measurements taken at 5 site locations (02PS011, 16-18; 09PS002, 16-18; 17PS001, 10-12; 05PS052, 14-16; 12PS001, 18-20); geometric mean of measured values used as input parameter in this model.

(3) Assumed values for vadose zone soil and water.

(4) Value for occupational worker.

(5) Assumes that a building is constructed on top of the contaminated soil.

(6) Assumes that groundwater is present at its shallowest depth on-site (12 feet), and that a building with an 8-foot basement is constructed above the groundwater (resulting in a building-groundwater separation of 4 feet).

(7) Thickest areas of soil contamination (surface to groundwater table = 12 feet) and groundwater plume (70 feet).

(8) Thickest smear zone (2 feet).

NOTE: All equations presented in the text accompanying this Table.

Table O-3-1a, cont.

CHEMICAL	H (unitless)	Koc (cm3/g)	Di_a (cm2/sec)	Di_w (cm2/sec)	$D_{eff\text{-}cap}$ (cm3/cm3)	$D_{eff\text{-}soil}$ (cm2/sec)
1,1,1-Trichloroethane	7.05E-01	1.10E+01	7.80E-02	8.80E-06	1.19E-05	5.78E-03
1,1,2,2-Tetrachloroethane	1.41E-02	9.33E+01	7.10E-02	7.90E-06	1.12E-04	5.26E-03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	7.80E-02	8.80E-06	5.30E-05	5.78E-03
1,1-Dichloroethane	2.30E-01	3.16E+01	7.42E-02	1.05E-05	1.75E-05	5.50E-03
1,1-Dichloroethene	1.07E+00	5.89E+01	9.00E-02	1.04E-05	1.28E-05	6.67E-03
1,2-Dichlorobenzene	7.79E-02	6.17E+02	6.90E-02	7.90E-06	2.72E-05	5.11E-03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.04E-01	9.90E-06	5.83E-05	7.71E-03
1,2-Dichloropropane	1.15E-01	4.37E+01	7.82E-02	8.73E-06	2.36E-05	5.79E-03
1,3-Dichlorbenzene	7.80E-02	1.20E+03	1.30E-01	7.90E-06	3.46E-05	9.63E-03
1,4-Dichlorobenzene	9.96E-02	6.17E+02	6.90E-02	7.90E-06	2.31E-05	5.11E-03
2-Butanone	1.10E-03	4.50E+00	9.00E-02	9.80E-06	1.66E-03	6.72E-03
2-Hexanone	6.36E-02	2.90E+00	7.60E-02	7.00E-05	2.12E-04	5.64E-03
4-Methyl-2-Pentanone	6.36E-02	2.90E+00	7.6E-02	7.0E-05	2.12E-04	5.64E-03
Acetone	1.59E-03	5.75E-01	1.24E-01	1.14E-05	1.34E-03	9.23E-03
Benzene	2.28E-01	5.89E+01	8.80E-02	9.80E-06	1.87E-05	6.52E-03
Bromomethane	2.67E-01	9.98E-02	9.61E-02	8.96E-06	1.80E-05	7.12E-03
Carbon tetrachloride	1.25E+00	1.74E+02	7.80E-02	8.80E-06	1.09E-05	5.78E-03
Chlorobenzene	1.52E-01	2.19E+02	7.30E-02	8.70E-06	1.95E-05	5.41E-03
Chloroethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
Chloroform	1.50E-01	3.98E+01	1.04E-01	1.00E-05	2.51E-05	7.71E-03
Chloromethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	7.36E-02	1.13E-05	2.15E-05	5.45E-03
1,3-dichloropropene	7.26E-01	4.57E+01	6.26E-02	1.00E-05	1.02E-05	4.64E-03
Ethylbenzene	3.23E-01	3.63E+02	7.50E-02	7.80E-06	1.37E-05	5.56E-03
Methylene Chloride	8.98E-02	1.17E+01	1.01E-01	1.17E-05	3.64E-05	7.48E-03
Methyl tertiary butyl ether					#DIV/0!	#DIV/0!
Styrene	1.13E-01	7.76E+02	7.10E-02	8.00E-06	2.18E-05	5.26E-03
Tetrachloroethene	7.54E-01	1.55E+02	7.20E-02	8.20E-06	1.08E-05	5.33E-03
Toluene	2.72E-01	1.82E+02	8.70E-02	8.60E-06	1.65E-05	6.45E-03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	7.07E-02	1.19E-05	1.44E-05	5.24E-03
Trichloroethene	4.22E-01	1.66E+02	7.90E-02	9.10E-06	1.37E-05	5.85E-03
Vinyl chloride	1.11E+00	1.86E+01	1.06E-01	1.23E-06	1.32E-05	7.85E-03
Xylene (total)	2.76E-01	3.86E+02	7.80E-02	8.70E-06	1.54E-05	5.78E-03
Acenapthene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
Acenaphthylene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
2-Methylnaphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03
Naphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03

Table O-3-1a, cont.

CHEMICAL	D_{eff}^{crack} (cm2/sec)	D_{eff}^{ws} (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	8.11E+01	1.14E+00	4.27E-05	3.89E-09	7.30E-05	1.05E-05
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	7.94E+01	2.28E+00	2.88E-07	6.60E-10	9.57E-05	5.39E-05
1,1,2-Trichloroethane	5.78E-03	3.52E-04	8.11E+01	1.60E+00	1.42E-06	8.85E-10	1.01E-04	3.80E-05
1,1-Dichloroethane	5.50E-03	1.20E-04	8.02E+01	1.21E+00	1.07E-05	1.86E-09	8.77E-05	1.60E-05
1,1-Dichloroethene	6.67E-03	8.88E-05	8.36E+01	1.14E+00	3.04E-05	6.39E-09	8.88E-05	1.04E-05
1,2-Dichlorobenzene	5.11E-03	1.84E-04	7.88E+01	1.35E+00	2.57E-07	9.66E-10	9.37E-05	2.34E-05
1,2-Dichloroethane	7.71E-03	3.91E-04	8.59E+01	1.53E+00	4.28E-06	1.05E-09	1.24E-04	4.38E-05
1,2-Dichloropropane	5.79E-03	1.61E-04	8.12E+01	1.27E+00	4.71E-06	1.25E-09	9.75E-05	2.12E-05
1,3-Dichlorbenzene	9.63E-03	2.37E-04	8.89E+01	1.27E+00	2.51E-07	1.25E-09	1.57E-04	3.14E-05
1,4-Dichlorobenzene	5.11E-03	1.57E-04	7.88E+01	1.29E+00	3.28E-07	1.05E-09	9.36E-05	2.06E-05
2-Butanone	6.72E-03	4.68E-03	8.37E+01	8.08E+00	1.94E-07	3.46E-10	1.16E-04	1.03E-04
2-Hexanone	5.64E-03	1.21E-03	8.07E+01	3.11E+00	9.47E-06	5.19E-09	9.06E-05	6.65E-05
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	8.07E+01	3.11E+00	9.47E-06	5.19E-09	9.06E-05	6.65E-05
Acetone	9.23E-03	5.01E-03	8.84E+01	6.84E+00	5.15E-07	5.36E-10	1.50E-04	1.31E-04
Benzene	6.52E-03	1.29E-04	8.32E+01	1.20E+00	8.01E-06	1.98E-09	1.04E-04	1.72E-05
Bromomethane	7.12E-03	1.24E-04	8.47E+01	1.18E+00	4.44E-05	2.23E-09	8.72E-05	1.66E-05
Carbon tetrachloride	5.78E-03	7.52E-05	8.11E+01	1.13E+00	1.37E-05	6.32E-09	8.89E-05	8.90E-06
Chlorobenzene	5.41E-03	1.34E-04	7.99E+01	1.24E+00	1.43E-06	1.37E-09	9.62E-05	1.79E-05
Chloroethane	7.78E-03	9.56E-05	8.60E+01	1.13E+00	6.37E-05	7.72E-09	8.67E-05	1.08E-05
Chloroform	7.71E-03	1.72E-04	8.59E+01	1.23E+00	8.63E-06	1.74E-09	1.19E-04	2.27E-05
Chloromethane	7.78E-03	9.56E-05	8.60E+01	1.13E+00	6.37E-05	7.72E-09	8.67E-05	1.08E-05
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	8.01E+01	1.26E+00	7.33E-06	1.65E-09	9.02E-05	1.91E-05
1,3-dichloropropene	4.64E-03	7.06E-05	7.68E+01	1.14E+00	1.85E-05	3.45E-09	7.12E-05	9.20E-06
Ethylbenzene	5.56E-03	9.42E-05	8.04E+01	1.17E+00	1.91E-06	2.05E-09	9.76E-05	1.29E-05
Methylene Chloride	7.48E-03	2.48E-04	8.54E+01	1.34E+00	1.10E-05	1.50E-09	1.13E-04	3.07E-05
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	7.94E+01	1.27E+00	3.05E-07	1.13E-09	9.56E-05	1.97E-05
Tetrachloroethene	5.33E-03	7.49E-05	7.96E+01	1.14E+00	8.87E-06	3.80E-09	8.72E-05	9.66E-06
Toluene	6.45E-03	1.14E-04	8.31E+01	1.18E+00	3.57E-06	2.08E-09	1.08E-04	1.54E-05
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	7.93E+01	1.18E+00	1.13E-05	2.56E-09	8.39E-05	1.30E-05
Trichloroethene	5.85E-03	9.43E-05	8.14E+01	1.16E+00	5.36E-06	2.68E-09	9.76E-05	1.26E-05
Vinyl chloride	7.85E-03	9.15E-05	8.62E+01	1.12E+00	6.33E-05	6.83E-09	8.76E-05	1.07E-05
Xylene (total)	5.78E-03	1.06E-04	8.11E+01	1.18E+00	1.60E-06	1.97E-09	1.01E-04	1.44E-05
Acenapthene	3.13E-03	1.11E-03	6.76E+01	3.91E+00	1.14E-09	4.75E-10	6.70E-05	5.05E-05
Acenaphthylene	3.13E-03	1.11E-03	6.76E+01	3.91E+00	1.14E-09	4.75E-10	6.70E-05	5.05E-05
2-Methylnaphthalene	4.37E-03	4.88E-04	7.56E+01	2.02E+00	1.75E-08	6.51E-10	8.38E-05	4.24E-05
Naphthalene	4.37E-03	4.88E-04	7.56E+01	2.02E+00	1.75E-08	6.51E-10	8.38E-05	4.24E-05

Table O-3-1a, cont.

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CS (g/g)	CGW (g/cm3)	T_D -SOIL	T_D -GW
1,1,1-Trichloroethane	2.76E+00	7.05E-01	1	1	5.33E+07	4.45E+10
1,1,2,2-Tetrachloroethane	2.04E-02	1.41E-02	1	1	7.76E+09	2.92E+11
1,1,2-Trichloroethane	9.15E-02	3.74E-02	1	1	1.61E+09	2.05E+11
1,1-Dichloroethane	7.26E-01	2.30E-01	1	1	2.11E+08	9.36E+10
1,1-Dichloroethene	1.70E+00	1.07E+00	1	1	7.69E+07	2.71E+10
1,2-Dichlorobenzene	1.87E-02	7.79E-02	1	1	8.65E+09	1.83E+11
1,2-Dichloroethane	2.07E-01	4.01E-02	1	1	5.59E+08	1.71E+11
1,2-Dichloropropane	3.04E-01	1.15E-01	1	1	4.83E+08	1.41E+11
1,3-Dichlorbenzene	9.74E-03	7.80E-02	1	1	9.81E+09	1.41E+11
1,4-Dichlorobenzene	2.39E-02	9.96E-02	1	1	6.77E+09	1.67E+11
2-Butanone	1.08E-02	1.10E-03	1	1	1.21E+10	8.51E+11
2-Hexanone	6.28E-01	6.36E-02	1	1	2.39E+08	4.00E+10
4-Methyl-2-Pentanone	6.28E-01	6.36E-02	1	1	2.39E+08	4.00E+10
Acetone	2.08E-02	1.59E-03	1	1	4.76E+09	5.09E+11
Benzene	4.59E-01	2.28E-01	1	1	2.90E+08	8.81E+10
Bromomethane	2.33E+00	2.67E-01	1	1	5.32E+07	7.80E+10
Carbon tetrachloride	8.82E-01	1.25E+00	1	1	1.67E+08	2.73E+10
Chlorobenzene	9.86E-02	1.52E-01	1	1	1.57E+09	1.28E+11
Chloroethane	3.06E+00	1.20E+00	1	1	3.76E+07	2.24E+10
Chloroform	4.18E-01	1.50E-01	1	1	2.77E+08	1.01E+11
Chloromethane	3.06E+00	1.20E+00	1	1	3.76E+07	2.24E+10
cis-1,2-Dichloroethene	5.02E-01	1.67E-01	1	1	3.07E+08	1.06E+11
1,3-dichloropropene	1.49E+00	7.26E-01	1	1	1.17E+08	5.02E+10
Ethylbenzene	1.28E-01	3.23E-01	1	1	1.18E+09	8.48E+10
Methylene Chloride	5.49E-01	8.98E-02	1	1	2.16E+08	1.18E+11
Methyl tertiary butyl ether	0.00E+00	0.00E+00	1	1	#DIV/0!	#DIV/0!
Styrene	2.17E-02	1.13E-01	1	1	7.31E+09	1.55E+11
Tetrachloroethene	6.21E-01	7.54E-01	1	1	2.52E+08	4.55E+10
Toluene	2.07E-01	2.72E-01	1	1	6.51E+08	8.35E+10
trans-1,2-Dichloroethene	8.04E-01	3.85E-01	1	1	1.98E+08	6.78E+10
Trichloroethene	3.42E-01	4.22E-01	1	1	4.26E+08	6.47E+10
Vinyl chloride	3.01E+00	1.11E+00	1	1	3.79E+07	2.53E+10
Xylene (total)	1.04E-01	2.76E-01	1	1	1.42E+09	8.83E+10
Acenapthene	1.36E-04	6.36E-03	1	1	1.71E+12	4.66E+11
Acenaphthylene	1.36E-04	6.36E-03	1	1	1.71E+12	4.66E+11
2-Methylnaphthalene	1.49E-03	1.98E-02	1	1	1.23E+11	2.90E+11
Naphthalene	1.49E-03	1.98E-02	1	1	1.23E+11	2.90E+11

Table O-3-1a, cont.

CHEMICAL	Is T>T_D -SOIL ?	Is T>T_D -GW ?	E-SOIL	E-GW	C[illegible] - SOIL (kg/m3)	C[illegible] - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	YES	NO	4.65E+00	NA	7.33E-02	7.41E-03	1.36E+01	1.35E+02
1,1,2,2-Tetrachloroethane	NO	NO	NA	NA	1.95E-03	7.60E-04	5.12E+02	1.32E+03
1,1,2-Trichloroethane	NO	NO	NA	NA	9.27E-03	1.42E-03	1.08E+02	7.03E+02
1,1-Dichloroethane	NO	NO	NA	NA	6.37E-02	3.69E-03	1.57E+01	2.71E+02
1,1-Dichloroethene	YES	NO	4.65E+00	NA	7.33E-02	1.12E-02	1.36E+01	8.94E+01
1,2-Dichlorobenzene	NO	NO	NA	NA	1.76E-03	1.82E-03	5.70E+02	5.49E+02
1,2-Dichloroethane	NO	NO	NA	NA	2.57E-02	1.76E-03	3.89E+01	5.69E+02
1,2-Dichloropropane	NO	NO	NA	NA	2.96E-02	2.44E-03	3.38E+01	4.10E+02
1,3-Dichlorbenzene	NO	NO	NA	NA	1.53E-03	2.45E-03	6.55E+02	4.09E+02
1,4-Dichlorobenzene	NO	NO	NA	NA	2.24E-03	2.05E-03	4.46E+02	4.88E+02
2-Butanone	NO	NO	NA	NA	1.25E-03	1.13E-04	8.01E+02	8.82E+03
2-Hexanone	NO	NO	NA	NA	5.69E-02	4.23E-03	1.76E+01	2.36E+02
4-Methyl-2-Pentanone	NO	NO	NA	NA	5.69E-02	4.23E-03	1.76E+01	2.36E+02
Acetone	NO	NO	NA	NA	3.13E-03	2.08E-04	3.19E+02	4.82E+03
Benzene	NO	NO	NA	NA	4.76E-02	3.93E-03	2.10E+01	2.55E+02
Bromomethane	YES	NO	4.65E+00	NA	7.33E-02	4.44E-03	1.36E+01	2.25E+02
Carbon tetrachloride	YES	NO	4.65E+00	NA	7.33E-02	1.11E-02	1.36E+01	8.99E+01
Chlorobenzene	NO	NO	NA	NA	9.49E-03	2.72E-03	1.05E+02	3.68E+02
Chloroethane	YES	NO	4.65E+00	NA	7.33E-02	1.30E-02	1.36E+01	7.68E+01
Chloroform	NO	NO	NA	NA	4.96E-02	3.41E-03	2.01E+01	2.93E+02
Chloromethane	YES	NO	4.65E+00	NA	7.33E-02	1.30E-02	1.36E+01	7.68E+01
cis-1,2-Dichloroethene	NO	NO	NA	NA	4.53E-02	3.20E-03	2.21E+01	3.13E+02
1,3-dichloropropene	YES	NO	4.65E+00	NA	7.33E-02	6.68E-03	1.36E+01	1.50E+02
Ethylbenzene	NO	NO	NA	NA	1.25E-02	4.15E-03	7.99E+01	2.41E+02
Methylene Chloride	NO	NO	NA	NA	6.22E-02	2.76E-03	1.61E+01	3.62E+02
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	NO	NO	NA	NA	2.07E-03	2.22E-03	4.82E+02	4.50E+02
Tetrachloroethene	NO	NO	NA	NA	5.42E-02	7.28E-03	1.85E+01	1.37E+02
Toluene	NO	NO	NA	NA	2.23E-02	4.18E-03	4.49E+01	2.39E+02
trans-1,2-Dichloroethene	NO	NO	NA	NA	6.74E-02	5.02E-03	1.48E+01	1.99E+02
Trichloroethene	NO	NO	NA	NA	3.34E-02	5.30E-03	3.00E+01	1.89E+02
Vinyl chloride	YES	NO	4.65E+00	NA	7.33E-02	1.19E-02	1.36E+01	8.42E+01
Xylene (total)	NO	NO	NA	NA	1.05E-02	3.96E-03	9.55E+01	2.52E+02
Acenapthene	NO	NO	NA	NA	9.11E-06	3.21E-04	1.10E+05	3.11E+03
Acenaphthylene	NO	NO	NA	NA	9.11E-06	3.21E-04	1.10E+05	3.11E+03
2-Methylnaphthalene	NO	NO	NA	NA	1.25E-04	8.40E-04	8.00E+03	1.19E+03
Naphthalene	NO	NO	NA	NA	1.25E-04	8.40E-04	8.00E+03	1.19E+03

Table O-3-1b
EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
TARGET CANCER RISK	TRc	1E-05	unitless	IDEM, 1997
TARGET NON-CANCER RISK	TRnc	1	unitless	IDEM, 1997
CANCER SLOPE FACTOR	CSF	chemical-specific	(mg/kg/day)-1	IDEM, 1997 (1)
INHALATION RATE	IR	20	m^3/day	IDEM, 1997
BODY WEIGHT	BW	70	kg	IDEM, 1997
REFERENCE DOSE	RfD	chemical-specific	mg/kg/day	IDEM, 1997 (1)
EXPOSURE FREQUENCY	EF	250	days/year	IDEM, 1997
EXPOSURE DURATION	ED	25	years	IDEM, 1997
AVERAGING TIME				
CANCER	AT	70	years	IDEM, 1997
NONCANCER	AT	25	years	IDEM, 1997

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management Office of Response. October, 1997. Values are for occupational worker.

VF values are derived in "Vapor Migration to Indoor Air" Model.

(1) Values for chemicals not published in IDEM were obtained from IRIS or HEAST.

EQUATIONS

$$\text{RBSLcancer (mg/m3)} = \frac{\text{TRc x BW x AT x 365 days/yr}}{\text{IR x ED x EF x CSF}}$$

$$\text{RBSLnon-cancer (mg/m3)} = \frac{\text{TRnc x BW x AT x 365 days/yr x RfD}}{\text{IR x ED x EF}}$$

SSL - soil (mg/kg) = VF (m3/kg) x RBSL (mg/m3)
SSL - gw (mg/L) = VF (m3/L) x RBSL (mg/m3)
(where 1 kg water = 1 L)

Note:
For noncarcinogenic effects: AT = ED
RBSL = Risk Based Screening Level
CSF = Cancer Slope Factor
RfD = Reference Dose

Table O-3-1b
CARCINOGENIC EFFECTS

COMPOUND	INHALATION CSF (mg/kg-day)^-1	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	NC	NC	1.36E+01	1.35E+02	NC	NC
1,1,2,2-Tetrachloroethane	2.00E-01	7.15E-04	5.12E+02	1.32E+03	3.66E-01	9.41E-01
1,1,2-Trichloroethane	5.60E-02	2.56E-03	1.08E+02	7.03E+02	2.76E-01	1.80E+00
1,1-Dichloroethane	NC	NC	1.57E+01	2.71E+02	NC	NC
1,1-Dichloroethene	1.80E-01	7.95E-04	1.36E+01	8.94E+01	1.08E-02	7.11E-02
1,2-Dichlorobenzene	NC	NC	5.70E+02	5.49E+02	NC	NC
1,2-Dichloroethane	9.10E-02	1.57E-03	3.89E+01	5.69E+02	6.12E-02	8.95E-01
1,2-Dichloropropane	6.80E-02	2.10E-03	3.38E+01	4.10E+02	7.11E-02	8.64E-01
1,3-Dichlorbenzene	NC	NC	6.55E+02	4.09E+02	NC	NC
1,4-Dichlorobenzene	2.40E-02	5.96E-03	4.46E+02	4.88E+02	2.66E+00	2.91E+00
2-Butanone	NC	NC	8.01E+02	8.82E+03	NC	NC
2-Hexanone	NC	NC	1.76E+01	2.36E+02	NC	NC
4-Methyl-2-Pentanone	NC	NC	1.76E+01	2.36E+02	NC	NC
Acetone	NC	NC	3.19E+02	4.82E+03	NC	NC
Benzene	2.90E-02	4.93E-03	2.10E+01	2.55E+02	1.04E-01	1.26E+00
Bromomethane	NC	NC	1.36E+01	2.25E+02	NC	NC
Carbon tetrachloride	5.30E-02	2.70E-03	1.36E+01	8.99E+01	3.68E-02	2.43E-01
Chlorobenzene	NC	NC	1.05E+02	3.68E+02	NC	NC
Chloroethane	NC	NC	1.36E+01	7.68E+01	NC	NC
Chloroform	8.10E-02	1.77E-03	2.01E+01	2.93E+02	3.56E-02	5.18E-01
Chloromethane	6.30E-03	2.27E-02	1.36E+01	7.68E+01	3.10E-01	1.74E+00
cis-1,2-Dichloroethene	NC	NC	2.21E+01	3.13E+02	NC	NC
1,3-dichloropropene	1.30E-01	1.10E-03	1.36E+01	1.50E+02	1.50E-02	1.65E-01
Ethylbenzene	NC	NC	7.99E+01	2.41E+02	NC	NC
Methylene chloride	1.60E-03	8.94E-02	1.61E+01	3.62E+02	1.44E+00	3.24E+01
Methyl tertiary butyl ether	NC	NC	#DIV/0!	#DIV/0!	NC	NC
Styrene	NC	NC	4.82E+02	4.50E+02	NC	NC
Tetrachloroethene	2.00E-03	7.15E-02	1.85E+01	1.37E+02	1.32E+00	9.82E+00
Toluene	NC	NC	4.49E+01	2.39E+02	NC	NC
trans-1,2-Dichloroethene	NC	NC	1.48E+01	1.99E+02	NC	NC
Trichloroethene	6.00E-03	2.38E-02	3.00E+01	1.89E+02	7.15E-01	4.50E+00
Vinyl chloride	3.00E-01	4.77E-04	1.36E+01	8.42E+01	6.50E-03	4.02E-02
Xylene (total)	NC	NC	9.55E+01	2.52E+02	NC	NC
Acenapthene	NC	NC	1.10E+05	3.11E+03	NC	NC
Acenaphthylene	NC	NC	1.10E+05	3.11E+03	NC	NC
2-Methylnaphthalene	NC	NC	8.00E+03	1.19E+03	NC	NC
Naphthalene	NC	NC	8.00E+03	1.19E+03	NC	NC

NC = Not Carcinogenic

Table O-3-1b
NONCARCINOGENIC EFFECTS

COMPOUND	INHALATION RfD (mg/kg-day)	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	2.90E-01	1.48E+00	1.36E+01	1.35E+02	2.02E+01	2.00E+02
1,1,2,2-Tetrachloroethane	ND	ND	5.12E+02	1.32E+03	ND	ND
1,1,2-Trichloroethane	4.00E-03	2.04E-02	1.08E+02	7.03E+02	2.21E+00	1.44E+01
1,1-Dichloroethane	5.00E-01	2.56E+00	1.57E+01	2.71E+02	4.01E+01	6.93E+02
1,1-Dichloroethene	9.00E-03	4.60E-02	1.36E+01	8.94E+01	6.27E-01	4.11E+00
1,2-Dichlorobenzene	2.00E-01	1.02E+00	5.70E+02	5.49E+02	5.82E+02	5.62E+02
1,2-Dichloroethane	2.90E-03	1.48E-02	3.89E+01	5.69E+02	5.77E-01	8.43E+00
1,2-Dichloropropane	4.00E-03	2.04E-02	3.38E+01	4.10E+02	6.90E-01	8.39E+00
1,3-Dichlorbenzene	3.00E-02	1.53E-01	6.55E+02	4.09E+02	1.00E+02	6.27E+01
1,4-Dichlorobenzene	8.00E-01	4.09E+00	4.46E+02	4.88E+02	1.82E+03	1.99E+03
2-Butanone	2.90E-01	1.48E+00	8.01E+02	8.82E+03	1.19E+03	1.31E+04
2-Hexanone	2.30E-02	1.18E-01	1.76E+01	2.36E+02	2.07E+00	2.78E+01
4-Methyl-2-Pentanone	2.30E-02	1.18E-01	1.76E+01	2.36E+02	2.07E+00	2.78E+01
Acetone	1.00E-01	5.11E-01	3.19E+02	4.82E+03	1.63E+02	2.46E+03
Benzene	ND	ND	2.10E+01	2.55E+02	ND	ND
Bromomethane	1.43E-03	7.31E-03	1.36E+01	2.25E+02	9.97E-02	1.65E+00
Carbon tetrachloride	5.70E-04	2.91E-03	1.36E+01	8.99E+01	3.97E-02	2.62E-01
Chlorobenzene	2.00E-02	1.02E-01	1.05E+02	3.68E+02	1.08E+01	3.76E+01
Chloroethane	2.86E+00	1.46E+01	1.36E+01	7.68E+01	1.99E+02	1.12E+03
Chloroform	1.00E-02	5.11E-02	2.01E+01	2.93E+02	1.03E+00	1.50E+01
Chloromethane	ND	ND	1.36E+01	7.68E+01	ND	ND
cis-1,2-Dichloroethene	1.00E-02	5.11E-02	2.21E+01	3.13E+02	1.13E+00	1.60E+01
1,3-dichloropropene	2.00E-02	1.02E-01	1.36E+01	1.50E+02	1.39E+00	1.53E+01
Ethylbenzene	1.00E+00	5.11E+00	7.99E+01	2.41E+02	4.08E+02	1.23E+03
Methylene Chloride	3.00E+00	1.53E+01	1.61E+01	3.62E+02	2.47E+02	5.55E+03
Methyl tertiary butyl ether	8.57E-01	4.38E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	1.00E+00	5.11E+00	4.82E+02	4.50E+02	2.46E+03	2.30E+03
Tetrachloroethene	1.00E-02	5.11E-02	1.85E+01	1.37E+02	9.43E-01	7.02E+00
Toluene	4.00E-01	2.04E+00	4.49E+01	2.39E+02	9.18E+01	4.89E+02
trans-1,2-Dichloroethene	2.00E-02	1.02E-01	1.48E+01	1.99E+02	1.52E+00	2.03E+01
Trichloroethene	6.00E-03	3.07E-02	3.00E+01	1.89E+02	9.19E-01	5.78E+00
Vinyl chloride	ND	ND	1.36E+01	8.42E+01	ND	ND
Xylene (total)	2.00E-01	1.02E+00	9.55E+01	2.52E+02	9.76E+01	2.58E+02
Acenapthene	6.00E-02	3.07E-01	1.10E+05	3.11E+03	3.37E+04	9.54E+02
Acenaphthylene	6.00E-02	3.07E-01	1.10E+05	3.11E+03	3.37E+04	9.54E+02
2-Methylnaphthalene	4.00E-02	2.04E-01	8.00E+03	1.19E+03	1.63E+03	2.43E+02
Naphthalene	4.00E-02	2.04E-01	8.00E+03	1.19E+03	1.63E+03	2.43E+02

ND = No data available
Value for 4-methyl-2-pentanone used for 2-hexanone
Value for napthalene used for 2-methylnaphthalene

Table O-3-1c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - SOIL (mg/kg)	NON-CANCER SSL - SOIL (mg/kg)	SELECTED SSL - SOIL (mg/kg)
ORGANICS			
1,1,1-Trichloroethane	NC	2.02E+01	2.02E+01
1,1,2,2-Tetrachloroethane	3.66E-01	ND	3.66E-01
1,1,2-Trichloroethane	2.76E-01	2.21E+00	2.76E-01
1,1-Dichloroethane	NC	4.01E+01	4.01E+01
1,1-Dichloroethene	1.08E-02	6.27E-01	1.08E-02
1,2-Dichlorobenzene	NC	5.82E+02	5.82E+02
1,2-Dichloroethane	6.12E-02	5.77E-01	6.12E-02
1,2-Dichloropropane	7.11E-02	6.90E-01	7.11E-02
1,3-Dichlorbenzene	NC	1.00E+02	1.00E+02
1,4-Dichlorobenzene	2.66E+00	1.82E+03	2.66E+00
2-Butanone	NC	1.19E+03	1.19E+03
2-Hexanone	NC	2.07E+00	2.07E+00
4-Methyl-2-Pentanone	NC	2.07E+00	2.07E+00
Acetone	NC	1.63E+02	1.63E+02
Benzene	1.04E-01	ND	1.04E-01
Bromomethane	NC	9.97E-02	9.97E-02
Carbon tetrachloride	3.68E-02	3.97E-02	3.68E-02
Chlorobenzene	NC	1.08E+01	1.08E+01
Chloroethane	NC	1.99E+02	1.99E+02
Chloroform	3.56E-02	1.03E+00	3.56E-02
Chloromethane	3.10E-01	ND	3.10E-01
cis-1,2-Dichloroethene	NC	1.13E+00	1.13E+00
1,3-dichloropropene	1.50E-02	1.39E+00	1.50E-02
Ethylbenzene	NC	4.08E+02	4.08E+02
Methylene chloride	1.44E+00	2.47E+02	1.44E+00
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	2.46E+03	2.46E+03
Tetrachloroethene	1.32E+00	9.43E-01	9.43E-01
Toluene	NC	9.18E+01	9.18E+01
trans-1,2-Dichloroethene	NC	1.52E+00	1.52E+00
Trichloroethene	7.15E-01	9.19E-01	7.15E-01
Vinyl chloride	6.50E-03	ND	6.50E-03
Xylene (total)	NC	9.76E+01	9.76E+01
Acenapthene	NC	3.37E+04	3.37E+04
Acenaphthylene	NC	3.37E+04	3.37E+04
2-Methylnaphthalene	NC	1.63E+03	1.63E+03
Naphthalene	NC	1.63E+03	1.63E+03

NC = Not Carcinogenic

Table O-3-1c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	2.00E+02	2.00E+02
1,1,2,2-Tetrachloroethane	9.41E-01	ND	9.41E-01
1,1,2-Trichloroethane	1.80E+00	1.44E+01	1.80E+00
1,1-Dichloroethane	NC	6.93E+02	6.93E+02
1,1-Dichloroethene	7.11E-02	4.11E+00	7.11E-02
1,2-Dichlorobenzene	NC	5.62E+02	5.62E+02
1,2-Dichloroethane	8.95E-01	8.43E+00	8.95E-01
1,2-Dichloropropane	8.64E-01	8.39E+00	8.64E-01
1,3-Dichlorbenzene	NC	6.27E+01	6.27E+01
1,4-Dichlorobenzene	2.91E+00	1.99E+03	2.91E+00
2-Butanone	NC	1.31E+04	1.31E+04
2-Hexanone	NC	2.78E+01	2.78E+01
4-Methyl-2-Pentanone	NC	2.78E+01	2.78E+01
Acetone	NC	2.46E+03	2.46E+03
Benzene	1.26E+00	ND	1.26E+00
Bromomethane	NC	1.65E+00	1.65E+00
Carbon tetrachloride	2.43E-01	2.62E-01	2.43E-01
Chlorobenzene	NC	3.76E+01	3.76E+01
Chloroethane	NC	1.12E+03	1.12E+03
Chloroform	5.18E-01	1.50E+01	5.18E-01
Chloromethane	1.74E+00	ND	1.74E+00
cis-1,2-Dichloroethene	NC	1.60E+01	1.60E+01
1,3-dichloropropene	1.65E-01	1.53E+01	1.65E-01
Ethylbenzene	NC	1.23E+03	1.23E+03
Methylene chloride	3.24E+01	5.55E+03	3.24E+01
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	2.30E+03	2.30E+03
Tetrachloroethene	9.82E+00	7.02E+00	7.02E+00
Toluene	NC	4.89E+02	4.89E+02
trans-1,2-Dichloroethene	NC	2.03E+01	2.03E+01
Trichloroethene	4.50E+00	5.78E+00	4.50E+00
Vinyl chloride	4.02E-02	ND	4.02E-02
Xylene (total)	NC	2.58E+02	2.58E+02
Acenapthene	NC	9.54E+02	9.54E+02
Acenaphthylene	NC	9.54E+02	9.54E+02
2-Methylnaphthalene	NC	2.43E+02	2.43E+02
Naphthalene	NC	2.43E+02	2.43E+02

NC = Not Carcinogenic

TABLE O-3-2a

PARAMETERS FOR CALCULATION OF VOLATILIZATION FROM SUBSURFACE SOIL AND GROUNDWATER TO INDOOR AIR

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
HENRY'S LAW CONSTANT	H	chemical-specific	dimensionless	IDEM, 1997
SOIL BULK DENSITY	Pb	1.66E+00	g-soil/cm3-soil	Site-specific (1)
WATER CONTENT VADOSE ZONE SOILS	0_W	0.12	cm3-water/cm3-soil	Site-specific (1)
AIR CONTENT VADOSE ZONE SOILS	0_A	0.26	cm3-air/cm3-soil	Site-specific (1)
SOIL-WATER PARTITION COEFFICIENT	Kd	chemical-specific	cm3-water/g-soil	IDEM, 1997
SOURCE-BUILDING SEPARATION AT t=0; SOIL	$L_T^0{}_{-SOIL}$	15	cm	Assumption (5)
SOURCE-BUILDING SEPARATION AT t=0; GROUNDWATER	$L_T^0{}_{-GW}$	122	cm	Assumption (6)
AREA OF BASEMENT	A_B	36927750	cm2	Assumption (9)
AREA OF CRACKS IN BASEMENT	A_{CRACK}	3692.775	cm2	USEPA, 1996 (9)
BUILDING VENTILATION RATE	$Q_{BUILDING}$	160000	cm3/sec	Assumption (10)
AVERAGE VAPOR FLOW RATE INTO BUILDING	Q_{SOIL}	4.4	cm3/sec	Per USEPA, 1996
ENCLOSED SPACE WALL THICKNESS	L_{CRACK}	15	cm	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN SOIL	$D_{eff-SOIL}$	chemical-specific	cm2/sec	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN GROUNDWATER	D_{eff-GW}	chemical-specific	cm2/sec	ASTM, 1995
EFFECTIVE DIFFUSION COEFFICIENT THROUGH CRACKS	$D_{eff-CRACK}$	chemical-specific	cm2/sec	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN SOIL	Cs	1	g/g	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN GROUNDWATER	Cgw	1	g/cm3	USEPA, 1996
THICKNESS OF SOURCE AREA - SOIL	H_{C-SOIL}	365.76	cm	Assumption (7)
THICKNESS OF SOURCE AREA - GROUNDWATER	H_{C-GW}	2133.6	cm	Assumption (7)
DIFFUSION COEFFICIENT IN AIR	Di_a	chemical-specific	cm2/sec	IDEM, 1997
DIFFUSION COEFFICIENT IN WATER	Di_w	chemical-specific	cm2/sec	IDEM, 1997
SOIL POROSITY IN IMPACTED ZONE	0_T	0.39	cm3/cm3	Site-specific (1)
THICKNESS OF CAPILLARY FRINGE	$hcap$	60.96	cm	Assumption (8)
THICKNESS OF VADOSE ZONE	hv	365.76	cm	Assumption (5)
EFFECTIVE DIFFUSION THROUGH CAPILLARY FRINGE	$D_{eff-CAP}$	chemical-specific	cm3/cm3	ASTM, 1995
AIR CONTENT CAPILLARY FRINGE	0_{A-CAP}	0.038	cm3-air/cm3-soil	ASTM, 1995
WATER CONTENT CAPILLARY FRINGE	0_{W-CAP}	0.342	cm3-water/cm3-soil	ASTM, 1995
AIR CONTENT IN WALL CRACKS	$0_{A-CRACK}$	0.26	cm3-air/cm3-tot.vol.	Assumption (3)
WATER CONTENT WALL CRACKS	$0_{W-CRACK}$	0.12	cm3-water/cm3-tot.vol.	Assumption (3)
AVERAGING TIME FOR VAPOR FLUX	T	1.60E+08	sec	IDEM, 1997 (4)
AIR CONCENTRATION - INDOOR AIR	$C_{BUILDING}$	chemical-specific	kg/m3	USEPA, 1996
VOLATILIZATION FACTOR - SUBSURFACE SOIL:INDOOR AIR	VF_{SOIL}	chemical-specific	m3/kg	USEPA, 1996
VOLATILIZATION FACTOR - GROUNDWATER:INDOOR AIR	VF_{GW}	chemical-specific	m3/kg	USEPA, 1996
FRACTION ORGANIC CARBON IN SOIL	foc	0.0068	unitless	Site-specific (2)
CONVERSION FACTOR 1	$CF1$	1.0E+03	cm3-kg/m3-g	USEPA, 1996
SOIL GAS CONCENTRATION	C_{SOURCE}	chemical-specific	g/cm3	Calculated in model

NOTES:

USEPA, 1996. Soil Screening Guidance: Technical Background Document. Appendix H. EPA/540/R-95/128

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM Standard E1739-95)

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management, Office of Response. October, 1997

(1) Site-specific values determined through measurements taken at 5 site locations (MW-5, 4-6; MW-5, 6-8; MW-9, 14-16; MW-4, 10-12; MW-3, 2-4); geometric mean of measured values used as input parameter in this model.

(2) Site-specific values determined through measurements taken at 5 site locations (02PS011, 16-18; 09PS002, 16-18; 17PS001, 10-12; 05PS052, 14-16; 12PS001, 18-20); geometric mean of measured values used as input parameter in this model.

(3) Assumed values for vadose zone soil and water.

(4) Value for occupational worker.

(5) Assumes that a building is constructed on top of the contaminated soil.

(6) Assumes that groundwater is present at its shallowest depth on-site (12 feet), and that a building with an 8-foot basement is constructed above the groundwater (resulting in a building-groundwater separation of 4 feet).

(7) Thickest areas of soil contamination (surface to groundwater table = 12 feet) and groundwater plume (70 feet).

(8) Thickest smear zone (2 feet).

(9) Value is based on typical small-sized building at South Bend facility (dimensions for Plant 13 used in calculation:225'x150'); crack area is 0.01% of basement area.

(10) Value assumes 20 workers in building, with minimum ASHRAE per-person building occupancy of 8 liters/person per second (ASHRAE 62-1989).

NOTE: All equations presented in the text accompanying this Table.

TABLE O-3-2a, CONT

CHEMICAL	H (unitless)	Koc (cm3/g)	Di_a (cm2/sec)	Di_w (cm2/sec)	D_{eff}^{CAP} (cm3/cm3)	D_{eff}^{SOIL} (cm2/sec)
1,1,1-Trichloroethane	7.05E-01	1.10E+01	7.80E-02	8.80E-06	1.19E-05	5.78E-03
1,1,2,2-Tetrachloroethane	1.41E-02	9.33E+01	7.10E-02	7.90E-06	1.12E-04	5.26E-03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	7.80E-02	8.80E-06	5.30E-05	5.78E-03
1,1-Dichloroethane	2.30E-01	3.16E+01	7.42E-02	1.05E-05	1.75E-05	5.50E-03
1,1-Dichloroethene	1.07E+00	5.89E+01	9.00E-02	1.04E-05	1.28E-05	6.67E-03
1,2-Dichlorobenzene	7.79E-02	6.17E+02	6.90E-02	7.90E-06	2.72E-05	5.11E-03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.04E-01	9.90E-06	5.83E-05	7.71E-03
1,2-Dichloropropane	1.15E-01	4.37E+01	7.82E-02	8.73E-06	2.36E-05	5.79E-03
1,3-Dichlorbenzene	7.80E-02	1.20E+03	1.30E-01	7.90E-06	3.46E-05	9.63E-03
1,4-Dichlorobenzene	9.96E-02	6.17E+02	6.90E-02	7.90E-06	2.31E-05	5.11E-03
2-Butanone	1.10E-03	4.50E+00	9.00E-02	9.80E-06	1.66E-03	6.72E-03
2-Hexanone	6.36E-02	2.90E+00	7.60E-02	7.00E-05	2.12E-04	5.64E-03
4-Methyl-2-Pentanone	6.36E-02	2.90E+00	7.6E-02	7.0E-05	2.12E-04	5.64E-03
Acetone	1.59E-03	5.75E-01	1.24E-01	1.14E-05	1.34E-03	9.23E-03
Benzene	2.28E-01	5.89E+01	8.80E-02	9.80E-06	1.87E-05	6.52E-03
Bromomethane	2.67E-01	9.98E-02	9.61E-02	8.96E-06	1.80E-05	7.12E-03
Carbon tetrachloride	1.25E+00	1.74E+02	7.80E-02	8.80E-06	1.09E-05	5.78E-03
Chlorobenzene	1.52E-01	2.19E+02	7.30E-02	8.70E-06	1.95E-05	5.41E-03
Chloroethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
Chloroform	1.50E-01	3.98E+01	1.04E-01	1.00E-05	2.51E-05	7.71E-03
Chloromethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	7.36E-02	1.13E-05	2.15E-05	5.45E-03
1,3-dichloropropene	7.26E-01	4.57E+01	6.26E-02	1.00E-05	1.02E-05	4.64E-03
Ethylbenzene	3.23E-01	3.63E+02	7.50E-02	7.80E-06	1.37E-05	5.56E-03
Methylene Chloride	8.98E-02	1.17E+01	1.01E-01	1.17E-05	3.64E-05	7.48E-03
Methyl tertiary butyl ether					#DIV/0!	#DIV/0!
Styrene	1.13E-01	7.76E+02	7.10E-02	8.00E-06	2.18E-05	5.26E-03
Tetrachloroethene	7.54E-01	1.55E+02	7.20E-02	8.20E-06	1.08E-05	5.33E-03
Toluene	2.72E-01	1.82E+02	8.70E-02	8.60E-06	1.65E-05	6.45E-03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	7.07E-02	1.19E-05	1.44E-05	5.24E-03
Trichloroethene	4.22E-01	1.66E+02	7.90E-02	9.10E-06	1.37E-05	5.85E-03
Vinyl chloride	1.11E+00	1.86E+01	1.06E-01	1.23E-06	1.32E-05	7.85E-03
Xylene (total)	2.76E-01	3.86E+02	7.80E-02	8.70E-06	1.54E-05	5.78E-03
Acenapthene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
Acenaphthylene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
2-Methylnaphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03
Naphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03

TABLE O-3-2a, CONT

CHEMICAL	D_{eff}^{crack} (cm2/sec)	D_{eff}^{ws} (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	3.09E+03	6.41E+00	4.27E-05	3.89E-09	2.87E-05	2.41E-05
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	2.85E+03	4.74E+01	2.88E-07	6.60E-10	2.84E-05	2.78E-05
1,1,2-Trichloroethane	5.78E-03	3.52E-04	3.10E+03	2.42E+01	1.42E-06	8.85E-10	2.87E-05	2.75E-05
1,1-Dichloroethane	5.50E-03	1.20E-04	2.96E+03	8.98E+00	1.07E-05	1.86E-09	2.85E-05	2.53E-05
1,1-Dichloroethene	6.67E-03	8.88E-05	3.49E+03	6.71E+00	3.04E-05	6.39E-09	2.94E-05	2.47E-05
1,2-Dichlorobenzene	5.11E-03	1.84E-04	2.78E+03	1.33E+01	2.57E-07	9.66E-10	2.83E-05	2.62E-05
1,2-Dichloroethane	7.71E-03	3.91E-04	3.90E+03	2.53E+01	4.28E-06	1.05E-09	3.04E-05	2.92E-05
1,2-Dichloropropane	5.79E-03	1.61E-04	3.10E+03	1.16E+01	4.71E-06	1.25E-09	2.87E-05	2.63E-05
1,3-Dichlorbenzene	9.63E-03	2.37E-04	4.57E+03	1.49E+01	2.51E-07	1.25E-09	3.24E-05	3.02E-05
1,4-Dichlorobenzene	5.11E-03	1.57E-04	2.78E+03	1.15E+01	3.28E-07	1.05E-09	2.83E-05	2.58E-05
2-Butanone	6.72E-03	4.68E-03	3.51E+03	3.01E+02	1.94E-07	3.46E-10	2.95E-05	2.94E-05
2-Hexanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	9.47E-06	5.19E-09	2.86E-05	2.83E-05
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	9.47E-06	5.19E-09	2.86E-05	2.83E-05
Acetone	9.23E-03	5.01E-03	4.44E+03	2.98E+02	5.15E-07	5.36E-10	3.20E-05	3.19E-05
Benzene	6.52E-03	1.29E-04	3.42E+03	9.32E+00	8.01E-06	1.98E-09	2.93E-05	2.61E-05
Bromomethane	7.12E-03	1.24E-04	3.67E+03	8.87E+00	4.44E-05	2.23E-09	2.98E-05	2.64E-05
Carbon tetrachloride	5.78E-03	7.52E-05	3.09E+03	5.95E+00	1.37E-05	6.32E-09	2.87E-05	2.35E-05
Chlorobenzene	5.41E-03	1.34E-04	2.92E+03	9.88E+00	1.43E-06	1.37E-09	2.85E-05	2.56E-05
Chloroethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	6.37E-05	7.72E-09	3.04E-05	2.57E-05
Chloroform	7.71E-03	1.72E-04	3.90E+03	1.17E+01	8.63E-06	1.74E-09	3.04E-05	2.78E-05
Chloromethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	6.37E-05	7.72E-09	3.04E-05	2.57E-05
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	2.94E+03	1.08E+01	7.33E-06	1.65E-09	2.85E-05	2.58E-05
1,3-dichloropropene	4.64E-03	7.06E-05	2.54E+03	5.76E+00	1.85E-05	3.45E-09	2.80E-05	2.30E-05
Ethylbenzene	5.56E-03	9.42E-05	2.99E+03	7.24E+00	1.91E-06	2.05E-09	2.86E-05	2.46E-05
Methylene Chlorine	7.48E-03	2.48E-04	3.82E+03	1.66E+01	1.10E-05	1.50E-09	3.02E-05	2.83E-05
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	2.85E+03	1.09E+01	3.05E-07	1.13E-09	2.84E-05	2.58E-05
Tetrachloroethene	5.33E-03	7.49E-05	2.89E+03	5.99E+00	8.87E-06	3.80E-09	2.84E-05	2.35E-05
Toluene	6.45E-03	1.14E-04	3.39E+03	8.36E+00	3.57E-06	2.08E-09	2.92E-05	2.57E-05
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	2.84E+03	7.60E+00	1.13E-05	2.56E-09	2.84E-05	2.46E-05
Trichloroethene	5.85E-03	9.43E-05	3.13E+03	7.20E+00	5.36E-06	2.68E-09	2.88E-05	2.47E-05
Vinyl chloride	7.85E-03	9.15E-05	3.96E+03	6.67E+00	6.33E-05	6.83E-09	3.05E-05	2.56E-05
Xylene (total)	5.78E-03	1.06E-04	3.09E+03	7.98E+00	1.60E-06	1.97E-09	2.87E-05	2.51E-05
Acenapthene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	1.14E-09	4.75E-10	2.76E-05	2.72E-05
Acenaphthylene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	1.14E-09	4.75E-10	2.76E-05	2.72E-05
2-Methylnaphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	1.75E-08	6.51E-10	2.79E-05	2.71E-05
Naphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	1.75E-08	6.51E-10	2.79E-05	2.71E-05

TABLE O-3-2a, CONT

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CS (g/g)	CGW (g/cm3)	To -SOIL	To -GW
1,1,1-Trichloroethane	2.76E+00	7.05E-01	1	1	1.77E+09	6.81E+10
1,1,2,2-Tetrachloroethane	2.04E-02	1.41E-02	1	1	2.43E+11	1.49E+12
1,1,2-Trichloroethane	9.15E-02	3.74E-02	1	1	5.35E+10	6.51E+11
1,1-Dichloroethane	7.26E-01	2.30E-01	1	1	6.79E+09	1.67E+11
1,1-Dichloroethene	1.70E+00	1.07E+00	1	1	2.81E+09	4.23E+10
1,2-Dichlorobenzene	1.87E-02	7.79E-02	1	1	2.65E+11	4.00E+11
1,2-Dichloroethane	2.07E-01	4.01E-02	1	1	2.23E+10	5.66E+11
1,2-Dichloropropane	3.04E-01	1.15E-01	1	1	1.61E+10	2.86E+11
1,3-Dichlorbenzene	9.74E-03	7.80E-02	1	1	4.45E+11	3.32E+11
1,4-Dichlorobenzene	2.39E-02	9.96E-02	1	1	2.08E+11	3.36E+11
2-Butanone	1.08E-02	1.10E-03	1	1	4.43E+11	1.57E+13
2-Hexanone	6.28E-01	6.36E-02	1	1	7.83E+09	3.03E+11
4-Methyl-2-Pentanone	6.28E-01	6.36E-02	1	1	7.83E+09	3.03E+11
Acetone	2.08E-02	1.59E-03	1	1	2.11E+11	1.00E+13
Benzene	4.59E-01	2.28E-01	1	1	1.05E+10	1.60E+11
Bromomethane	2.33E+00	2.67E-01	1	1	2.03E+09	1.38E+11
Carbon tetrachloride	8.82E-01	1.25E+00	1	1	5.55E+09	4.07E+10
Chlorobenzene	9.86E-02	1.52E-01	1	1	5.01E+10	2.38E+11
Chloroethane	3.06E+00	1.20E+00	1	1	1.51E+09	3.56E+10
Chloroform	4.18E-01	1.50E-01	1	1	1.11E+10	2.06E+11
Chloromethane	3.06E+00	1.20E+00	1	1	1.51E+09	3.56E+10
cis-1,2-Dichloroethene	5.02E-01	1.67E-01	1	1	9.83E+09	2.07E+11
1,3-dichloropropene	1.49E+00	7.26E-01	1	1	3.37E+09	7.37E+10
Ethylbenzene	1.28E-01	3.23E-01	1	1	3.84E+10	1.37E+11
Methylene Chloride	5.49E-01	8.98E-02	1	1	8.49E+09	2.96E+11
Methyl tertiary butyl ether	0.00E+00	0.00E+00	1	1	#DIV/0!	#DIV/0!
Styrene	2.17E-02	1.13E-01	1	1	2.29E+11	3.04E+11
Tetrachloroethene	6.21E-01	7.54E-01	1	1	7.96E+09	6.78E+10
Toluene	2.07E-01	2.72E-01	1	1	2.33E+10	1.44E+11
trans-1,2-Dichloroethene	8.04E-01	3.85E-01	1	1	6.17E+09	1.12E+11
Trichloroethene	3.42E-01	4.22E-01	1	1	1.43E+10	1.04E+11
Vinyl chloride	3.01E+00	1.11E+00	1	1	1.53E+09	3.95E+10
Xylene (total)	1.04E-01	2.76E-01	1	1	4.72E+10	1.49E+11
Acenapthene	1.36E-04	6.36E-03	1	1	3.77E+13	3.17E+12
Acenaphthylene	1.36E-04	6.36E-03	1	1	3.77E+13	3.17E+12
2-Methylnaphthalene	1.49E-03	1.98E-02	1	1	3.38E+12	1.15E+12
Naphthalene	1.49E-03	1.98E-02	1	1	3.38E+12	1.15E+12

TABLE O-3-2a, CONT

CHEMICAL	Is T>T_B -SOIL ?	Is T>T_B -GW ?	E-SOIL	E-GW	$C_{saturated}$ - SOIL (kg/m3)	$C_{solubility}$ - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	NO	NO	NA	NA	7.93E-02	1.70E-02	1.26E+01	5.90E+01
1,1,2,2-Tetrachloroethane	NO	NO	NA	NA	5.80E-04	3.92E-04	1.72E+03	2.55E+03
1,1,2-Trichloroethane	NO	NO	NA	NA	2.63E-03	1.03E-03	3.80E+02	9.71E+02
1,1-Dichloroethane	NO	NO	NA	NA	2.07E-02	5.82E-03	4.83E+01	1.72E+02
1,1-Dichloroethene	NO	NO	NA	NA	5.01E-02	2.65E-02	2.00E+01	3.78E+01
1,2-Dichlorobenzene	NO	NO	NA	NA	5.30E-04	2.04E-03	1.89E+03	4.90E+02
1,2-Dichloroethane	NO	NO	NA	NA	6.30E-03	1.17E-03	1.59E+02	8.55E+02
1,2-Dichloropropane	NO	NO	NA	NA	8.73E-03	3.02E-03	1.15E+02	3.31E+02
1,3-Dichlorbenzene	NO	NO	NA	NA	3.16E-04	2.36E-03	3.17E+03	4.24E+02
1,4-Dichlorobenzene	NO	NO	NA	NA	6.78E-04	2.57E-03	1.48E+03	3.89E+02
2-Butanone	NO	NO	NA	NA	3.17E-04	3.23E-05	3.15E+03	3.09E+04
2-Hexanone	NO	NO	NA	NA	1.80E-02	1.80E-03	5.57E+01	5.56E+02
4-Methyl-2-Pentanone	NO	NO	NA	NA	1.80E-02	1.80E-03	5.57E+01	5.56E+02
Acetone	NO	NO	NA	NA	6.66E-04	5.07E-05	1.50E+03	1.97E+04
Benzene	NO	NO	NA	NA	1.34E-02	5.95E-03	7.44E+01	1.68E+02
Bromomethane	NO	NO	NA	NA	6.94E-02	7.05E-03	1.44E+01	1.42E+02
Carbon tetrachloride	NO	NO	NA	NA	2.54E-02	2.94E-02	3.94E+01	3.40E+01
Chlorobenzene	NO	NO	NA	NA	2.81E-03	3.89E-03	3.56E+02	2.57E+02
Chloroethane	NO	NO	NA	NA	9.31E-02	3.08E-02	1.07E+01	3.24E+01
Chloroform	NO	NO	NA	NA	1.27E-02	4.16E-03	7.87E+01	2.40E+02
Chloromethane	NO	NO	NA	NA	9.31E-02	3.08E-02	1.07E+01	3.24E+01
cis-1,2-Dichloroethene	NO	NO	NA	NA	1.43E-02	4.31E-03	6.99E+01	2.32E+02
1,3-dichloropropene	NO	NO	NA	NA	4.17E-02	1.67E-02	2.40E+01	5.99E+01
Ethylbenzene	NO	NO	NA	NA	3.66E-03	7.93E-03	2.73E+02	1.26E+02
Methylene Chloride	NO	NO	NA	NA	1.66E-02	2.54E-03	6.04E+01	3.93E+02
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	NO	NO	NA	NA	6.16E-04	2.91E-03	1.62E+03	3.43E+02
Tetrachloroethene	NO	NO	NA	NA	1.77E-02	1.77E-02	5.66E+01	5.65E+01
Toluene	NO	NO	NA	NA	6.04E-03	6.99E-03	1.65E+02	1.43E+02
trans-1,2-Dichloroethene	NO	NO	NA	NA	2.28E-02	9.45E-03	4.39E+01	1.06E+02
Trichloroethene	NO	NO	NA	NA	9.84E-03	1.04E-02	1.02E+02	9.60E+01
Vinyl chloride	NO	NO	NA	NA	9.18E-02	2.84E-02	1.09E+01	3.52E+01
Xylene (total)	NO	NO	NA	NA	2.98E-03	6.92E-03	3.36E+02	1.45E+02
Acenapthene	NO	NO	NA	NA	3.75E-06	1.73E-04	2.67E+05	5.78E+03
Acenaphthylene	NO	NO	NA	NA	3.75E-06	1.73E-04	2.67E+05	5.78E+03
2-Methylnaphthalene	NO	NO	NA	NA	4.17E-05	5.37E-04	2.40E+04	1.86E+03
Naphthalene	NO	NO	NA	NA	4.17E-05	5.37E-04	2.40E+04	1.86E+03

TABLE O-3-2c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - SOIL (mg/kg)	NON-CANCER SSL - SOIL (mg/kg)	SELECTED SSL - SOIL (mg/kg)
ORGANICS			
1,1,1-Trichloroethane	NC	1.87E+01	1.87E+01
1,1,2,2-Tetrachloroethane	1.23E+00	ND	1.23E+00
1,1,2-Trichloroethane	9.72E-01	7.78E+00	9.72E-01
1,1-Dichloroethane	NC	1.23E+02	1.23E+02
1,1-Dichloroethene	1.59E-02	9.18E-01	1.59E-02
1,2-Dichlorobenzene	NC	1.93E+03	1.93E+03
1,2-Dichloroethane	2.50E-01	2.35E+00	2.50E-01
1,2-Dichloropropane	2.41E-01	2.34E+00	2.41E-01
1,3-Dichlorbenzene	NC	4.85E+02	4.85E+02
1,4-Dichlorobenzene	8.80E+00	6.03E+03	8.80E+00
2-Butanone	NC	4.67E+03	4.67E+03
2-Hexanone	NC	6.54E+00	6.54E+00
4-Methyl-2-Pentanone	NC	6.54E+00	6.54E+00
Acetone	NC	7.68E+02	7.68E+02
Benzene	3.67E-01	ND	3.67E-01
Bromomethane	NC	1.05E-01	1.05E-01
Carbon tetrachloride	1.06E-01	1.15E-01	1.06E-01
Chlorobenzene	NC	3.64E+01	3.64E+01
Chloroethane	NC	1.57E+02	1.57E+02
Chloroform	1.39E-01	4.02E+00	1.39E-01
Chloromethane	2.44E-01	ND	2.44E-01
cis-1,2-Dichloroethene	NC	3.57E+00	3.57E+00
1,3-dichloropropene	2.64E-02	2.45E+00	2.64E-02
Ethylbenzene	NC	1.39E+03	1.39E+03
Methylene chloride	5.40E+00	9.26E+02	5.40E+00
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	8.30E+03	8.30E+03
Tetrachloroethene	4.05E+00	2.89E+00	2.89E+00
Toluene	NC	3.38E+02	3.38E+02
trans-1,2-Dichloroethene	NC	4.48E+00	4.48E+00
Trichloroethene	2.42E+00	3.11E+00	2.42E+00
Vinyl chloride	5.20E-03	ND	5.20E-03
Xylene (total)	NC	3.43E+02	3.43E+02
Acenapthene	NC	8.18E+04	8.18E+04
Acenaphthylene	NC	8.18E+04	8.18E+04
2-Methylnaphthalene	NC	4.91E+03	4.91E+03
Naphthalene	NC	4.91E+03	4.91E+03

NC = Not Carcinogenic

TABLE O-3-2c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	8.74E+01	**8.74E+01**
1,1,2,2-Tetrachloroethane	1.83E+00	ND	**1.83E+00**
1,1,2-Trichloroethane	2.48E+00	1.98E+01	**2.48E+00**
1,1-Dichloroethane	NC	4.39E+02	**4.39E+02**
1,1-Dichloroethene	3.00E-02	1.74E+00	**3.00E-02**
1,2-Dichlorobenzene	NC	5.01E+02	**5.01E+02**
1,2-Dichloroethane	1.34E+00	1.27E+01	**1.34E+00**
1,2-Dichloropropane	6.97E-01	6.77E+00	**6.97E-01**
1,3-Dichlorbenzene	NC	6.50E+01	**6.50E+01**
1,4-Dichlorobenzene	2.32E+00	1.59E+03	**2.32E+00**
2-Butanone	NC	4.59E+04	**4.59E+04**
2-Hexanone	NC	6.53E+01	**6.53E+01**
4-Methyl-2-Pentanone	NC	6.53E+01	**6.53E+01**
Acetone	NC	1.01E+04	**1.01E+04**
Benzene	8.29E-01	ND	**8.29E-01**
Bromomethane	NC	1.04E+00	**1.04E+00**
Carbon tetrachloride	9.17E-02	9.90E-02	**9.17E-02**
Chlorobenzene	NC	2.63E+01	**2.63E+01**
Chloroethane	NC	4.74E+02	**4.74E+02**
Chloroform	4.24E-01	1.23E+01	**4.24E-01**
Chloromethane	7.36E-01	ND	**7.36E-01**
cis-1,2-Dichloroethene	NC	1.18E+01	**1.18E+01**
1,3-dichloropropene	6.60E-02	6.13E+00	**6.60E-02**
Ethylbenzene	NC	6.44E+02	**6.44E+02**
Methylene chloride	3.52E+01	6.03E+03	**3.52E+01**
Methyl tertiary butyl ether	NC	NA	**NA**
Styrene	NC	1.75E+03	**1.75E+03**
Tetrachloroethene	4.04E+00	2.89E+00	**2.89E+00**
Toluene	NC	2.93E+02	**2.93E+02**
trans-1,2-Dichloroethene	NC	1.08E+01	**1.08E+01**
Trichloroethene	2.29E+00	2.94E+00	**2.29E+00**
Vinyl chloride	1.68E-02	ND	**1.68E-02**
Xylene (total)	NC	1.48E+02	**1.48E+02**
Acenapthene	NC	1.77E+03	**1.77E+03**
Acenaphthylene	NC	1.77E+03	**1.77E+03**
2-Methylnaphthalene	NC	3.81E+02	**3.81E+02**
Naphthalene	NC	3.81E+02	**3.81E+02**

NC = Not Carcinogenic

TABLE O-3-3a

PARAMETERS FOR CALCULATION OF VOLATILIZATION FROM SUBSURFACE SOIL AND GROUNDWATER TO INDOOR AIR

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
HENRY'S LAW CONSTANT	H	chemical-specific	dimensionless	IDEM, 1997
SOIL BULK DENSITY	Pb	1.66E+00	g-soil/cm3-soil	Site-specific (1)
WATER CONTENT VADOSE ZONE SOILS	θ_W	0.12	cm3-water/cm3-soil	Site-specific (1)
AIR CONTENT VADOSE ZONE SOILS	θ_A	0.26	cm3-air/cm3-soil	Site-specific (1)
SOIL-WATER PARTITION COEFFICIENT	Kd	chemical-specific	cm3-water/g-soil	IDEM, 1997
SOURCE-BUILDING SEPARATION AT t=0; SOIL	$L_{T\text{-SOIL}}^{0}$	15	cm	Assumption (5)
SOURCE-BUILDING SEPARATION AT t=0; GROUNDWATER	$L_{T\text{-GW}}^{0}$	122	cm	Assumption (6)
AREA OF BASEMENT	A_B	36927750	cm2	Assumption (9)
AREA OF CRACKS IN BASEMENT	A_{CRACK}	3692.775	cm2	USEPA, 1996 (9)
BUILDING VENTILATION RATE	$Q_{BUILDING}$	160000	cm3/sec	Assumption (10)
AVERAGE VAPOR FLOW RATE INTO BUILDING	Q_{SOIL}	4.4	cm3/sec	Per USEPA, 1996
ENCLOSED SPACE WALL THICKNESS	L_{CRACK}	15	cm	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN SOIL	$D_{eff\text{-SOIL}}$	chemical-specific	cm2/sec	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN GROUNDWATER	$D_{eff\text{-GW}}$	chemical-specific	cm2/sec	ASTM, 1995
EFFECTIVE DIFFUSION COEFFICIENT THROUGH CRACKS	$D_{eff\text{-CRACK}}$	chemical-specific	cm2/sec	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN SOIL	CR	chemical-specific	g/g	Site-specific (11)
AVERAGE CONTAMINANT LEVEL IN GROUNDWATER	Cgw	1	g/cm3	USEPA, 1996
THICKNESS OF SOURCE AREA - SOIL	$H_{C\text{-SOIL}}$	365.76	cm	Assumption (7)
THICKNESS OF SOURCE AREA - GROUNDWATER	$H_{C\text{-GW}}$	2133.6	cm	Assumption (7)
DIFFUSION COEFFICIENT IN AIR	Di_a	chemical-specific	cm2/sec	IDEM, 1997
DIFFUSION COEFFICIENT IN WATER	Di_w	chemical-specific	cm2/sec	IDEM, 1997
SOIL POROSITY IN IMPACTED ZONE	θ_T	0.39	cm3/cm3	Site-specific (1)
THICKNESS OF CAPILLARY FRINGE	hcap	60.96	cm	Assumption (8)
THICKNESS OF VADOSE ZONE	hv	365.76	cm	Assumption (5)
EFFECTIVE DIFFUSION THROUGH CAPILLARY FRINGE	$D_{eff\text{-CAP}}$	chemical-specific	cm3/cm3	ASTM, 1995
AIR CONTENT CAPILLARY FRINGE	$\theta_{A\text{-CAP}}$	0.038	cm3-air/cm3-soil	ASTM, 1995
WATER CONTENT CAPILLARY FRINGE	$\theta_{W\text{-CAP}}$	0.342	cm3-water/cm3-soil	ASTM, 1995
AIR CONTENT IN WALL CRACKS	$\theta_{A\text{-CRACK}}$	0.26	cm3-air/cm3-tot.vol.	Assumption (3)
WATER CONTENT WALL CRACKS	$\theta_{W\text{-CRACK}}$	0.12	cm3-water/cm3-tot.vol.	Assumption (3)
AVERAGING TIME FOR VAPOR FLUX	T	1.80E+08	sec	IDEM, 1997 (4)
AIR CONCENTRATION - INDOOR AIR	$C_{BUILDING}$	chemical-specific	kg/m3	USEPA, 1996
VOLATILIZATION FACTOR - SUBSURFACE SOIL:INDOOR AIR	VF_{SOIL}	chemical-specific	m3/kg	USEPA, 1996
VOLATILIZATION FACTOR - GROUNDWATER:INDOOR AIR	VF_{GW}	chemical-specific	m3/kg	USEPA, 1996
FRACTION ORGANIC CARBON IN SOIL	foc	0.0066	unitless	Site-specific (2)
CONVERSION FACTOR 1	CF1	1.0E+03	cm3-kg/m3-g	USEPA, 1996
SOIL GAS CONCENTRATION	C_{SOURCE}	chemical-specific	g/cm3	Calculated in model

NOTES:

USEPA, 1996. Soil Screening Guidance: Technical Background Document. Appendix H. EPA/540/R-95/128

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM Standard E1739-95)

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management, Office of Response. October, 1997

(1) Site-specific values determined through measurements taken at 5 site locations (MW-5, 4-6; MW-5, 6-8; MW-9, 14-16; MW-4, 10-12; MW-3, 2-4); geometric mean of measured values used as input parameter in this model.

(2) Site-specific values determined through measurements taken at 5 site locations (02PS011, 16-18; 09PS002, 16-18; 17PS001, 10-12; 05PS052, 14-16; 12PS001, 18-20); geometric mean of measured values used as input parameter in this model.

(3) Assumed values for vadose zone soil and water.

(4) Value for occupational worker.

(5) Assumes that a building is constructed on top of the contaminated soil.

(6) Assumes that groundwater is present at its shallowest depth on-site (12 feet), and that a building with an 8-foot basement is constructed above the groundwater (resulting in a building-groundwater separation of 4 feet).

(7) Thickest areas of soil contamination (surface to groundwater table = 12 feet) and groundwater plume (70 feet).

(8) Thickest smear zone (2 feet).

(9) Value is based on typical small-sized building at South Bend facility (dimensions for Plant 13 used in calculation:225'x150'); crack area is 0.01% of basement area.

(10) Value assumes 20 workers in building, with minimum ASHRAE per-person building occupancy of 8 liters/person per second (ASHRAE 62-1989).

(11) Average concentration among all samples from soil boring where soil gas result was detected; see "Soil Gas" Table

(12) Groundwater concentration measured at well/boring associated with detected soil gas concentration; see "Soil Gas" Table

NOTE: All equations presented in the text accompanying this Table.

TABLE O-3-3a, CONT

CHEMICAL	H (unitless)	Koc (cm3/g)	Di_a (cm2/sec)	Di_w (cm2/sec)	$D_{eff-cap}$ (cm3/cm3)	$D_{eff-vadz}$ (cm2/sec)
1,1,1-Trichloroethane	7.05E-01	1.10E+01	7.80E-02	8.80E-06	1.19E-05	5.78E-03
1,1,2,2-Tetrachloroethane	1.41E-02	9.33E+01	7.10E-02	7 90E-06	1.12E-04	5.26E-03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	7.80E-02	8.80E-06	5.30E-05	5.78E-03
1,1-Dichloroethane	2.30E-01	3.16E+01	7.42E-02	1.05E-05	1.75E-05	5.50E-03
1,1-Dichloroethene	1.07E+00	5.89E+01	9.00E-02	1.04E-05	1.28E-05	6.67E-03
1,2-Dichlorobenzene	7.79E-02	6.17E+02	6.90E-02	7.90E-06	2.72E-05	5.11E-03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.04E-01	9.90E-06	5.83E-05	7.71E-03
1,2-Dichloropropane	1.15E-01	4.37E+01	7.82E-02	8.73E-06	2.36E-05	5.79E-03
1,3-Dichlorbenzene	7.80E-02	1.20E+03	1.30E-01	7.90E-06	3.46E-05	9.63E-03
1,4-Dichlorobenzene	9.96E-02	6.17E+02	6.90E-02	7.90E-06	2.31E-05	5.11E-03
2-Butanone	1.10E-03	4.50E+00	9.00E-02	9.80E-06	1.66E-03	6.72E-03
2-Hexanone	6.36E-02	2.90E+00	7.60E-02	7.00E-05	2.12E-04	5.64E-03
4-Methyl-2-Pentanone	6.36E-02	2.90E+00	7.6E-02	7.0E-05	2.12E-04	5.64E-03
Acetone	1.59E-03	5.75E-01	1.24E-01	1.14E-05	1.34E-03	9.23E-03
Benzene	2.28E-01	5.89E+01	8.80E-02	9.80E-06	1.87E-05	6.52E-03
Bromomethane	2.67E-01	9.98E-02	9.61E-02	8.96E-06	1.80E-05	7.12E-03
Carbon tetrachloride	1.25E+00	1.74E+02	7.80E-02	8.80E-06	1.09E-05	5.78E-03
Chlorobenzene	1.52E-01	2.19E+02	7.30E-02	8.70E-06	1.95E-05	5.41E-03
Chloroethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
Chloroform	1.50E-01	3.98E+01	1.04E-01	1.00E-05	2.51E-05	7.71E-03
Chloromethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	7.36E-02	1.13E-05	2.15E-05	5.45E-03
1,3-dichloropropene	7.26E-01	4.57E+01	6.26E-02	1.00E-05	1.02E-05	4.64E-03
Ethylbenzene	3.23E-01	3.63E+02	7.50E-02	7.80E-06	1.37E-05	5.56E-03
Methylene Chloride	8.98E-02	1.17E+01	1.01E-01	1.17E-05	3.64E-05	7.48E-03
Methyl tertiary butyl ether					#DIV/0!	#DIV/0!
Styrene	1.13E-01	7.76E+02	7.10E-02	8.00E-06	2.18E-05	5.26E-03
Tetrachloroethene	7.54E-01	1.55E+02	7.20E-02	8.20E-06	1.08E-05	5.33E-03
Toluene	2.72E-01	1.82E+02	8.70E-02	8.60E-06	1.65E-05	6.45E-03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	7.07E-02	1.19E-05	1.44E-05	5.24E-03
Trichloroethene	4.22E-01	1.66E+02	7.90E-02	9.10E-06	1.37E-05	5.85E-03
Vinyl chloride	1.11E+00	1.86E+01	1.06E-01	1.23E-06	1.32E-05	7.85E-03
Xylene (total)	2.76E-01	3.86E+02	7.80E-02	8.70E-06	1.54E-05	5.78E-03
Acenapthene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
Acenaphthylene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
2-Methylnaphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03
Naphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03

TABLE O-3-3a, CONT

CHEMICAL	D_eff crack (cm2/sec)	D_eff ow (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	3.09E+03	6.41E+00	9.62E-09	2.98E-11	2.87E-05	2.43E-05
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	2.85E+03	4.74E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	5.78E-03	3.52E-04	3.10E+03	2.42E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	5.50E-03	1.20E-04	2.96E+03	8.98E+00	1.42E-10	1.17E-11	2.85E-05	2.54E-05
1,1-Dichloroethene	6.67E-03	8.88E-05	3.49E+03	6.71E+00	#DIV/0!	3.10E-12	#DIV/0!	2.50E-05
1,2-Dichlorobenzene	5.11E-03	1.84E-04	2.78E+03	1.33E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloroethane	7.71E-03	3.91E-04	3.90E+03	2.53E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	5.79E-03	1.61E-04	3.10E+03	1.16E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	9.63E-03	2.37E-04	4.57E+03	1.49E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	5.11E-03	1.57E-04	2.78E+03	1.15E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	6.72E-03	4.68E-03	3.51E+03	3.01E+02	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Hexanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acetone	9.23E-03	5.01E-03	4.44E+03	2.98E+02	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Benzene	6.52E-03	1.29E-04	3.42E+03	9.32E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Bromomethane	7.12E-03	1.24E-04	3.67E+03	8.87E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Carbon tetrachloride	5.78E-03	7.52E-05	3.09E+03	5.95E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	5.41E-03	1.34E-04	2.92E+03	9.88E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroform	7.71E-03	1.72E-04	3.90E+03	1.17E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	2.94E+03	1.08E+01	5.30E-11	4.92E-12	2.85E-05	2.59E-05
1,3-dichloropropene	4.64E-03	7.06E-05	2.54E+03	5.76E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	5.56E-03	9.42E-05	2.99E+03	7.24E+00	7.42E-14	#DIV/0!	2.86E-05	#DIV/0!
Methylene Chloride	7.48E-03	2.48E-04	3.82E+03	1.66E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	2.85E+03	1.09E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Tetrachloroethene	5.33E-03	7.49E-05	2.89E+03	5.99E+00	3.57E-10	3.16E-13	2.84E-05	2.37E-05
Toluene	6.45E-03	1.14E-04	3.39E+03	8.36E+00	1.17E-11	#DIV/0!	2.92E-05	#DIV/0!
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	2.84E+03	7.60E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Trichloroethene	5.85E-03	9.43E-05	3.13E+03	7.20E+00	2.08E-10	6.92E-14	2.88E-05	2.48E-05
Vinyl chloride	7.85E-03	9.15E-05	3.96E+03	6.67E+00	#DIV/0!	1.25E-13	#DIV/0!	2.59E-05
Xylene (total)	5.78E-03	1.06E-04	3.09E+03	7.98E+00	2.46E-11	#DIV/0!	2.87E-05	#DIV/0!
Acenapthene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acenaphthylene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Methylnaphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Naphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

TABLE O-3-3a, CONT

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CR (g/g)	CGW (g/cm3)	T_D -SOIL	T_D -GW
1,1,1-Trichloroethane	3.67E-10	1.35E-09	0.00000059	0.00000025	7.87E+12	8.89E+12
1,1,2,2-Tetrachloroethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	ND	8.10E-13	ND	ND	#DIV/0!	#DIV/0!
1,1-Dichloroethane	2.5E-12	2.74E-10	0.00000026	0.00000019	5.13E+14	2.66E+13
1,1-Dichloroethene	ND	9.34E-11	ND	0.00000018	#DIV/0!	8.73E+13
1,2-Dichlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,2-Dichloroethane	ND	7.60E-13	ND	ND	#DIV/0!	#DIV/0!
1,2-Dichloropropane	ND	NA	ND	ND	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
2-Butanone	ND	8.50E-13	ND	ND	#DIV/0!	#DIV/0!
2-Hexanone	ND	NA	NA	NA	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	ND	9.20E-13	ND	ND	#DIV/0!	#DIV/0!
Acetone	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Benzene	ND	NA	ND	NA	#DIV/0!	#DIV/0!
Bromomethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Carbon tetrachloride	ND	2.70E-13	ND	ND	#DIV/0!	#DIV/0!
Chlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Chloroethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Chloroform	ND	3.43E-12	ND	ND	#DIV/0!	#DIV/0!
Chloromethane	ND	3.34E-12	ND	ND	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	6.9E-13	7.46E-11	0.00000019	0.00000015	1.36E+15	6.94E+13
1,3-dichloropropene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Ethylbenzene	1.6E-13	NA	0.00003208	NA	9.87E+17	#DIV/0!
Methylene Chloride	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Styrene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Tetrachloroethene	2.25E-12	4.07E-12	0.00000009	0.000000065	1.98E+14	8.17E+14
Toluene	7.3E-13	NA	0.00000108	NA	7.12E+15	#DIV/0!
trans-1,2-Dichloroethene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Trichloroethene	6.25E-12	1.64E-11	0.00000047	0.0000015	3.68E+14	4.04E+15
Vinyl chloride	ND	2.54E-12	ND	0.000000125	#DIV/0!	2.16E+15
Xylene (total)	5.4E-13	NA	0.00000034	NA	3.08E+15	#DIV/0!
Acenapthene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Acenaphthylene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
2-Methylnaphthalene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Naphthalene	ND	NA	NA	NA	#DIV/0!	#DIV/0!

TABLE O-3-3a, CONT

CHEMICAL	Is $T>T_b$ -SOIL ?	Is $T>T_b$ -GW ?	E-SOIL	E-GW	$C_{sat,avg}$ - SOIL (kg/m3)	$C_{sat,max}$ - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	NO	NO	NA	NA	1.05E-11	3.28E-11	9.48E+10	3.05E+10
1,1,2,2-Tetrachloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NO	NO	NA	NA	7.14E-14	6.95E-12	1.40E+13	1.44E+11
1,1-Dichloroethene	#DIV/0!	NO	#DIV/0!	NA	#DIV/0!	2.34E-12	#DIV/0!	4.27E+11
1,2-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Hexanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acetone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Bromomethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	NO	NO	NA	NA	1.97E-14	1.93E-12	5.08E+13	5.18E+11
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NO	#DIV/0!	NA	#DIV/0!	4.57E-15	#DIV/0!	2.19E+14	#DIV/0!
Methylene Chloride	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Tetrachloroethene	NO	NO	NA	NA	6.40E-14	9.64E-14	1.56E+13	1.04E+13
Toluene	NO	#DIV/0!	NA	#DIV/0!	2.13E-14	#DIV/0!	4.68E+13	#DIV/0!
trans-1,2-Dichloroethene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Trichloroethene	NO	NO	NA	NA	1.80E-13	4.05E-13	5.56E+12	2.47E+12
Vinyl chloride	#DIV/0!	NO	#DIV/0!	NA	#DIV/0!	6.59E-14	#DIV/0!	1.52E+13
Xylene (total)	NO	#DIV/0!	NA	#DIV/0!	1.55E-14	#DIV/0!	6.45E+13	#DIV/0!
Acenapthene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acenaphthylene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Methylnaphthalene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Naphthalene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

TABLE 0-3-3c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - SOIL (mg/kg)	NON-CANCER SSL - SOIL (mg/kg)	SELECTED SSL - SOIL (mg/kg)
ORGANICS			
1,1,1-Trichloroethane	NC	1.41E+11	1.41E+11
1,1,2,2-Tetrachloroethane	#DIV/0!	ND	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NC	3.58E+13	3.58E+13
1,1-Dichloroethene	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichlorobenzene	NC	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	NC	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	NC	#DIV/0!	#DIV/0!
2-Hexanone	NC	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	NC	#DIV/0!	#DIV/0!
Acetone	NC	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	ND	#DIV/0!
Bromomethane	NC	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	NC	#DIV/0!	#DIV/0!
Chloroethane	NC	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	ND	#DIV/0!
cis-1,2-Dichloroethene	NC	2.60E+12	2.60E+12
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NC	1.12E+15	1.12E+15
Methylene chloride	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	#DIV/0!	#DIV/0!
Tetrachloroethene	1.12E+12	7.99E+11	7.99E+11
Toluene	NC	9.58E+13	9.58E+13
trans-1,2-Dichloroethene	NC	#DIV/0!	#DIV/0!
Trichloroethene	1.33E+11	1.70E+11	1.33E+11
Vinyl chloride	#DIV/0!	ND	#DIV/0!
Xylene (total)	NC	6.59E+13	6.59E+13
Acenapthene	NC	#DIV/0!	#DIV/0!
Acenaphthylene	NC	#DIV/0!	#DIV/0!
2-Methylnaphthalene	NC	#DIV/0!	#DIV/0!
Naphthalene	NC	#DIV/0!	#DIV/0!

NC = Not Carcinogenic

TABLE O-3-3c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	4.52E+10	4.52E+10
1,1,2,2-Tetrachloroethane	#DIV/0!	ND	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NC	3.68E+11	3.68E+11
1,1-Dichloroethene	3.40E+08	1.97E+10	3.40E+08
1,2-Dichlorobenzene	NC	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	NC	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	NC	#DIV/0!	#DIV/0!
2-Hexanone	NC	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	NC	#DIV/0!	#DIV/0!
Acetone	NC	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	ND	#DIV/0!
Bromomethane	NC	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	NC	#DIV/0!	#DIV/0!
Chloroethane	NC	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	ND	#DIV/0!
cis-1,2-Dichloroethene	NC	2.65E+10	2.65E+10
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NC	#DIV/0!	#DIV/0!
Methylene chloride	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	#DIV/0!	#DIV/0!
Tetrachloroethene	7.42E+11	5.30E+11	5.30E+11
Toluene	NC	#DIV/0!	#DIV/0!
trans-1,2-Dichloroethene	NC	#DIV/0!	#DIV/0!
Trichloroethene	5.88E+10	7.56E+10	5.88E+10
Vinyl chloride	7.24E+09	ND	7.24E+09
Xylene (total)	NC	#DIV/0!	#DIV/0!
Acenapthene	NC	#DIV/0!	#DIV/0!
Acenaphthylene	NC	#DIV/0!	#DIV/0!
2-Methylnaphthalene	NC	#DIV/0!	#DIV/0!
Naphthalene	NC	#DIV/0!	#DIV/0!

NC = Not Carcinogenic

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	05GP070			13GP003		
AOC	A13-P10			A13-P10		
	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS						
Benzene	0.27 B	–	–	0.57 B	–	–
Toluene	0.23	–	–	0.17	–	–
Ethylbenzene	–	–	–	–	–	–
Xylenes (total)	0.12	–	–	–	–	–
Total BTEX	0.62	–	–	0.74	–	–
2-Butanone	–	–	–	–	–	–
Carbon Tetrachloride	0.27	–	–	–	–	–
Chloroform	3.43	–	–	1.49	–	–
Chloromethane	2.53	–	–	4.9	–	–
1,1-Dichloroethane	222.86	–	–	161.36	–	1300
1,2-Dichloroethane	–	–	–	–	–	–
1,1-Dichloroethene	75.11	–	–	93.4	–	180
1,2-Dichloroethene (total)	34.7	–	–	10.24	–	380
1,2-Dichloropropane	–	–	–	–	–	–
4-Methyl-2-Pentanone	–	–	–	–	–	–
Tetrachloroethene	1.14	–	–	4.07	–	<130
1,1,1-Trichloroethane	61.57	0.12	–	1167.2	–	2700
1,1,2-Trichloroethane	–	–	–	–	–	–
Trichloroethene	9.02	0.43	–	2.08	0.77	2100
Vinyl Chloride	3.45	–	–	2.54	0.11	<250

"–" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION / AOC	13GP006 A13-P10 Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	05GP006 A5-P6/16 C Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS						
Benzene	0.75 B	–	–	–	0.09	–
Toluene	0.21	–	–	0.73	1.08	–
Ethylbenzene	–	–	–	–	25.57	–
Xylenes (total)	0.1	–	–	0.26	1.69	–
Total BTEX	1.06	–	–	0.99	28.43	–
2-Butanone	–	–	–	–	–	–
Carbon Tetrachloride	–	–	–	–	–	–
Chloroform	2.17	–	–	–	–	–
Chloromethane	–	–	–	1.08	–	–
1,1-Dichloroethane	274.35	–	190	–	–	–
1,2-Dichloroethane	–	–	–	–	–	–
1,1-Dichloroethene	124.25	–	–	–	–	–
1,2-Dichloroethene (total)	74.63	–	150	–	–	–
1,2-Dichloropropane	–	–	–	–	–	–
4-Methyl-2-Pentanone	–	–	–	–	–	–
Tetrachloroethene	1.06	–	–	–	–	–
1,1,1-Trichloroethane	1351.68	0.42	250	0.26	–	–
1,1,2-Trichloroethane	0.81	–	–	–	–	–
Trichloroethene	16.35	1.02	1500	2.26	–	–
Vinyl Chloride	3.36	–	–	–	–	–

"--" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	05GP008			05GP009			15GP005		
AOC	A5-P6/16 C			A5-P6/16 C			A15		
	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS									
Benzene	–	0.95	–	–	1.35	–	–	–	–
Toluene	–	–	–	0.25	–	–	0.78	–	–
Ethylbenzene	–	26.97	–	0.16	32.08	–	0.14	–	–
Xylenes (total)	–	2.08	–	0.73	–	–	0.65	–	–
Total BTEX	–	30	–	1.14	33.43	–	1.57	–	–
2-Butanone	–	–	–	–	–	–	0.85	–	–
Carbon Tetrachloride	–	–	–	–	–	–	–	–	–
Chloroform	–	–	–	–	–	–	–	–	–
Chloromethane	–	–	–	–	–	–	–	–	–
1,1-Dichloroethane	–	–	–	–	–	–	2.5	0.26	57
1,2-Dichloroethane	–	–	–	–	–	–	–	–	–
1,1-Dichloroethene	–	–	–	–	–	–	0.65	–	–
1,2-Dichloroethene (total)	–	–	–	–	–	–	–	–	19
1,2-Dichloropropane	–	–	–	–	–	–	–	–	–
4-Methyl-2-Pentanone	–	–	–	–	–	–	0.92	–	–
Tetrachloroethene	–	–	–	–	–	–	2.25	0.09	–
1,1,1-Trichloroethane	–	–	–	–	–	–	33.34	0.33	15
1,1,2-Trichloroethane	–	–	–	–	–	–	–	–	–
Trichloroethene	0.29	–	–	1.18	–	–	5.3	0.12	8.1 B
Vinyl Chloride	–	–	–	–	–	–	–	–	–

"–" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	15GP013			15GP012			14GP031		
AOC	A15			A15			A14-P1 C		
CONTAMINANTS	Soil-Gas (ng/L)	Soil (mg/kg	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
Benzene	1.07 B	–	–	0.63	–	–	0.37 B	–	–
Toluene	0.94	–	–	0.62	–	–	0.42	0.09	–
Ethylbenzene	–	–	–	–	–	–	–	0.15	–
Xylenes (total)	0.54	0.34	–	0.5	0.35	–	0.18	0.52	–
Total BTEX	2.55	–	–	1.75	–	–	0.97	–	–
2-Butanone	0.23	–	–	0.32	–	–	0.27	–	–
Carbon Tetrachloride	–	–	–	–	–	–	–	–	–
Chloroform	0.98	–	–	–	–	–	–	–	–
Chloromethane	3.34	–	–	1.75	–	–	–	–	–
1,1-Dichloroethane	172.25	–	2700	1.46	–	–	2.74	0.04	100
1,2-Dichloroethane	0.76	–	–	–	–	–	–	–	–
1,1-Dichloroethene	16.76	–	–	0.33	–	–	0.47	–	–
1,2-Dichloroethene (total)	67.82	0.11	13000	0.69	0.19	–	–	0.06	9.3
1,2-Dichloropropane	0.54	–	–	–	–	–	–	–	–
4-Methyl-2-Pentanone	0.2	–	–	0.56	–	–	0.22	–	–
Tetrachloroethene	7.8	4.3	–	4.91	12.7	–	3.64	0.17	–
1,1,1-Trichloroethane	367.08	0.59	–	1.63	0.75	–	8.89	0.37	7.1
1,1,2-Trichloroethane	–	–	–	–	–	–	–	–	–
Trichloroethene	6.25	0.47	–	5.04	1.96	–	3.39	0.2	–
Vinyl Chloride	2.85	–	–	–	–	–	–	–	18

"–" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

TABLE O-3-4a

PARAMETERS FOR CALCULATION OF VOLATILIZATION FROM SUBSURFACE SOIL AND GROUNDWATER TO INDOOR AIR

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
HENRY'S LAW CONSTANT	H	chemical-specific	dimensionless	IDEM, 1997
SOIL BULK DENSITY	Pb	1.66E+00	g-soil/cm3-soil	Site-specific (1)
WATER CONTENT VADOSE ZONE SOILS	θ_W	0.12	cm3-water/cm3-soil	Site-specific (1)
AIR CONTENT VADOSE ZONE SOILS	θ_A	0.26	cm3-air/cm3-soil	Site-specific (1)
SOIL-WATER PARTITION COEFFICIENT	Kd	chemical-specific	cm3-water/g-soil	IDEM, 1997
SOURCE-BUILDING SEPARATION AT t=0; SOIL	$L_T^0{}_{-SOIL}$	15	cm	Assumption (5)
SOURCE-BUILDING SEPARATION AT t=0; GROUNDWATER	$L_T^0{}_{-GW}$	122	cm	Assumption (6)
AREA OF BASEMENT	A_B	1960000	cm2	MDEQ, 1998
AREA OF CRACKS IN BASEMENT	A_{CRACK}	196	cm2	MDEQ, 1998
BUILDING VENTILATION RATE	$Q_{BUILDING}$	151000	cm3/sec	MDEQ, 1998
AVERAGE VAPOR FLOW RATE INTO BUILDING	Q_{SOIL}	0.81	cm3/sec	MDEQ, 1998
ENCLOSED SPACE WALL THICKNESS	L_{CRACK}	15	cm	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN SOIL	$D_{eff-SOIL}$	chemical-specific	cm2/sec	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN GROUNDWATER	D_{eff-GW}	chemical-specific	cm2/sec	ASTM, 1995
EFFECTIVE DIFFUSION COEFFICIENT THROUGH CRACKS	$D_{eff-CRACK}$	chemical-specific	cm2/sec	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN SOIL	Cs	1	g/g	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN GROUNDWATER	Cgw	1	g/cm3	USEPA, 1996
THICKNESS OF SOURCE AREA - SOIL	H_{C-SOIL}	365.76	cm	Assumption (7)
THICKNESS OF SOURCE AREA - GROUNDWATER	H_{C-GW}	2133.6	cm	Assumption (7)
DIFFUSION COEFFICIENT IN AIR	Di_a	chemical-specific	cm2/sec	IDEM, 1997
DIFFUSION COEFFICIENT IN WATER	Di_w	chemical-specific	cm2/sec	IDEM, 1997
SOIL POROSITY IN IMPACTED ZONE	θ_T	0.39	cm3/cm3	Site-specific (1)
THICKNESS OF CAPILLARY FRINGE	hcap	60.96	cm	Assumption (8)
THICKNESS OF VADOSE ZONE	hv	365.76	cm	Assumption (5)
EFFECTIVE DIFFUSION THROUGH CAPILLARY FRINGE	$D_{eff-CAP}$	chemical-specific	cm3/cm3	ASTM, 1995
AIR CONTENT CAPILLARY FRINGE	θ_{A-CAP}	0.038	cm3-air/cm3-soil	ASTM, 1995
WATER CONTENT CAPILLARY FRINGE	θ_{W-CAP}	0.342	cm3-water/cm3-soil	ASTM, 1995
AIR CONTENT IN WALL CRACKS	$\theta_{A-CRACK}$	0.26	cm3-air/cm3-tot.vol.	Assumption (3)
WATER CONTENT WALL CRACKS	$\theta_{W-CRACK}$	0.12	cm3-water/cm3-tot.vol.	Assumption (3)
AVERAGING TIME FOR VAPOR FLUX	T	1.80E+08	sec	IDEM, 1997 (4)
AIR CONCENTRATION - INDOOR AIR	$C_{BUILDING}$	chemical-specific	kg/m3	USEPA, 1996
VOLATILIZATION FACTOR - SUBSURFACE SOIL:INDOOR AIR	VF_{SOIL}	chemical-specific	m3/kg	USEPA, 1996
VOLATILIZATION FACTOR - GROUNDWATER:INDOOR AIR	VF_{GW}	chemical-specific	m3/kg	USEPA, 1996
FRACTION ORGANIC CARBON IN SOIL	foc	0.0066	unitless	Site-specific (2)
CONVERSION FACTOR 1	CF1	1.0E+03	cm3-kg/m3-g	USEPA, 1996
SOIL GAS CONCENTRATION	C_{SOURCE}	chemical-specific	g/cm3	Calculated in model

NOTES:

USEPA, 1996. Soil Screening Guidance: Technical Background Document. Appendix H. EPA/540/R-95/128

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM Standard E1739-95)

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management, Office of Response. October, 1997

MDEQ, 1998. Michigan Department of Environmental Quality. Part 213, Risk-based screening levels for groundwater and soil volatilization to indoor air inhalation criteria. Residential parameters used.

(1) Site-specific values determined through measurements taken at 5 site locations (MW-5, 4-6; MW-5, 6-8; MW-9, 14-16; MW-4, 10-12; MW-3, 2-4); geometric mean of measured values used as input parameter in this model.

(2) Site-specific values determined through measurements taken at 5 site locations (02PS011, 16-18; 09PS002, 16-18; 17PS001, 10-12; 05PS052, 14-16; 12PS001, 18-20); geometric mean of measured values used as input parameter in this model.

(3) Assumed values for vadose zone soil and water.

(4) Value for resident.

(5) Assumes that a building is constructed on top of the contaminated soil.

(6) Assumes that groundwater is present at its shallowest depth on-site (12 feet), and that a building with an 8-foot basement is constructed above the groundwater (resulting in a building-groundwater separation of 4 feet).

(7) Thickest areas of soil contamination (surface to groundwater table = 12 feet) and groundwater plume (70 feet).

(8) Thickest smear zone (2 feet).

NOTE: All equations presented in the text accompanying this Table.

TABLE O-3-4a, CONT

CHEMICAL	H (unitless)	Koc (cm3/g)	Di_a (cm2/sec)	Di_w (cm2/sec)	$D_{cr\text{-}cap}$ (cm3/cm3)	$D_{eff\text{-}soil}$ (cm2/sec)
1,1,1-Trichloroethane	7.05E-01	1.10E+01	7.80E-02	8.80E-06	1.19E-05	5.78E-03
1,1,2,2-Tetrachloroethane	1.41E-02	9.33E+01	7.10E-02	7.90E-06	1.12E-04	5.26E-03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	7.80E-02	8.80E-06	5.30E-05	5.78E-03
1,1-Dichloroethane	2.30E-01	3.16E+01	7.42E-02	1.05E-05	1.75E-05	5.50E-03
1,1-Dichloroethene	1.07E+00	5.89E+01	9.00E-02	1.04E-05	1.28E-05	6.67E-03
1,2-Dichlorobenzene	7.79E-02	6.17E+02	6.90E-02	7.90E-06	2.72E-05	5.11E-03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.04E-01	9.90E-06	5.83E-05	7.71E-03
1,2-Dichloropropane	1.15E-01	4.37E+01	7.82E-02	8.73E-06	2.36E-05	5.79E-03
1,3-Dichlorbenzene	7.80E-02	1.20E+03	1.30E-01	7.90E-06	3.46E-05	9.63E-03
1,4-Dichlorobenzene	9.96E-02	6.17E+02	6.90E-02	7.90E-06	2.31E-05	5.11E-03
2-Butanone	1.10E-03	4.50E+00	9.00E-02	9.80E-06	1.66E-03	6.72E-03
2-Hexanone	6.36E-02	2.90E+00	7.60E-02	7.00E-05	2.12E-04	5.64E-03
4-Methyl-2-Pentanone	6.36E-02	2.90E+00	7.6E-02	7.0E-05	2.12E-04	5.64E-03
Acetone	1.59E-03	5.75E-01	1.24E-01	1.14E-05	1.34E-03	9.23E-03
Benzene	2.28E-01	5.89E+01	8.80E-02	9.80E-06	1.87E-05	6.52E-03
Bromomethane	2.67E-01	9.98E-02	9.61E-02	8.96E-06	1.80E-05	7.12E-03
Carbon tetrachloride	1.25E+00	1.74E+02	7.80E-02	8.80E-06	1.09E-05	5.78E-03
Chlorobenzene	1.52E-01	2.19E+02	7.30E-02	8.70E-06	1.95E-05	5.41E-03
Chloroethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
Chloroform	1.50E-01	3.98E+01	1.04E-01	1.00E-05	2.51E-05	7.71E-03
Chloromethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	7.36E-02	1.13E-05	2.15E-05	5.45E-03
1,3-dichloropropene	7.26E-01	4.57E+01	6.26E-02	1.00E-05	1.02E-05	4.64E-03
Ethylbenzene	3.23E-01	3.63E+02	7.50E-02	7.80E-06	1.37E-05	5.56E-03
Methylene Chloride	8.98E-02	1.17E+01	1.01E-01	1.17E-05	3.64E-05	7.48E-03
Methyl tertiary butyl ether					#DIV/0!	#DIV/0!
Styrene	1.13E-01	7.76E+02	7.10E-02	8.00E-06	2.18E-05	5.26E-03
Tetrachloroethene	7.54E-01	1.55E+02	7.20E-02	8.20E-06	1.08E-05	5.33E-03
Toluene	2.72E-01	1.82E+02	8.70E-02	8.60E-06	1.65E-05	6.45E-03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	7.07E-02	1.19E-05	1.44E-05	5.24E-03
Trichloroethene	4.22E-01	1.66E+02	7.90E-02	9.10E-06	1.37E-05	5.85E-03
Vinyl chloride	1.11E+00	1.86E+01	1.06E-01	1.23E-06	1.32E-05	7.85E-03
Xylene (total)	2.76E-01	3.86E+02	7.80E-02	8.70E-06	1.54E-05	5.78E-03
Acenapthene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
Acenaphthylene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
2-Methylnaphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03
Naphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03

TABLE O-3-4a, CONT

CHEMICAL	D_{eff}-crack (cm2/sec)	D_{eff}-gw (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	9.33E+02	2.63E+00	4.27E-05	3.89E-09	5.34E-06	3.17E-06
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	8.50E+02	1.48E+01	2.88E-07	6.60E-10	5.36E-06	5.00E-06
1,1,2-Trichloroethane	5.78E-03	3.52E-04	9.33E+02	7.98E+00	1.42E-06	8.85E-10	5.36E-06	4.69E-06
1,1-Dichloroethane	5.50E-03	1.20E-04	8.88E+02	3.39E+00	1.07E-05	1.86E-09	5.35E-06	3.73E-06
1,1-Dichloroethene	6.67E-03	8.88E-05	1.08E+03	2.76E+00	3.04E-05	6.39E-09	5.35E-06	3.20E-06
1,2-Dichlorobenzene	5.11E-03	1.84E-04	8.26E+02	4.66E+00	2.57E-07	9.66E-10	5.36E-06	4.20E-06
1,2-Dichloroethane	7.71E-03	3.91E-04	1.24E+03	8.75E+00	4.28E-06	1.05E-09	5.36E-06	4.75E-06
1,2-Dichloropropane	5.79E-03	1.61E-04	9.36E+02	4.20E+00	4.71E-06	1.25E-09	5.36E-06	4.06E-06
1,3-Dichlorbenzene	9.63E-03	2.37E-04	1.55E+03	5.70E+00	2.51E-07	1.25E-09	5.37E-06	4.41E-06
1,4-Dichlorobenzene	5.11E-03	1.57E-04	8.26E+02	4.12E+00	3.28E-07	1.05E-09	5.36E-06	4.04E-06
2-Butanone	6.72E-03	4.68E-03	1.08E+03	9.38E+01	1.94E-07	3.46E-10	5.36E-06	5.31E-06
2-Hexanone	5.64E-03	1.21E-03	9.10E+02	2.51E+01	9.47E-06	5.19E-09	5.35E-06	5.15E-06
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	9.10E+02	2.51E+01	9.47E-06	5.19E-09	5.35E-06	5.15E-06
Acetone	9.23E-03	5.01E-03	1.49E+03	1.00E+02	5.15E-07	5.36E-10	5.37E-06	5.32E-06
Benzene	6.52E-03	1.29E-04	1.05E+03	3.56E+00	8.01E-06	1.98E-09	5.36E-06	3.80E-06
Bromomethane	7.12E-03	1.24E-04	1.15E+03	3.46E+00	4.44E-05	2.23E-09	5.34E-06	3.75E-06
Carbon tetrachloride	5.78E-03	7.52E-05	9.33E+02	2.49E+00	1.37E-05	6.32E-09	5.35E-06	2.96E-06
Chlorobenzene	5.41E-03	1.34E-04	8.73E+02	3.65E+00	1.43E-06	1.37E-09	5.36E-06	3.86E-06
Chloroethane	7.78E-03	9.56E-05	1.26E+03	2.90E+00	6.37E-05	7.72E-09	5.34E-06	3.26E-06
Chloroform	7.71E-03	1.72E-04	1.24E+03	4.41E+00	8.63E-06	1.74E-09	5.36E-06	4.12E-06
Chloromethane	7.78E-03	9.56E-05	1.26E+03	2.90E+00	6.37E-05	7.72E-09	5.34E-06	3.26E-06
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	8.81E+02	3.92E+00	7.33E-06	1.65E-09	5.35E-06	3.96E-06
1,3-dichloropropene	4.64E-03	7.06E-05	7.49E+02	2.40E+00	1.85E-05	3.45E-09	5.34E-06	2.98E-06
Ethylbenzene	5.56E-03	9.42E-05	8.97E+02	2.87E+00	1.91E-06	2.05E-09	5.36E-06	3.42E-06
Methylene Chloride	7.48E-03	2.48E-04	1.21E+03	5.92E+00	1.10E-05	1.50E-09	5.36E-06	4.44E-06
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	8.50E+02	3.95E+00	3.05E-07	1.13E-09	5.36E-06	3.98E-06
Tetrachloroethene	5.33E-03	7.49E-05	8.61E+02	2.49E+00	8.87E-06	3.80E-09	5.35E-06	3.05E-06
Toluene	6.45E-03	1.14E-04	1.04E+03	3.26E+00	3.57E-06	2.08E-09	5.36E-06	3.65E-06
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	8.46E+02	2.96E+00	1.13E-05	2.56E-09	5.35E-06	3.47E-06
Trichloroethene	5.85E-03	9.43E-05	9.45E+02	2.87E+00	5.36E-06	2.68E-09	5.36E-06	3.40E-06
Vinyl chloride	7.85E-03	9.15E-05	1.27E+03	2.82E+00	6.33E-05	6.83E-09	5.34E-06	3.23E-06
Xylene (total)	5.78E-03	1.06E-04	9.33E+02	3.10E+00	1.60E-06	1.97E-09	5.36E-06	3.57E-06
Acenapthene	3.13E-03	1.11E-03	5.05E+02	2.31E+01	1.14E-09	4.75E-10	5.35E-06	5.13E-06
Acenaphthylene	3.13E-03	1.11E-03	5.05E+02	2.31E+01	1.14E-09	4.75E-10	5.35E-06	5.13E-06
2-Methylnaphthalene	4.37E-03	4.88E-04	7.06E+02	1.07E+01	1.75E-08	6.51E-10	5.36E-06	4.86E-06
Naphthalene	4.37E-03	4.88E-04	7.06E+02	1.07E+01	1.75E-08	6.51E-10	5.36E-06	4.86E-06

TABLE O-3-4a, CONT

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CS (g/g)	CGW (g/cm3)	T_b -SOIL	T_b -GW
1,1,1-Trichloroethane	2.76E+00	7.05E-01	1	1	5.40E+08	5.12E+10
1,1,2,2-Tetrachloroethane	2.04E-02	1.41E-02	1	1	7.30E+10	6.25E+11
1,1,2-Trichloroethane	9.15E-02	3.74E-02	1	1	1.63E+10	3.31E+11
1,1-Dichloroethane	7.26E-01	2.30E-01	1	1	2.05E+09	1.14E+11
1,1-Dichloroethene	1.70E+00	1.07E+00	1	1	8.74E+08	3.15E+10
1,2-Dichlorobenzene	1.87E-02	7.79E-02	1	1	7.96E+10	2.43E+11
1,2-Dichloroethane	2.07E-01	4.01E-02	1	1	7.16E+09	2.91E+11
1,2-Dichloropropane	3.04E-01	1.15E-01	1	1	4.91E+09	1.82E+11
1,3-Dichlorbenzene	9.74E-03	7.80E-02	1	1	1.52E+11	2.03E+11
1,4-Dichlorobenzene	2.39E-02	9.96E-02	1	1	6.23E+10	2.14E+11
2-Butanone	1.08E-02	1.10E-03	1	1	1.38E+11	5.19E+12
2-Hexanone	6.28E-01	6.36E-02	1	1	2.37E+09	1.14E+11
4-Methyl-2-Pentanone	6.28E-01	6.36E-02	1	1	2.37E+09	1.14E+11
Acetone	2.08E-02	1.59E-03	1	1	7.11E+10	3.56E+12
Benzene	4.59E-01	2.28E-01	1	1	3.24E+09	1.09E+11
Bromomethane	2.33E+00	2.67E-01	1	1	6.38E+08	9.59E+10
Carbon tetrachloride	8.82E-01	1.25E+00	1	1	1.69E+09	3.11E+10
Chlorobenzene	9.86E-02	1.52E-01	1	1	1.51E+10	1.59E+11
Chloroethane	3.06E+00	1.20E+00	1	1	4.85E+08	2.64E+10
Chloroform	4.18E-01	1.50E-01	1	1	3.55E+09	1.33E+11
Chloromethane	3.06E+00	1.20E+00	1	1	4.85E+08	2.64E+10
cis-1,2-Dichloroethene	5.02E-01	1.67E-01	1	1	2.97E+09	1.34E+11
1,3-dichloropropene	1.49E+00	7.26E-01	1	1	1.00E+09	5.66E+10
Ethylbenzene	1.28E-01	3.23E-01	1	1	1.16E+10	9.94E+10
Methylene Chloride	5.49E-01	8.98E-02	1	1	2.70E+09	1.71E+11
Methyl tertiary butyl ether	0.00E+00	0.00E+00	1	1	#DIV/0!	#DIV/0!
Styrene	2.17E-02	1.13E-01	1	1	6.88E+10	1.97E+11
Tetrachloroethene	6.21E-01	7.54E-01	1	1	2.40E+09	5.17E+10
Toluene	2.07E-01	2.72E-01	1	1	7.20E+09	1.01E+11
trans-1,2-Dichloroethene	8.04E-01	3.85E-01	1	1	1.86E+09	8.00E+10
Trichloroethene	3.42E-01	4.22E-01	1	1	4.36E+09	7.59E+10
Vinyl chloride	3.01E+00	1.11E+00	1	1	4.93E+08	2.96E+10
Xylene (total)	1.04E-01	2.76E-01	1	1	1.44E+10	1.05E+11
Acenapthene	1.36E-04	6.36E-03	1	1	1.11E+13	1.17E+12
Acenaphthylene	1.36E-04	6.36E-03	1	1	1.11E+13	1.17E+12
2-Methylnaphthalene	1.49E-03	1.98E-02	1	1	1.00E+12	5.23E+11
Naphthalene	1.49E-03	1.98E-02	1	1	1.00E+12	5.23E+11

TABLE O-3-4a, CONT

CHEMICAL	Is T>T_b-SOIL ?	Is T>T_b-GW ?	E-SOIL	E-GW	$C_{sat,soil}$ - SOIL (kg/m3)	$C_{sat,gw}$ - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	NO	NO	NA	NA	1.47E-02	2.24E-03	6.79E+01	4.47E+02
1,1,2,2-Tetrachloroethane	NO	NO	NA	NA	1.09E-04	7.05E-05	9.14E+03	1.42E+04
1,1,2-Trichloroethane	NO	NO	NA	NA	4.90E-04	1.75E-04	2.04E+03	5.71E+03
1,1-Dichloroethane	NO	NO	NA	NA	3.88E-03	8.57E-04	2.57E+02	1.17E+03
1,1-Dichloroethene	NO	NO	NA	NA	9.10E-03	3.42E-03	1.10E+02	2.92E+02
1,2-Dichlorobenzene	NO	NO	NA	NA	1.00E-04	3.27E-04	9.96E+03	3.06E+03
1,2-Dichloroethane	NO	NO	NA	NA	1.11E-03	1.90E-04	9.00E+02	5.25E+03
1,2-Dichloropropane	NO	NO	NA	NA	1.63E-03	4.67E-04	6.15E+02	2.14E+03
1,3-Dichlorbenzene	NO	NO	NA	NA	5.23E-05	3.44E-04	1.91E+04	2.90E+03
1,4-Dichlorobenzene	NO	NO	NA	NA	1.28E-04	4.03E-04	7.80E+03	2.48E+03
2-Butanone	NO	NO	NA	NA	5.77E-05	5.84E-06	1.73E+04	1.71E+05
2-Hexanone	NO	NO	NA	NA	3.36E-03	3.28E-04	2.98E+02	3.05E+03
4-Methyl-2-Pentanone	NO	NO	NA	NA	3.36E-03	3.28E-04	2.98E+02	3.05E+03
Acetone	NO	NO	NA	NA	1.12E-04	8.45E-06	8.95E+03	1.18E+05
Benzene	NO	NO	NA	NA	2.46E-03	8.67E-04	4.07E+02	1.15E+03
Bromomethane	NO	NO	NA	NA	1.24E-02	1.00E-03	8.04E+01	9.97E+02
Carbon tetrachloride	NO	NO	NA	NA	4.72E-03	3.70E-03	2.12E+02	2.70E+02
Chlorobenzene	NO	NO	NA	NA	5.28E-04	5.87E-04	1.89E+03	1.70E+03
Chloroethane	NO	NO	NA	NA	1.63E-02	3.91E-03	6.12E+01	2.55E+02
Chloroform	NO	NO	NA	NA	2.24E-03	6.18E-04	4.46E+02	1.62E+03
Chloromethane	NO	NO	NA	NA	1.63E-02	3.91E-03	6.12E+01	2.55E+02
cis-1,2-Dichloroethene	NO	NO	NA	NA	2.69E-03	6.61E-04	3.72E+02	1.51E+03
1,3-dichloropropene	NO	NO	NA	NA	7.95E-03	2.16E-03	1.26E+02	4.63E+02
Ethylbenzene	NO	NO	NA	NA	6.87E-04	1.10E-03	1.46E+03	9.05E+02
Methylene Chloride	NO	NO	NA	NA	2.94E-03	3.99E-04	3.40E+02	2.51E+03
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	NO	NO	NA	NA	1.16E-04	4.50E-04	8.61E+03	2.22E+03
Tetrachloroethene	NO	NO	NA	NA	3.33E-03	2.30E-03	3.01E+02	4.35E+02
Toluene	NO	NO	NA	NA	1.11E-03	9.94E-04	9.03E+02	1.01E+03
trans-1,2-Dichloroethene	NO	NO	NA	NA	4.30E-03	1.33E-03	2.33E+02	7.49E+02
Trichloroethene	NO	NO	NA	NA	1.83E-03	1.43E-03	5.46E+02	6.97E+02
Vinyl chloride	NO	NO	NA	NA	1.61E-02	3.58E-03	6.22E+01	2.79E+02
Xylene (total)	NO	NO	NA	NA	5.55E-04	9.86E-04	1.80E+03	1.01E+03
Acenapthene	NO	NO	NA	NA	7.28E-07	3.26E-05	1.37E+06	3.06E+04
Acenaphthylene	NO	NO	NA	NA	7.28E-07	3.26E-05	1.37E+06	3.06E+04
2-Methylnaphthalene	NO	NO	NA	NA	7.99E-06	9.62E-05	1.25E+05	1.04E+04
Naphthalene	NO	NO	NA	NA	7.99E-06	9.62E-05	1.25E+05	1.04E+04

Table O-3-4b
EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
TARGET CANCER RISK	TRc	1E-05	unitless	IDEM, 1997
TARGET NON-CANCER RISK	TRnc	1	unitless	IDEM, 1997
CANCER SLOPE FACTOR	CSF	chemical-specific	(mg/kg/day)-1	IDEM, 1997 (1)
INHALATION RATE	IR	15	m^3/day	IDEM, 1997
BODY WEIGHT	BW	70	kg	IDEM, 1997
REFERENCE DOSE	RfD	chemical-specific	mg/kg/day	IDEM, 1997 (1)
EXPOSURE FREQUENCY	EF	350	days/year	IDEM, 1997
EXPOSURE DURATION	ED	30	years	IDEM, 1997
AVERAGING TIME				
CANCER	AT	70	years	IDEM, 1997
NONCANCER	AT	30	years	IDEM, 1997

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management Office of Response. October, 1997. Values are for occupational worker.
VF values are derived in "Vapor Migration to Indoor Air" Model.
(1) Values for chemicals not published in IDEM were obtained from IRIS or HEAST.

EQUATIONS

$$\text{RBSLcancer (mg/m3)} = \frac{\text{TRc x BW x AT x 365 days/yr}}{\text{IR x ED x EF x CSF}}$$

$$\text{RBSLnon-cancer (mg/m3)} = \frac{\text{TRnc x BW x AT x 365 days/yr x RfD}}{\text{IR x ED x EF}}$$

SSL - soil (mg/kg) = VF (m3/kg) x RBSL (mg/m3)
SSL - gw (mg/L) = VF (m3/L) x RBSL (mg/m3)
(where 1 kg water = 1 L)

Note:
For noncarcinogenic effects: AT = ED
RBSL = Risk Based Screening Level
CSF = Cancer Slope Factor
RfD = Reference Dose

Table O-3-4b
CARCINOGENIC EFFECTS

COMPOUND	INHALATION CSF (mg/kg-day)^-1	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	NC	NC	6.79E+01	4.47E+02	NC	NC
1,1,2,2-Tetrachloroethane	2.00E-01	5.68E-04	9.14E+03	1.42E+04	5.19E+00	8.05E+00
1,1,2-Trichloroethane	5.60E-02	2.03E-03	2.04E+03	5.71E+03	4.14E+00	1.16E+01
1,1-Dichloroethane	NC	NC	2.57E+02	1.17E+03	NC	NC
1,1-Dichloroethene	1.80E-01	6.31E-04	1.10E+02	2.92E+02	6.93E-02	1.84E-01
1,2-Dichlorobenzene	NC	NC	9.96E+03	3.06E+03	NC	NC
1,2-Dichloroethane	9.10E-02	1.25E-03	9.00E+02	5.25E+03	1.12E+00	6.56E+00
1,2-Dichloropropane	6.80E-02	1.67E-03	6.15E+02	2.14E+03	1.03E+00	3.58E+00
1,3-Dichlorbenzene	NC	NC	1.91E+04	2.90E+03	NC	NC
1,4-Dichlorobenzene	2.40E-02	4.73E-03	7.80E+03	2.48E+03	3.69E+01	1.18E+01
2-Butanone	NC	NC	1.73E+04	1.71E+05	NC	NC
2-Hexanone	NC	NC	2.98E+02	3.05E+03	NC	NC
4-Methyl-2-Pentanone	NC	NC	2.98E+02	3.05E+03	NC	NC
Acetone	NC	NC	8.95E+03	1.18E+05	NC	NC
Benzene	2.90E-02	3.92E-03	4.07E+02	1.15E+03	1.59E+00	4.52E+00
Bromomethane	NC	NC	8.04E+01	9.97E+02	NC	NC
Carbon tetrachloride	5.30E-02	2.14E-03	2.12E+02	2.70E+02	4.54E-01	5.79E-01
Chlorobenzene	NC	NC	1.89E+03	1.70E+03	NC	NC
Chloroethane	NC	NC	6.12E+01	2.55E+02	NC	NC
Chloroform	8.10E-02	1.40E-03	4.46E+02	1.62E+03	6.25E-01	2.27E+00
Chloromethane	6.30E-03	1.80E-02	6.12E+01	2.55E+02	1.10E+00	4.60E+00
cis-1,2-Dichloroethene	NC	NC	3.72E+02	1.51E+03	NC	NC
1,3-dichloropropene	1.30E-01	8.74E-04	1.26E+02	4.63E+02	1.10E-01	4.04E-01
Ethylbenzene	NC	NC	1.46E+03	9.05E+02	NC	NC
Methylene chloride	1.60E-03	7.10E-02	3.40E+02	2.51E+03	2.41E+01	1.78E+02
Methyl tertiary butyl ether	NC	NC	#DIV/0!	#DIV/0!	NC	NC
Styrene	NC	NC	8.61E+03	2.22E+03	NC	NC
Tetrachloroethene	2.00E-03	5.68E-02	3.01E+02	4.35E+02	1.71E+01	2.47E+01
Toluene	NC	NC	9.03E+02	1.01E+03	NC	NC
trans-1,2-Dichloroethene	NC	NC	2.33E+02	7.49E+02	NC	NC
Trichloroethene	6.00E-03	1.89E-02	5.46E+02	6.97E+02	1.03E+01	1.32E+01
Vinyl chloride	3.00E-01	3.79E-04	6.22E+01	2.79E+02	2.35E-02	1.06E-01
Xylene (total)	NC	NC	1.80E+03	1.01E+03	NC	NC
Acenapthene	NC	NC	1.37E+06	3.06E+04	NC	NC
Acenaphthylene	NC	NC	1.37E+06	3.06E+04	NC	NC
2-Methylnaphthalene	NC	NC	1.25E+05	1.04E+04	NC	NC
Naphthalene	NC	NC	1.25E+05	1.04E+04	NC	NC

NC = Not Carcinogenic

Table O-3-4b
NONCARCINOGENIC EFFECTS

COMPOUND	INHALATION RfD (mg/kg-day)	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	2.90E-01	1.41E+00	6.79E+01	4.47E+02	9.58E+01	6.31E+02
1,1,2,2-Tetrachloroethane	ND	ND	9.14E+03	1.42E+04	ND	ND
1,1,2-Trichloroethane	4.00E-03	1.95E-02	2.04E+03	5.71E+03	3.97E+01	1.11E+02
1,1-Dichloroethane	5.00E-01	2.43E+00	2.57E+02	1.17E+03	6.26E+02	2.84E+03
1,1-Dichloroethene	9.00E-03	4.38E-02	1.10E+02	2.92E+02	4.81E+00	1.28E+01
1,2-Dichlorobenzene	2.00E-01	9.73E-01	9.96E+03	3.06E+03	9.69E+03	2.98E+03
1,2-Dichloroethane	2.90E-03	1.41E-02	9.00E+02	5.25E+03	1.27E+01	7.41E+01
1,2-Dichloropropane	4.00E-03	1.95E-02	6.15E+02	2.14E+03	1.20E+01	4.17E+01
1,3-Dichlorbenzene	3.00E-02	1.46E-01	1.91E+04	2.90E+03	2.79E+03	4.24E+02
1,4-Dichlorobenzene	8.00E-01	3.89E+00	7.80E+03	2.48E+03	3.04E+04	9.67E+03
2-Butanone	2.90E-01	1.41E+00	1.73E+04	1.71E+05	2.45E+04	2.42E+05
2-Hexanone	2.30E-02	1.12E-01	2.98E+02	3.05E+03	3.33E+01	3.42E+02
4-Methyl-2-Pentanone	2.30E-02	1.12E-01	2.98E+02	3.05E+03	3.33E+01	3.42E+02
Acetone	1.00E-01	4.87E-01	8.95E+03	1.18E+05	4.35E+03	5.76E+04
Benzene	ND	ND	4.07E+02	1.15E+03	ND	ND
Bromomethane	1.43E-03	6.96E-03	8.04E+01	9.97E+02	5.60E-01	6.94E+00
Carbon tetrachloride	5.70E-04	2.77E-03	2.12E+02	2.70E+02	5.87E-01	7.49E-01
Chlorobenzene	2.00E-02	9.73E-02	1.89E+03	1.70E+03	1.84E+02	1.66E+02
Chloroethane	2.86E+00	1.39E+01	6.12E+01	2.55E+02	8.52E+02	3.56E+03
Chloroform	1.00E-02	4.87E-02	4.46E+02	1.62E+03	2.17E+01	7.88E+01
Chloromethane	ND	ND	6.12E+01	2.55E+02	ND	ND
cis-1,2-Dichloroethene	1.00E-02	4.87E-02	3.72E+02	1.51E+03	1.81E+01	7.36E+01
1,3-dichloropropene	2.00E-02	9.73E-02	1.26E+02	4.63E+02	1.22E+01	4.50E+01
Ethylbenzene	1.00E+00	4.87E+00	1.46E+03	9.05E+02	7.08E+03	4.41E+03
Methylene Chloride	3.00E+00	1.46E+01	3.40E+02	2.51E+03	4.96E+03	3.66E+04
Methyl tertiary butyl ether	8.57E-01	4.17E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	1.00E+00	4.87E+00	8.61E+03	2.22E+03	4.19E+04	1.08E+04
Tetrachloroethene	1.00E-02	4.87E-02	3.01E+02	4.35E+02	1.46E+01	2.12E+01
Toluene	4.00E-01	1.95E+00	9.03E+02	1.01E+03	1.76E+03	1.96E+03
trans-1,2-Dichloroethene	2.00E-02	9.73E-02	2.33E+02	7.49E+02	2.26E+01	7.29E+01
Trichloroethene	6.00E-03	2.92E-02	5.46E+02	6.97E+02	1.59E+01	2.03E+01
Vinyl chloride	ND	ND	6.22E+01	2.79E+02	ND	ND
Xylene (total)	2.00E-01	9.73E-01	1.80E+03	1.01E+03	1.75E+03	9.87E+02
Acenapthene	6.00E-02	2.92E-01	1.37E+06	3.06E+04	4.01E+05	8.95E+03
Acenaphthylene	6.00E-02	2.92E-01	1.37E+06	3.06E+04	4.01E+05	8.95E+03
2-Methylnaphthalene	4.00E-02	1.95E-01	1.25E+05	1.04E+04	2.44E+04	2.02E+03
Naphthalene	4.00E-02	1.95E-01	1.25E+05	1.04E+04	2.44E+04	2.02E+03

ND = No data available
Value for 4-methyl-2-pentanone used for 2-hexanone
Value for napthalene used for 2-methylnaphthalene

TABLE O-3-4c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	6.31E+02	6.31E+02
1,1,2,2-Tetrachloroethane	8.05E+00	ND	8.05E+00
1,1,2-Trichloroethane	1.16E+01	1.11E+02	1.16E+01
1,1-Dichloroethane	NC	2.84E+03	2.84E+03
1,1-Dichloroethene	1.84E-01	1.28E+01	1.84E-01
1,2-Dichlorobenzene	NC	2.98E+03	2.98E+03
1,2-Dichloroethane	6.56E+00	7.41E+01	6.56E+00
1,2-Dichloropropane	3.58E+00	4.17E+01	3.58E+00
1,3-Dichlorbenzene	NC	4.24E+02	4.24E+02
1,4-Dichlorobenzene	1.18E+01	9.67E+03	1.18E+01
2-Butanone	NC	2.42E+05	2.42E+05
2-Hexanone	NC	3.42E+02	3.42E+02
4-Methyl-2-Pentanone	NC	3.42E+02	3.42E+02
Acetone	NC	5.76E+04	5.76E+04
Benzene	4.52E+00	ND	4.52E+00
Bromomethane	NC	6.94E+00	6.94E+00
Carbon tetrachloride	5.79E-01	7.49E-01	5.79E-01
Chlorobenzene	NC	1.66E+02	1.66E+02
Chloroethane	NC	3.56E+03	3.56E+03
Chloroform	2.27E+00	7.88E+01	2.27E+00
Chloromethane	4.60E+00	ND	4.60E+00
cis-1,2-Dichloroethene	NC	7.36E+01	7.36E+01
1,3-dichloropropene	4.04E-01	4.50E+01	4.04E-01
Ethylbenzene	NC	4.41E+03	4.41E+03
Methylene chloride	1.78E+02	3.66E+04	1.78E+02
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	1.08E+04	1.08E+04
Tetrachloroethene	2.47E+01	2.12E+01	2.12E+01
Toluene	NC	1.96E+03	1.96E+03
trans-1,2-Dichloroethene	NC	7.29E+01	7.29E+01
Trichloroethene	1.32E+01	2.03E+01	1.32E+01
Vinyl chloride	1.06E-01	ND	1.06E-01
Xylene (total)	NC	9.87E+02	9.87E+02
Acenapthene	NC	8.95E+03	8.95E+03
Acenaphthylene	NC	8.95E+03	8.95E+03
2-Methylnaphthalene	NC	2.02E+03	2.02E+03
Naphthalene	NC	2.02E+03	2.02E+03

NC = Not Carcinogenic

Environmental Protection Agency
Emergency Response Washington, DC 20460
EPA/540/R-95/128
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Superfund
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Soil Screening Guidance: Technical Background Document

APPENDIX H

Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger Model (EQ, 1994a)

ENVIRONMENTAL QUALITY MANAGEMENT, INC.

MEMORANDUM

TO: Janine Dinan

DATE: October 7, 1994

SUBJECT: Evaluation of the Effect on the Draft SSLs of the Johnson and Ettinger (1991) Model for the Intrusion of Contaminant Vapors Into Buildings

FROM: Craig S. Mann

FILE: 5099-3

CC:

Under U.S. Environmental Protection Agency (EPA) Contract No. 68-D3-0035, Task order No. 0-25, Environmental Quality Management, Inc. (EQ) was directed to evaluate the effect on the draft soil screening levels (SSLs) of employing the Johnson and Ettinger (1991) model for estimating the intrusion rate of contaminant vapors from soil into buildings. This memorandum summarizes the evaluation.

Model Review:

Johnson and Ettinger (1991) is a closed-form analytical solution for both convective and diffusive transport of vapor-phase contaminants fully incorporated in soil into enclosed structures. The nondimensionalized mass balance is written as:

$$\frac{\partial \sum_i \epsilon_i C_i^*}{\partial t^*} - \left(\frac{L_P}{L_D}\right)(\nabla^* P^*) \cdot (\nabla^* C_v^*) = \nabla^* \cdot \left[\frac{D^{eff} \mu L_P}{k_v \Delta P_t L_D}\right] \nabla^* C_v^* + \sum_i R_i^* \qquad (1)$$

where

*	=	Nondimensional variables
ϵ_i	=	Volume fraction of phase i, unitless
C_i	=	Concentration of contaminant in phase i, g/cm^3
t	=	Time, s
L_P	=	Convection path length, cm

L_D = Diffusion path length, cm

P = Pressure in vapor-phase, g/cm-s^2

∇ = Del operator, 1/cm

C_v = Contaminant concentration in vapor phase, g/cm^3

D^{eff} = Effective diffusion coefficient, cm^2/s

μ = Vapor viscosity, g/cm-s

k_v = Soil permeability to vapor flow, cm^2

ΔP_r = Reference indoor-outdoor pressure differential, g/cm-s^2

R_i = Formation rate of contaminant in phase i, g/cm^3-s

and,

$C_i^* = C_i/C_r$

$\nabla^* = L_D \nabla$

$P^* = P/\Delta P_r$

$t^* = t\,(k_v\, \Delta P_r/L_p L_D\, \mu)$

$R_i^* = R_i\, L_p\, L_D\, \mu/C_r k_v\, \Delta P_r$

where C_r, L_p and L_D are characteristic concentration, convection pathway length, and diffusion pathway length, chosen to give the dependent concentration variable and derivatives of C_i^* and P^* magnitudes of order unity.

The mass balance solution includes the following assumptions:

1. The soil column is isotropic within any horizontal plane.
2. The effective diffusion coefficient is constant within any horizontal plane.
3. Concentration at the soil-air interface is zero (i.e., boundary layer resistance is zero).

4. No loss of contaminant occurs across the lower boundary (i.e., no leaching).

5. Source degradation and transformation are not considered.

6. Convective vapor flow near the building foundation is uniform.

7. Contaminant vapors enter the building primarily through openings in the walls and foundation at or below grade.

8. Convective velocities decrease with increasing contaminant source-building distance.

9. All contaminant vapors directly below a basement will enter the basement, unless the floor and walls are perfect vapor barriers.

10. The building contains no other contaminant sources or sinks, and the air volume is well mixed.

Therefore,

$$Q_{building}\, C_{building} = E \tag{2}$$

where $Q_{building}$, $C_{building}$, and E represent the volumetric flow rate or ventilation rate of the building (cm^3/s), contaminant concentration within the building (g/cm^3), and rate of contaminant entry (g/s), respectively.

Also,

$$\alpha = C_{building}/C_{source} \tag{3}$$

where C_{source} is the vapor-phase contaminant concentration within the soil at the source, and α represents the attenuation coefficient. C_{source} is written as:

$$C_{source} = \frac{H\,C_s\,\rho_b}{\theta_w + K_d\rho_b + H\theta_a} \tag{4}$$

where H = Henry's law constant, unitless

C_s = Soil bulk concentration, g/g

ρ_b = Soil dry bulk density, g/cm³

Θ_w = Soil water-filled porosity, unitless

K_d = Soil-water partion coefficient, cm³/g

Θ_a = Soil air-filled porosity, unitless.

The authors derive a solution for α for both steady-state conditions (i.e., depth of contamination, $z = \infty$) and for quasi-steady-state conditions ($0 < z < L$). For steady-state conditions α is written as:

$$\alpha = \left[\left[\frac{D^{eff}\,A_B}{Q_{building}\,L_T}\right] x \exp\left(\frac{Q_{soil}\,L_{crack}}{D^{crack}\,A_{crack}}\right)\right] /$$

$$\left[\exp\left(\frac{Q_{soil}\,L_{crack}}{D^{crack}\,A_{crack}}\right) + \left[\frac{D^{eff}\,A_B}{Q_{building}\,L_T}\right] + \left[\frac{D^{eff}\,A_B}{Q_{soil}\,L_T}\right]\left[\exp\left(\frac{Q_{soil}\,L_{crack}}{D^{crack}\,A_{crack}}\right) - 1\right]\right] \tag{5}$$

where D^{eff} = Effective diffusion coefficient, cm²/s

A_B = Area of basement, cm²

L_T = Source-building separation, cm

Q_{soil} = Volumetric flow rate of soil gas into the building, cm^3/s

L_{crack} = Building foundation thickness, cm

D^{crack} = Effective diffusion coefficient through crack, cm^2/s ($D^{crack} = D^{eff}$)

A_{crack} = Area of crack, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s.

For quasi-steady-state conditions the long-term average attenuation coefficient $<\alpha>$ is:

$$<\alpha> = \frac{\rho_b \, C_R \, \Delta H_C \, A_B}{Q_{building} \, C_{source} \, \tau} \left(\frac{L_T^0}{\Delta H_C}\right) \left[(\beta^2 + 2\psi\tau)^{1/2} - \beta\right] \tag{6}$$

where ρ_b = Soil dry bulk density, g/cm^3

C_R = Average contaminant level in soil, g/g

ΔH_c = Thickness of depth over which contaminant is distributed, cm

A_B = Area of basement, cm^2

$Q_{building}$ = Building ventilation rate, cm^3/s

C_{source} = Vapor-phase soil concentration at source, g/cm^3

τ = Exposure averaging period, s

L_T^0 = Source-building separation at t=0, cm

and,

$$\beta = \left(\frac{D^{eff} A_B}{L_T^0 Q_{soil}}\right)\left[1 - \exp\left(- \frac{Q_{soil} L_{crack}}{D^{crack} A_{crack}}\right)\right] + 1 \tag{7}$$

$$\psi = D^{eff} C_{source} / (L_T^0)^2 \rho_b C_R \tag{8}$$

The time required to deplete a finite source (τ_D) of depth ΔH_c is given as:

$$\tau_D = \frac{\left[\Delta H_c / L_T^0 + \beta\right]^2 - \beta^2}{2\psi} \tag{9}$$

If the exposure period (τ) is greater than τ_D, the average emission rate into the building <E> is given as a simple mass balance:

$$<E> = \rho_b C_R \Delta H_c A_B / \tau \tag{10}$$

and the average building concentration ($C_{building}$) is:

$$C_{building} = <E> / Q_{building} \tag{11}$$

Evaluation

In order to evaluate the effects of using the model on the SSLs for volatile contaminants, a case example was constructed which best estimates a reasonable high end exposure point concentration for residential land use. Where possible, values of model variables were taken directly from Johnson and Ettinger (1991).

The case example assumes that a residential dwelling with a basement is constructed within the area of homogeneous residual contamination such that the contaminant source lies directly below the basement floor at t = 0. Therefore, the diffusion and convection path lengths were set equal to the thickness of the basement slab (15 cm). Soil permeability to vapor flow from the basement floor to the bottom of contamination was set equal to 1.0×10^{-8} cm^2 (1 darcy) which is representative of silty to fine sand. Soil column-building pressure differential was set equal to 1 pascal (10 $g/cm\text{-}s^2$) as a reasonable long-term average value (Johnson and Ettinger, 1991). Values for all other soil properties were set equal to those of the Generic SSLs in the July 1994 Technical Background Document for Draft Soil Screening Level Framework (TBD). Building variables, i.e., basement area, ventilation rate, etc., were taken from Johnson and Ettinger (1991).

In the analysis, the values for $C_{building}$ (kg/m^3) were calculated for the 42 chemicals in the TBD for which human health benchmarks are available. Please note that the values of C_{source} and $C_{building}$ were calculated for an initial soil concentration of 1 mg/kg instead of 1×10^{-6} g/g. This was done to facilitate reverse calculation of the SSL in units of mg/kg. Therefore, these values are artificially high by a factor of 1×10^{6}. The inverse of the value of $C_{building}$ (m^3/kg) was used as the indoor volatilization factor (VF_{indoor}) and substituted into Equations 2-4 or 2-5 of the TBD as appropriate to calculate the resulting carcinogenic and noncarcinogenic inhalation SSLs. SSLs were calculated for both steady-state conditions (infinite source depth) and quasi-steady-state conditions (finite source depth). In each case were the exposure period exceeded the time required for source depletion (finite source depth), the volatilization factor was normalized to an average contaminant level in soil (C_t) of 1 mg/kg. For quasi-steady-state conditions, the depth to the bottom of contamination was set equal to 2 meters below the basement floor.

The value of the indoor SSL for each contaminant was compared to the respective SSL calculated for outdoor exposures of the same duration using the Generic SSL calculations found in the TBD. The outdoor SSLs were computed for a 30 acre square area source of emissions. Table 1 summarizes the results of this comparison. The attachment to this memorandum gives the detailed computations for this evaluation.

As can be seen from Table 1, results on a chemical-specific basis indicate a rate of change as high as three orders of magnitude between the outdoor SSL and the infinite source indoor SSLs in the case of highly volatile contaminants. For very persistent contaminants, the relative difference was considerably less, and in some cases there was no difference in SSL concentrations.

This variability is due to: 1) the variability in the human health benchmarks used to calculate the risk-based SSLs, and 2) the apparent diffusion coefficient of each compound. The apparent diffusion coefficient can be expressed as the effective diffusion coefficient through soil divided by the liquid-phase partition coefficient (Jury et al., 1983). The apparent diffusion coefficient (D_A) is given here so as not to be confused with the effective diffusion coefficient (D^{eff}) from Johnson and Ettinger (1991):

TABLE 1. SUMMARY OF INDOOR AND OUTDOOR INHALATION SSLs FOR VOLATILE CONTAMINANTS

Chemical	Indoor SSL, infinite source (mg/kg)	Indoor SSL, finite source (mg/kg)	Outdoor SSL, infinite source (mg/kg)
Aldrin	0.4	0.4	0.5
Benzene	0.002	0.02	0.5
Bis(2-chloroethyl)ether	0.02	0.05	0.3
Bromoform	0.8	0.9	43
Carbon disulfide	0.03	0.7	11
Carbon tetrachloride	0.0007	0.01	0.2
Chlordane	51	53	54
Chlorobenzene	0.7	2	87
Chloroform	0.001	0.007	0.2
DDT	5 [a]	5 [a]	5 [a]
1,2-Dichlorobenzene	26	65	297 [a]
1,4-Dichlorobenzene	102	235 [a]	235 [a]
1,1-Dichloroethane	4	35	939
1,2-Dichloroethane	0.002	0.007	0.3
1,1-Dichloroethylene	0.0001	0.003	0.04
1,2-Dichloropropane	0.06	0.3	10
1,3-Dichloropropene	0.0007	0.004	0.1
Dieldrin	3	4	2
Ethylbenzene	21	69	257 [a]
Heptachlor	0.04	0.04	0.3
Heptachlor epoxide	1	1	1
Hexachloro-1,3-butadiene	0.03	0.05	1
Hexachlorobenzene	0.3	0.6	1
HCH-alpha(alpha-BHC)	0.5	0.6	0.9
HCH-beta(beta-BHC)	7 [a]	7 [a]	7 [a]
Hexachlorocyclopentadiene	0.06	0.07	2
Hexachloroethane	0.6	0.6	45
Methyl bromide	0.01	0.3	3
Methylene chloride	0.04	0.3	7
Nitrobenzene	9	25	100
Styrene	185	472	1439 [a]
1,1,2,2-Tetrachloroethane	0.007	0.02	0.4
Tetrachloroethylene	0.05	0.3	11
Toluene	6	28	521 [a]
Toxaphene	2	2	2 [a]
1,2,4-Trichlorobenzene	6	9	214
1,1,1-Trichloroethane	5	69	980 [a]
1,1,2-Trichloroethane	0.009	0.02	1
Trichloroethylene	0.01	0.09	3
2,4,6-Trichlorophenol	64	94	190
Vinyl acetate	5	14	351
Vinyl chloride	0.00002	0.002	0.01

[a] = SSL based on C_{sat}.

$$D_A = \left[\left(\theta_a^{10/3} D_a H + \theta_w^{10/3} D_w\right)/\theta_t^2\right]/\left(\rho_b K_d + \theta_w + \theta_a H\right) \quad (12)$$

where D_A = Apparent diffusion coefficient, cm^2/s

Θ_a = Air-filled soil porosity, unitless

D_a = Diffusivity in air, cm^2/s

H = Henry's law constant, unitless

Θ_w = Water-filled soil porosity, unitless

D_w = Diffusivity in water, cm^2/s

Θ_t = Total soil porosity, unitless

ρ_b = Soil dry bulk density, g/cm^3

K_d = Soil-water partition coefficient, cm^3/g.

With all nonchemical-specific variables held constant, Figure 1 shows the exponential relationship between the apparent diffusion coefficient and the building concentration for quasi-steady-state conditions (finite source).

For nonchemical-specific variables, a sensitivity analysis was performed for soil permeability to vapor flow (k_v), soil-building pressure differential (ΔP), depth of contamination (ΔH_c), source-building separation at $t = 0$ (L_T^0), crack-to-total area ratio (η), and building ventilation rate ($Q_{building}$).

Table 2 shows the results of the sensitivity analysis for the quasi-steady-state condition (finite source). As can be seen from Table 2, the effect of the building ventilation rate is linear if the value of C_{sat} is not included in limiting the value of the SSL. Depth of contamination (ΔH_c) has the greatest effect for contaminants with higher apparent diffusion coefficients (e.g., benzene, chloroform, vinyl chloride, etc.), in that as ΔH_c increases, the time required for source depletion (τ_D) also increases. Therefore, with greater initial contaminant mass in the soil, these compounds are emitted for a longer period of time thus reducing the SSL. For the more persistent contaminants, an increase in k_v or ΔP produces the greatest results. This is to be expected as values of τ_D for these contaminants exceed the exposure duration. Table 2 also indicates that an order of magnitude change in values of L_T^0 and η produce same order of magnitude results. It must be remembered, however, that in the case of L_T^0, the model assumes isotropic soil

$$D_{crack}^{eff} = \left[D^a * \frac{\theta_{acrack}^{3.33}}{\theta_T^{2.0}}\right] + \left[D^w * \frac{1}{H} * \frac{\theta_{wcrack}^{3.33}}{\theta_T^{2.0}}\right]$$

where:

D^a = Diffusion coefficient in air [cm^2/s]
θ_{acrack} = Volumetric air content in foundation/wall cracks [cm^3-air/cm^3-total volume]
θ_{wcrack} = Volumetric water content in foundation/wall cracks [cm^3-H_2O/cm^3-total volume]
D_{crack}^{eff} = Effective diffusion coefficient through foundation cracks [cm^2/s]

$$D_s^{eff} = \left[D^a * \frac{\theta_{as}^{3.33}}{\theta_T^{2.0}}\right] + \left[D^w * \frac{1}{H} * \frac{\theta_{ws}^{3.33}}{\theta_T^{2.0}}\right]$$

where:

D^a = Chemical-specific diffusion coefficient in air [cm^2/s]
θ_T = Total soil porosity in the impacted zone [cm^3/cm^3-soil]
D^w = Chemical-specific diffusion coefficient in water [cm^2/s]

$$D_{ws}^{eff} = (h_{cap} + h_v) * \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}}\right]^{-1}$$

where:

h_{cap} = Thickness of capillary fringe [cm]
h_v = Thickness of vadose zone [cm]
D_{cap}^{eff} = Effective diffusion through capillary fringe [cm^2/s]
D_s^{eff} = Effective diffusion through vadose zone [cm^2/s]

In Equation C-16, D_{cap}^{eff} is calculated as:

$$D_{cap}^{eff} = \left[D^a * \frac{\theta_{acap}^{3.33}}{\theta_T^{2.0}}\right] + \left[D^w * \frac{1}{H} * \frac{\theta_{wcap}^{3.33}}{\theta_T^{2.0}}\right]$$

where:

D^a = Diffusion coefficient in air [cm^2/s]
θ_{acap} = Volumetric air content in capillary fringe soils [cm^3-air/cm^3-soil]
θ_T = Total soil porosity [cm^3/cm^3-soil]
D^w = Diffusion coefficient in water [cm^2/s]
H = Dimensionless form of Henry's Law constant [(cm^3-H_2O)/(cm^3-air)]
θ_{wcap} = Volumetric water content in capillary fringe soils [cm^3-H2O/cm^3-soil]

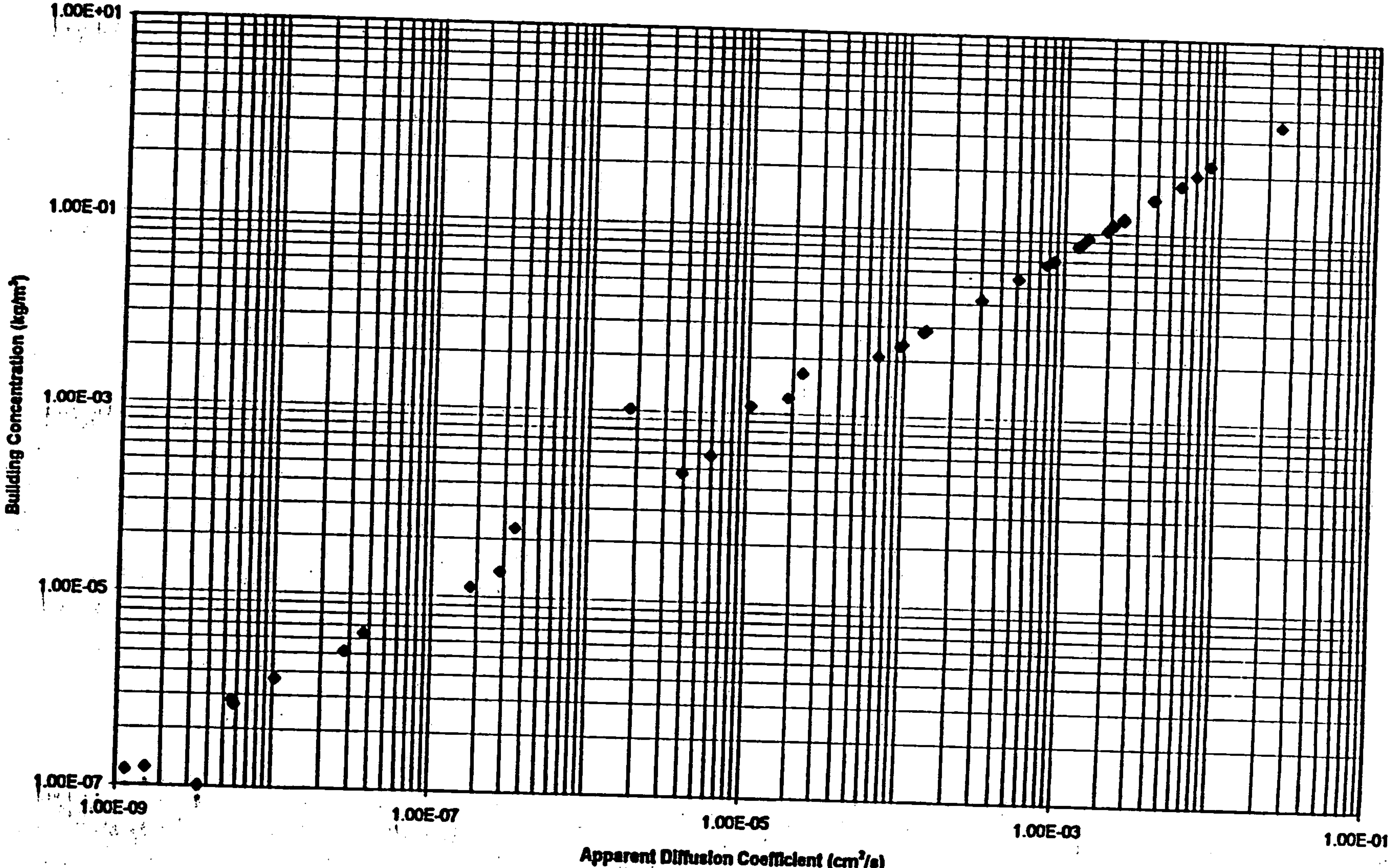


Figure 1. Building concentration versus apparent diffusion coefficient

TABLE 2. MODEL SENSITIVITY TO NONCHEMICAL SPECIFIC VARIABLES

Chemical	Apparent diffusion coefficient, D_A (cm^2/s)	Test condition SSL, (mg/kg)	Ratio of Variable-to-Test Condition SSL					
			Soil vapor permeability, k_v x 10	Soil-bldg. pressure differential, ΔP x 10	Depth to source lower boundary, ΔH_c x 10	Source-bldg. separation at t=0, L_t^0 x 10	Inverse of crack-to-total area ratio, $1/\eta$ x 10	Bldg. ventilation rate, $Q_{building}$ x 10
DDT	1.16E-09	5 [a]	1	1	1	1	1	1.0
Dieldrin	1.59E-09	4	0.1	0.1	1	1.2	1.5	3.4
HCH-beta(beta-BHC)	3.54E-09	7 [a]	0.8	0.8	1	1	1	1.0
Chlordane	5.63E-09	53	0.1	0.1	1	1.3	1.3	1.3
Heptachlor epoxide	5.78E-09	1	0.1	0.1	1	1.3	1.5	8.4
Aldrin	1.03E-08	0.4	0.1	0.1	1	1.2	1.5	10
HCH-alpha(alpha-BHC)	2.81E-08	0.6	0.1	0.1	1	1.2	1.5	10
Toxaphene	3.69E-08	2	0.1	0.1	1	1.1	1.1	1.1
2,4,6-Trichlorophenol	1.81E-07	94	0.1	0.1	1	1.1	1.5	10
Hexachlorobenzene	2.84E-07	0.6	0.1	0.1	1	1.1	1.5	3.2
Heptachlor	3.52E-07	0.04	0.1	0.1	1	1.3	1.5	10
Hexachloroethane	1.80E-06	0.6	0.3	0.3	1	2	1.4	10
Nitrobenzene	3.92E-06	25	0.1	0.1	1	1	1.5	10
Bis(2-chloroethyl)ether	5.94E-06	0.05	0.1	0.1	1	1	1.5	10
Hexachlorocyclopentadiene	1.06E-05	0.07	0.2	0.2	1	1.2	1.5	10
1,2,4-Trichlorobenzene	1.89E-05	9	0.1	0.1	1	1.1	1.5	10
Bromoform	2.32E-05	0.8	0.2	0.2	1	1.2	1.5	10
Hexachloro-1,3-butadiene	6.97E-05	0.05	0.1	0.1	1	1.1	1.5	10
Styrene	9.50E-05	472	0.1	0.1	1	1	1.5	3.0
1,1,2,2-Tetrachloroethane	9.89E-05	0.02	0.2	0.2	1	1	1.5	10
1,2-Dichlorobenzene	1.34E-04	65	0.2	0.2	1	1	1.5	4.6
1,4-Dichlorobenzene	1.38E-04	235 [a]	0.2	0.2	1	1	1	1.0
1,1,2-Trichloroethane	3.04E-04	0.02	0.4	0.4	1	1	1.5	10
Chlorobenzene	5.18E-04	2	0.8	0.8	1	1	1.5	10
Vinyl acetate	7.79E-04	14	1	1	1	1	1.5	10
1,2-Dichloroethane	8.57E-04	0.007	0.9	0.9	1	1	1.5	10
Ethylbenzene	8.64E-04	69	1	1	0.8	1	1.2	3.7
1,2-Dichloropropane	1.24E-03	0.3	1	1	0.6	1	1	10
Toluene	1.25E-03	28	1	1	0.7	1	1	10
Tetrachloroethylene	1.34E-03	0.3	1	1	0.5	1	1	10
1,3-Dichloropropene	1.44E-03	0.004	1	1	0.4	1	1	10
Chloroform	1.91E-03	0.007	1	1	0.5	1	1	10
1,1-Dichloroethane	2.06E-03	35	1	1	0.4	1	1	10
Benzene	2.12E-03	0.02	1	1	0.4	1	1	10
Trichloroethylene	2.44E-03	0.09	1	1	0.3	1	1	10
Methylene chloride	2.45E-03	0.3	1	1	0.4	1	1	10
1,1,1-Trichloroethane	3.79E-03	69	1	1	0.2	1	1	10
Carbon tetrachloride	3.82E-03	0.01	1	1	0.2	1	1	10
Carbon disulfide	5.67E-03	0.7	1	1	0.2	1	1	10
1,1-Dichloroethylene	7.09E-03	0.003	1	1	0.1	1	1	10
Methyl bromide	8.56E-03	0.3	1	1	0.1	1	1	10
Vinyl chloride	2.40E-02	0.002	1	1	0.1	1	1	10

[a] = SSL based C_{sat}.

conditions from the point of building entry to the bottom of contamination. As L_T^0 increases, α decreases until diffusion not convection limits the rate of contaminant vapor transport. The effect of changes in the value of η decrease as values of k_v decrease such that for very permeable soils and convection-dominated vapor transport, the effect of crack size is relatively insignificant.

Conclusions

Use of the Johnson and Ettinger (1991) model to calculate SSLs based on indoor chronic exposures can have significant impacts on the values of the SSLs for contaminants with high apparent diffusion coefficients. When comparing the infinite source indoor model to the infinite source outdoor model for these contaminants, values of the SSL differ by orders of magnitude for case example conditions. Under these conditions, diffusion is the limiting transport mechanisms for all but one contaminant for both steady-state and quasi-steady-state conditions. To effect case example conditions, the following must be true:

1. The contaminant source must be relatively close or directly beneath the structure.

2. The soil between the structure and the source must be very permeable ($k_v \geq 10^{8}$ cm^2).

3. The structure must be underpressurized.

4. The air within the structure must be well mixed (i.e., little or no soil-air boundary layer resistance).

5. The combination of diffusion coefficient through the cracks, area of the cracks, and building underpressurization must offer no more resistance than the soil column beneath the structure.

From this evaluation, the four most important factors affecting the average long-term building concentration and thus the SSL are building ventilation rate, source-building separation, soil permeability to vapor flow, and source depth. If the source of contamination is relatively deep and close to the building, and if the soil between the source and the building is very permeable, building concentrations of contaminants with relatively high apparent diffusion coefficients will increase dramatically.

It should be noted, however, that soil permeability, k_v, is the most variable parameter at any given site, and may vary by three orders of magnitude across a typical residential lot (Johnson and Ettinger, 1991). For this reason, the overall effective diffusion coefficient should be determined by integration across each soil type. Overall diffusion/convection vapor transport will therefore be limited by the soil stratum offering the greatest resistance to vapor flow.

References

Johnson, Paul C., and Robert A. Ettinger. 1991. Heuristic model for predicting the intrusion rate of contaminant vapors into buildings. Environ. Sci. Technol., 25(8):1445-1452.

Jury, W. A., W. J. Farmer, and W. F. Spencer. 1983. Behavior Assessment Model for Trace Organics in Soil, I, Model description. J. Environ. Qual., 12:558-564.

Attachment

TABLE O-3-3a, CONT

CHEMICAL	$D_{eff-crack}$ (cm2/sec)	D_{eff-gw} (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	3.09E+03	6.41E+00	9.62E-09	2.98E-11	2.87E-05	2.43E-05
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	2.85E+03	4.74E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	5.78E-03	3.52E-04	3.10E+03	2.42E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	5.50E-03	1.20E-04	2.96E+03	8.98E+00	1.42E-10	1.17E-11	2.85E-05	2.54E-05
1,1-Dichloroethene	6.67E-03	8.88E-05	3.49E+03	6.71E+00	#DIV/0!	3.10E-12	#DIV/0!	2.50E-05
1,2-Dichlorobenzene	5.11E-03	1.84E-04	2.78E+03	1.33E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloroethane	7.71E-03	3.91E-04	3.90E+03	2.53E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	5.79E-03	1.61E-04	3.10E+03	1.16E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	9.63E-03	2.37E-04	4.57E+03	1.49E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	5.11E-03	1.57E-04	2.78E+03	1.15E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	6.72E-03	4.68E-03	3.51E+03	3.01E+02	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Hexanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	3.03E+03	8.11E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acetone	9.23E-03	5.01E-03	4.44E+03	2.98E+02	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Benzene	6.52E-03	1.29E-04	3.42E+03	9.32E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Bromomethane	7.12E-03	1.24E-04	3.67E+03	8.87E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Carbon tetrachloride	5.78E-03	7.52E-05	3.09E+03	5.95E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	5.41E-03	1.34E-04	2.92E+03	9.88E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroform	7.71E-03	1.72E-04	3.90E+03	1.17E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	7.78E-03	9.56E-05	3.93E+03	6.94E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	2.94E+03	1.08E+01	5.30E-11	4.92E-12	2.85E-05	2.59E-05
1,3-dichloropropene	4.64E-03	7.06E-05	2.54E+03	5.76E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	5.56E-03	9.42E-05	2.99E+03	7.24E+00	7.42E-14	#DIV/0!	2.86E-05	#DIV/0!
Methylene Chloride	7.48E-03	2.48E-04	3.82E+03	1.66E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	2.85E+03	1.09E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Tetrachloroethene	5.33E-03	7.49E-05	2.89E+03	5.99E+00	3.57E-10	3.16E-13	2.84E-05	2.37E-05
Toluene	6.45E-03	1.14E-04	3.39E+03	8.36E+00	1.17E-11	#DIV/0!	2.92E-05	#DIV/0!
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	2.84E+03	7.60E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Trichloroethene	5.85E-03	9.43E-05	3.13E+03	7.20E+00	2.08E-10	6.92E-14	2.88E-05	2.48E-05
Vinyl chloride	7.85E-03	9.15E-05	3.96E+03	6.67E+00	#DIV/0!	1.25E-13	#DIV/0!	2.59E-05
Xylene (total)	5.78E-03	1.06E-04	3.09E+03	7.98E+00	2.46E-11	#DIV/0!	2.87E-05	#DIV/0!
Acenapthene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acenaphthylene	3.13E-03	1.11E-03	1.74E+03	7.73E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Methylnaphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Naphthalene	4.37E-03	4.88E-04	2.41E+03	3.41E+01	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

TABLE O-3-3a, CONT

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CR (g/g)	CGW (g/cm3)	T_p -SOIL	T_p -GW
1,1,1-Trichloroethane	3.67E-10	1.35E-09	0.00000059	0.00000025	7.87E+12	8.89E+12
1,1,2,2-Tetrachloroethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	ND	8.10E-13	ND	ND	#DIV/0!	#DIV/0!
1,1-Dichloroethane	2.5E-12	2.74E-10	0.00000026	0.00000019	5.13E+14	2.66E+13
1,1-Dichloroethene	ND	9.34E-11	ND	0.00000018	#DIV/0!	8.73E+13
1,2-Dichlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,2-Dichloroethane	ND	7.60E-13	ND	ND	#DIV/0!	#DIV/0!
1,2-Dichloropropane	ND	NA	ND	ND	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
2-Butanone	ND	8.50E-13	ND	ND	#DIV/0!	#DIV/0!
2-Hexanone	ND	NA	NA	NA	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	ND	9.20E-13	ND	ND	#DIV/0!	#DIV/0!
Acetone	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Benzene	ND	NA	ND	NA	#DIV/0!	#DIV/0!
Bromomethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Carbon tetrachloride	ND	2.70E-13	ND	ND	#DIV/0!	#DIV/0!
Chlorobenzene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Chloroethane	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Chloroform	ND	3.43E-12	ND	ND	#DIV/0!	#DIV/0!
Chloromethane	ND	3.34E-12	ND	ND	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	6.9E-13	7.46E-11	0.00000019	0.00000015	1.36E+15	6.94E+13
1,3-dichloropropene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Ethylbenzene	1.6E-13	NA	0.00003208	NA	9.87E+17	#DIV/0!
Methylene Chloride	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Styrene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Tetrachloroethene	2.25E-12	4.07E-12	0.00000009	0.000000065	1.98E+14	8.17E+14
Toluene	7.3E-13	NA	0.00000108	NA	7.12E+15	#DIV/0!
trans-1,2-Dichloroethene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Trichloroethene	6.25E-12	1.64E-11	0.00000047	0.0000015	3.68E+14	4.04E+15
Vinyl chloride	ND	2.54E-12	ND	0.000000125	#DIV/0!	2.16E+15
Xylene (total)	5.4E-13	NA	0.00000034	NA	3.08E+15	#DIV/0!
Acenapthene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Acenaphthylene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
2-Methylnaphthalene	ND	NA	NA	NA	#DIV/0!	#DIV/0!
Naphthalene	ND	NA	NA	NA	#DIV/0!	#DIV/0!

TABLE O-3-3a, CONT

CHEMICAL	Is T>T_b -SOIL ?	Is T>T_b -GW ?	E-SOIL	E-GW	$C_{sat,calc}$ - SOIL (kg/m3)	$C_{sat,calc}$ - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	NO	NO	NA	NA	1.05E-11	3.28E-11	9.48E+10	3.05E+10
1,1,2,2-Tetrachloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NO	NO	NA	NA	7.14E-14	6.95E-12	1.40E+13	1.44E+11
1,1-Dichloroethene	#DIV/0!	NO	#DIV/0!	NA	#DIV/0!	2.34E-12	#DIV/0!	4.27E+11
1,2-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Hexanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acetone	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Bromomethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
cis-1,2-Dichloroethene	NO	NO	NA	NA	1.97E-14	1.93E-12	5.08E+13	5.18E+11
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NO	#DIV/0!	NA	#DIV/0!	4.57E-15	#DIV/0!	2.19E+14	#DIV/0!
Methylene Chloride	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Tetrachloroethene	NO	NO	NA	NA	6.40E-14	9.64E-14	1.56E+13	1.04E+13
Toluene	NO	#DIV/0!	NA	#DIV/0!	2.13E-14	#DIV/0!	4.68E+13	#DIV/0!
trans-1,2-Dichloroethene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Trichloroethene	NO	NO	NA	NA	1.80E-13	4.05E-13	5.56E+12	2.47E+12
Vinyl chloride	#DIV/0!	NO	#DIV/0!	NA	#DIV/0!	6.59E-14	#DIV/0!	1.52E+13
Xylene (total)	NO	#DIV/0!	NA	#DIV/0!	1.55E-14	#DIV/0!	6.45E+13	#DIV/0!
Acenapthene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Acenaphthylene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
2-Methylnaphthalene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Naphthalene	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

TABLE O-3-3c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - SOIL (mg/kg)	NON-CANCER SSL - SOIL (mg/kg)	SELECTED SSL - SOIL (mg/kg)
ORGANICS			
1,1,1-Trichloroethane	NC	1.41E+11	1.41E+11
1,1,2,2-Tetrachloroethane	#DIV/0!	ND	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NC	3.58E+13	3.58E+13
1,1-Dichloroethene	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichlorobenzene	NC	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	NC	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	NC	#DIV/0!	#DIV/0!
2-Hexanone	NC	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	NC	#DIV/0!	#DIV/0!
Acetone	NC	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	ND	#DIV/0!
Bromomethane	NC	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	NC	#DIV/0!	#DIV/0!
Chloroethane	NC	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	ND	#DIV/0!
cis-1,2-Dichloroethene	NC	2.60E+12	2.60E+12
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NC	1.12E+15	1.12E+15
Methylene chloride	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	#DIV/0!	#DIV/0!
Tetrachloroethene	1.12E+12	7.99E+11	7.99E+11
Toluene	NC	9.58E+13	9.58E+13
trans-1,2-Dichloroethene	NC	#DIV/0!	#DIV/0!
Trichloroethene	1.33E+11	1.70E+11	1.33E+11
Vinyl chloride	#DIV/0!	ND	#DIV/0!
Xylene (total)	NC	6.59E+13	6.59E+13
Acenapthene	NC	#DIV/0!	#DIV/0!
Acenaphthylene	NC	#DIV/0!	#DIV/0!
2-Methylnaphthalene	NC	#DIV/0!	#DIV/0!
Naphthalene	NC	#DIV/0!	#DIV/0!

NC = Not Carcinogenic

TABLE O-3-3c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	4.52E+10	4.52E+10
1,1,2,2-Tetrachloroethane	#DIV/0!	ND	#DIV/0!
1,1,2-Trichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,1-Dichloroethane	NC	3.68E+11	3.68E+11
1,1-Dichloroethene	3.40E+08	1.97E+10	3.40E+08
1,2-Dichlorobenzene	NC	#DIV/0!	#DIV/0!
1,2-Dichloroethane	#DIV/0!	#DIV/0!	#DIV/0!
1,2-Dichloropropane	#DIV/0!	#DIV/0!	#DIV/0!
1,3-Dichlorbenzene	NC	#DIV/0!	#DIV/0!
1,4-Dichlorobenzene	#DIV/0!	#DIV/0!	#DIV/0!
2-Butanone	NC	#DIV/0!	#DIV/0!
2-Hexanone	NC	#DIV/0!	#DIV/0!
4-Methyl-2-Pentanone	NC	#DIV/0!	#DIV/0!
Acetone	NC	#DIV/0!	#DIV/0!
Benzene	#DIV/0!	ND	#DIV/0!
Bromomethane	NC	#DIV/0!	#DIV/0!
Carbon tetrachloride	#DIV/0!	#DIV/0!	#DIV/0!
Chlorobenzene	NC	#DIV/0!	#DIV/0!
Chloroethane	NC	#DIV/0!	#DIV/0!
Chloroform	#DIV/0!	#DIV/0!	#DIV/0!
Chloromethane	#DIV/0!	ND	#DIV/0!
cis-1,2-Dichloroethene	NC	2.65E+10	2.65E+10
1,3-dichloropropene	#DIV/0!	#DIV/0!	#DIV/0!
Ethylbenzene	NC	#DIV/0!	#DIV/0!
Methylene chloride	#DIV/0!	#DIV/0!	#DIV/0!
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	#DIV/0!	#DIV/0!
Tetrachloroethene	7.42E+11	5.30E+11	5.30E+11
Toluene	NC	#DIV/0!	#DIV/0!
trans-1,2-Dichloroethene	NC	#DIV/0!	#DIV/0!
Trichloroethene	5.88E+10	7.56E+10	5.88E+10
Vinyl chloride	7.24E+09	ND	7.24E+09
Xylene (total)	NC	#DIV/0!	#DIV/0!
Acenapthene	NC	#DIV/0!	#DIV/0!
Acenaphthylene	NC	#DIV/0!	#DIV/0!
2-Methylnaphthalene	NC	#DIV/0!	#DIV/0!
Naphthalene	NC	#DIV/0!	#DIV/0!

NC = Not Carcinogenic

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	05GP070			13GP003		
AOC	A13-P10			A13-P10		
	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS						
Benzene	0.27 B	--	--	0.57 B	--	--
Toluene	0.23	--	--	0.17	--	--
Ethylbenzene	--	--	--	--	--	--
Xylenes (total)	0.12	--	--	--	--	--
Total BTEX	0.62	--	--	0.74	--	--
2-Butanone	--	--	--	--	--	--
Carbon Tetrachloride	0.27	--	--	--	--	--
Chloroform	3.43	--	--	1.49	--	--
Chloromethane	2.53	--	--	4.9	--	--
1,1-Dichloroethane	222.86	--	--	161.36	--	1300
1,2-Dichloroethane	--	--	--	--	--	--
1,1-Dichloroethene	75.11	--	--	93.4	--	180
1,2-Dichloroethene (total)	34.7	--	--	10.24	--	380
1,2-Dichloropropane	--	--	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	--	--	--
Tetrachloroethene	1.14	--	--	4.07	--	<130
1,1,1-Trichloroethane	61.57	0.12	--	1167.2	--	2700
1,1,2-Trichloroethane	--	--	--	--	--	--
Trichloroethene	9.02	0.43	--	2.08	0.77	2100
Vinyl Chloride	3.45	--	--	2.54	0.11	<250

"--" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	13GP006			05GP006		
AOC	A13-P10			A5-P6/16 C		
	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS						
Benzene	0.75 B	--	--	--	0.09	--
Toluene	0.21	--	--	0.73	1.08	--
Ethylbenzene	--	--	--	--	25.57	--
Xylenes (total)	0.1	--	--	0.26	1.69	--
Total BTEX	1.06	--	--	0.99	28.43	--
2-Butanone	--	--	--	--	--	--
Carbon Tetrachloride	--	--	--	--	--	--
Chloroform	2.17	--	--	--	--	--
Chloromethane	--	--	--	1.08	--	--
1,1-Dichloroethane	274.35	--	190	--	--	--
1,2-Dichloroethane	--	--	--	--	--	--
1,1-Dichloroethene	124.25	--	--	--	--	--
1,2-Dichloroethene (total)	74.63	--	150	--	--	--
1,2-Dichloropropane	--	--	--	--	--	--
4-Methyl-2-Pentanone	--	--	--	--	--	--
Tetrachloroethene	1.06	--	--	--	--	--
1,1,1-Trichloroethane	1351.66	0.42	250	0.26	--	--
1,1,2-Trichloroethane	0.81	--	--	--	--	--
Trichloroethene	16.35	1.02	1500	2.26	--	--
Vinyl Chloride	3.36	--	--	--	--	--

"--" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION AOC	05GP008 A5-P6/16 C			05GP009 A5-P6/16 C			15GP005 A15		
CONTAMINANTS	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
Benzene	–	0.95	–	–	1.35	–	–	–	–
Toluene	–	–	–	0.25	–	–	0.78	–	–
Ethylbenzene	–	26.97	–	0.16	32.08	–	0.14	–	–
Xylenes (total)	–	2.08	–	0.73	–	–	0.65	–	–
Total BTEX	–	30	–	1.14	33.43	–	1.57	–	–
2-Butanone	–	–	–	–	–	–	0.85	–	–
Carbon Tetrachloride	–	–	–	–	–	–	–	–	–
Chloroform	–	–	–	–	–	–	–	–	–
Chloromethane	–	–	–	–	–	–	–	–	–
1,1-Dichloroethane	–	–	–	–	–	–	2.5	0.26	57
1,2-Dichloroethane	–	–	–	–	–	–	–	–	–
1,1-Dichloroethene	–	–	–	–	–	–	0.65	–	–
1,2-Dichloroethene (total)	–	–	–	–	–	–	–	–	19
1,2-Dichloropropane	–	–	–	–	–	–	–	–	–
4-Methyl-2-Pentanone	–	–	–	–	–	–	0.92	–	–
Tetrachloroethene	–	–	–	–	–	–	2.25	0.09	–
1,1,1-Trichloroethane	–	–	–	–	–	–	33.34	0.33	15
1,1,2-Trichloroethane	–	–	–	–	–	–	–	–	–
Trichloroethene	0.29	–	–	1.18	–	–	5.3	0.12	8.1 B
Vinyl Chloride	–	–	–	–	–	–	–	–	–

"–" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

Table O-3-3d
Soil-Gas Concentrations and Associated
Soil and Groundwater Concentrations

ALLIED SIGNAL
South Bend, Indiana

SAMPLE LOCATION	15GP013			15GP012			14GP031		
AOC	A15			A15			A14-P1 C		
	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)	Soil-Gas (ng/L)	Soil (mg/kg)	Groundwater (ug/L)
CONTAMINANTS									
Benzene	1.07 B	–	–	0.63	–	–	0.37 B	–	–
Toluene	0.94	–	–	0.62	–	–	0.42	0.09	–
Ethylbenzene	–	–	–	–	–	–	–	0.15	–
Xylenes (total)	0.54	0.34	–	0.5	0.35	–	0.18	0.52	–
Total BTEX	2.55	–	–	1.75	–	–	0.97	–	–
2-Butanone	0.23	–	–	0.32	–	–	0.27	–	–
Carbon Tetrachloride	–	–	–	–	–	–	–	–	–
Chloroform	0.98	–	–	–	–	–	–	–	–
Chloromethane	3.34	–	–	1.75	–	–	–	–	–
1,1-Dichloroethane	172.25	–	2700	1.46	–	–	2.74	0.04	100
1,2-Dichloroethane	0.76	–	–	–	–	–	–	–	–
1,1-Dichloroethene	16.76	–	–	0.33	–	–	0.47	–	–
1,2-Dichloroethene (total)	67.82	0.11	13000	0.69	0.19	–	–	0.06	9.3
1,2-Dichloropropane	0.54	–	–	–	–	–	–	–	–
4-Methyl-2-Pentanone	0.2	–	–	0.56	–	–	0.22	–	–
Tetrachloroethene	7.8	4.3	–	4.91	12.7	–	3.64	0.17	–
1,1,1-Trichloroethane	367.08	0.59	–	1.63	0.75	–	8.89	0.37	7.1
1,1,2-Trichloroethane	–	–	–	–	–	–	–	–	–
Trichloroethene	6.25	0.47	–	5.04	1.96	–	3.39	0.2	–
Vinyl Chloride	2.85	–	–	–	–	–	–	–	18

"–" denotes absence of detection above the reported quantitation level.
B denotes compound detected on daily method blank
Outlined values indicate soil gas:soil concentration relationship selected for use in model
Shaded values indicate soil gas:gw concentration relationship selected for use in model

TABLE O-3-4a

PARAMETERS FOR CALCULATION OF VOLATILIZATION FROM SUBSURFACE SOIL AND GROUNDWATER TO INDOOR AIR

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
HENRY'S LAW CONSTANT	H	chemical-specific	dimensionless	IDEM, 1997
SOIL BULK DENSITY	Pb	1.66E+00	g-soil/cm3-soil	Site-specific (1)
WATER CONTENT VADOSE ZONE SOILS	θ_W	0.12	cm3-water/cm3-soil	Site-specific (1)
AIR CONTENT VADOSE ZONE SOILS	θ_A	0.26	cm3-air/cm3-soil	Site-specific (1)
SOIL-WATER PARTITION COEFFICIENT	Kd	chemical-specific	cm3-water/g-soil	IDEM, 1997
SOURCE-BUILDING SEPARATION AT t=0; SOIL	L_T^0-SOIL	15	cm	Assumption (5)
SOURCE-BUILDING SEPARATION AT t=0; GROUNDWATER	L_T^0-GW	122	cm	Assumption (6)
AREA OF BASEMENT	A_B	1960000	cm2	MDEQ, 1998
AREA OF CRACKS IN BASEMENT	A_{CRACK}	196	cm2	MDEQ, 1998
BUILDING VENTILATION RATE	$Q_{BUILDING}$	151000	cm3/sec	MDEQ, 1998
AVERAGE VAPOR FLOW RATE INTO BUILDING	Q_{SOIL}	0.81	cm3/sec	MDEQ, 1998
ENCLOSED SPACE WALL THICKNESS	L_{CRACK}	15	cm	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN SOIL	D_{eff}-SOIL	chemical-specific	cm2/sec	USEPA, 1996
EFFECTIVE DIFFUSION COEFFICIENT IN GROUNDWATER	D_{eff}-GW	chemical-specific	cm2/sec	ASTM, 1995
EFFECTIVE DIFFUSION COEFFICIENT THROUGH CRACKS	D_{eff}-CRACK	chemical-specific	cm2/sec	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN SOIL	Cs	1	g/g	USEPA, 1996
AVERAGE CONTAMINANT LEVEL IN GROUNDWATER	Cgw	1	g/cm3	USEPA, 1996
THICKNESS OF SOURCE AREA - SOIL	H_C - SOIL	365.76	cm	Assumption (7)
THICKNESS OF SOURCE AREA - GROUNDWATER	H_C - GW	2133.6	cm	Assumption (7)
DIFFUSION COEFFICIENT IN AIR	Di_a	chemical-specific	cm2/sec	IDEM, 1997
DIFFUSION COEFFICIENT IN WATER	Di_w	chemical-specific	cm2/sec	IDEM, 1997
SOIL POROSITY IN IMPACTED ZONE	θ_T	0.39	cm3/cm3	Site-specific (1)
THICKNESS OF CAPILLARY FRINGE	hcap	60.96	cm	Assumption (8)
THICKNESS OF VADOSE ZONE	hv	365.76	cm	Assumption (5)
EFFECTIVE DIFFUSION THROUGH CAPILLARY FRINGE	D_{eff}-CAP	chemical-specific	cm3/cm3	ASTM, 1995
AIR CONTENT CAPILLARY FRINGE	θ_A-CAP	0.038	cm3-air/cm3-soil	ASTM, 1995
WATER CONTENT CAPILLARY FRINGE	θ_W-CAP	0.342	cm3-water/cm3-soil	ASTM, 1995
AIR CONTENT IN WALL CRACKS	θ_A-CRACK	0.26	cm3-air/cm3-tot.vol.	Assumption (3)
WATER CONTENT WALL CRACKS	θ_W-CRACK	0.12	cm3-water/cm3-tot.vol.	Assumption (3)
AVERAGING TIME FOR VAPOR FLUX	T	1.80E+08	sec	IDEM, 1997 (4)
AIR CONCENTRATION - INDOOR AIR	$C_{BUILDING}$	chemical-specific	kg/m3	USEPA, 1996
VOLATILIZATION FACTOR - SUBSURFACE SOIL:INDOOR AIR	VF_{SOIL}	chemical-specific	m3/kg	USEPA, 1996
VOLATILIZATION FACTOR - GROUNDWATER:INDOOR AIR	VF_{GW}	chemical-specific	m3/kg	USEPA, 1996
FRACTION ORGANIC CARBON IN SOIL	foc	0.0066	unitless	Site-specific (2)
CONVERSION FACTOR 1	CF1	1.0E+03	cm3-kg/m3-g	USEPA, 1996
SOIL GAS CONCENTRATION	C_{SOURCE}	chemical-specific	g/cm3	Calculated in model

NOTES:

USEPA, 1996. Soil Screening Guidance: Technical Background Document. Appendix H. EPA/540/R-95/128

ASTM, 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM Standard E1739-95)

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management, Office of Response. October, 1997

MDEQ, 1998. Michigan Department of Environmental Quality. Part 213, Risk-based screening levels for groundwater and soil volatilization to indoor air inhalation criteria. Residential parameters used.

(1) Site-specific values determined through measurements taken at 5 site locations (MW-5, 4-6; MW-5, 6-8; MW-9, 14-16; MW-4, 10-12; MW-3, 2-4); geometric mean of measured values used as input parameter in this model.

(2) Site-specific values determined through measurements taken at 5 site locations (02PS011, 16-18; 09PS002, 16-18; 17PS001, 10-12; 05PS052, 14-16; 12PS001, 18-20); geometric mean of measured values used as input parameter in this model.

(3) Assumed values for vadose zone soil and water.

(4) Value for resident.

(5) Assumes that a building is constructed on top of the contaminated soil.

(6) Assumes that groundwater is present at its shallowest depth on-site (12 feet), and that a building with an 8-foot basement is constructed above the groundwater (resulting in a building-groundwater separation of 4 feet).

(7) Thickest areas of soil contamination (surface to groundwater table = 12 feet) and groundwater plume (70 feet).

(8) Thickest smear zone (2 feet).

NOTE: All equations presented in the text accompanying this Table.

TABLE O-3-4a, CONT

CHEMICAL	H (unitless)	Koc (cm3/g)	Di_a (cm2/sec)	Di_w (cm2/sec)	$D_{eff-cap}$ (cm3/cm3)	$D_{eff-soil}$ (cm2/sec)
1,1,1-Trichloroethane	7.05E-01	1.10E+01	7.80E-02	8.80E-06	1.19E-05	5.78E-03
1,1,2,2-Tetrachloroethane	1.41E-02	9.33E+01	7.10E-02	7.90E-06	1.12E-04	5.26E-03
1,1,2-Trichloroethane	3.74E-02	5.01E+01	7.80E-02	8.80E-06	5.30E-05	5.78E-03
1,1-Dichloroethane	2.30E-01	3.16E+01	7.42E-02	1.05E-05	1.75E-05	5.50E-03
1,1-Dichloroethene	1.07E+00	5.89E+01	9.00E-02	1.04E-05	1.28E-05	6.67E-03
1,2-Dichlorobenzene	7.79E-02	6.17E+02	6.90E-02	7.90E-06	2.72E-05	5.11E-03
1,2-Dichloroethane	4.01E-02	1.74E+01	1.04E-01	9.90E-06	5.83E-05	7.71E-03
1,2-Dichloropropane	1.15E-01	4.37E+01	7.82E-02	8.73E-06	2.36E-05	5.79E-03
1,3-Dichlorbenzene	7.80E-02	1.20E+03	1.30E-01	7.90E-06	3.46E-05	9.63E-03
1,4-Dichlorobenzene	9.96E-02	6.17E+02	6.90E-02	7.90E-06	2.31E-05	5.11E-03
2-Butanone	1.10E-03	4.50E+00	9.00E-02	9.80E-06	1.66E-03	6.72E-03
2-Hexanone	6.36E-02	2.90E+00	7.60E-02	7.00E-05	2.12E-04	5.64E-03
4-Methyl-2-Pentanone	6.36E-02	2.90E+00	7.6E-02	7.0E-05	2.12E-04	5.64E-03
Acetone	1.59E-03	5.75E-01	1.24E-01	1.14E-05	1.34E-03	9.23E-03
Benzene	2.28E-01	5.89E+01	8.80E-02	9.80E-06	1.87E-05	6.52E-03
Bromomethane	2.67E-01	9.98E-02	9.61E-02	8.96E-06	1.80E-05	7.12E-03
Carbon tetrachloride	1.25E+00	1.74E+02	7.80E-02	8.80E-06	1.09E-05	5.78E-03
Chlorobenzene	1.52E-01	2.19E+02	7.30E-02	8.70E-06	1.95E-05	5.41E-03
Chloroethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
Chloroform	1.50E-01	3.98E+01	1.04E-01	1.00E-05	2.51E-05	7.71E-03
Chloromethane	1.20E+00	2.00E+01	1.05E-01	6.00E-06	1.38E-05	7.78E-03
cis-1,2-Dichloroethene	1.67E-01	3.55E+01	7.36E-02	1.13E-05	2.15E-05	5.45E-03
1,3-dichloropropene	7.26E-01	4.57E+01	6.26E-02	1.00E-05	1.02E-05	4.64E-03
Ethylbenzene	3.23E-01	3.63E+02	7.50E-02	7.80E-06	1.37E-05	5.56E-03
Methylene Chloride	8.98E-02	1.17E+01	1.01E-01	1.17E-05	3.64E-05	7.48E-03
Methyl tertiary butyl ether					#DIV/0!	#DIV/0!
Styrene	1.13E-01	7.76E+02	7.10E-02	8.00E-06	2.18E-05	5.26E-03
Tetrachloroethene	7.54E-01	1.55E+02	7.20E-02	8.20E-06	1.08E-05	5.33E-03
Toluene	2.72E-01	1.82E+02	8.70E-02	8.60E-06	1.65E-05	6.45E-03
trans-1,2-Dichloroethene	3.85E-01	5.25E+01	7.07E-02	1.19E-05	1.44E-05	5.24E-03
Trichloroethene	4.22E-01	1.66E+02	7.90E-02	9.10E-06	1.37E-05	5.85E-03
Vinyl chloride	1.11E+00	1.86E+01	1.06E-01	1.23E-06	1.32E-05	7.85E-03
Xylene (total)	2.76E-01	3.86E+02	7.80E-02	8.70E-06	1.54E-05	5.78E-03
Acenapthene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
Acenaphthylene	6.36E-03	7.08E+03	4.21E-02	7.69E-06	2.28E-04	3.13E-03
2-Methylnaphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03
Naphthalene	1.98E-02	2.00E+03	5.90E-02	7.50E-06	7.71E-05	4.37E-03

TABLE O-3-4a, CONT

CHEMICAL	$D_{eff-crack}$ (cm2/sec)	D_{eff-ws} (cm2/sec)	B-SOIL	B-GW	Y-SOIL	Y-GW	a-SOIL	a-GW
1,1,1-Trichloroethane	5.78E-03	8.21E-05	9.33E+02	2.63E+00	4.27E-05	3.89E-09	5.34E-06	3.17E-06
1,1,2,2-Tetrachloroethane	5.26E-03	6.96E-04	8.50E+02	1.48E+01	2.88E-07	6.60E-10	5.36E-06	5.00E-06
1,1,2-Trichloroethane	5.78E-03	3.52E-04	9.33E+02	7.98E+00	1.42E-06	8.85E-10	5.36E-06	4.69E-06
1,1-Dichloroethane	5.50E-03	1.20E-04	8.88E+02	3.39E+00	1.07E-05	1.86E-09	5.35E-06	3.73E-06
1,1-Dichloroethene	6.67E-03	8.88E-05	1.08E+03	2.76E+00	3.04E-05	6.39E-09	5.35E-06	3.20E-06
1,2-Dichlorobenzene	5.11E-03	1.84E-04	8.26E+02	4.66E+00	2.57E-07	9.66E-10	5.36E-06	4.20E-06
1,2-Dichloroethane	7.71E-03	3.91E-04	1.24E+03	8.75E+00	4.28E-06	1.05E-09	5.36E-06	4.75E-06
1,2-Dichloropropane	5.79E-03	1.61E-04	9.36E+02	4.20E+00	4.71E-06	1.25E-09	5.36E-06	4.06E-06
1,3-Dichlorbenzene	9.63E-03	2.37E-04	1.55E+03	5.70E+00	2.51E-07	1.25E-09	5.37E-06	4.41E-06
1,4-Dichlorobenzene	5.11E-03	1.57E-04	8.26E+02	4.12E+00	3.28E-07	1.05E-09	5.36E-06	4.04E-06
2-Butanone	6.72E-03	4.68E-03	1.08E+03	9.38E+01	1.94E-07	3.46E-10	5.36E-06	5.31E-06
2-Hexanone	5.64E-03	1.21E-03	9.10E+02	2.51E+01	9.47E-06	5.19E-09	5.35E-06	5.15E-06
4-Methyl-2-Pentanone	5.64E-03	1.21E-03	9.10E+02	2.51E+01	9.47E-06	5.19E-09	5.35E-06	5.15E-06
Acetone	9.23E-03	5.01E-03	1.49E+03	1.00E+02	5.15E-07	5.36E-10	5.37E-06	5.32E-06
Benzene	6.52E-03	1.29E-04	1.05E+03	3.56E+00	8.01E-06	1.98E-09	5.36E-06	3.80E-06
Bromomethane	7.12E-03	1.24E-04	1.15E+03	3.46E+00	4.44E-05	2.23E-09	5.34E-06	3.75E-06
Carbon tetrachloride	5.78E-03	7.52E-05	9.33E+02	2.49E+00	1.37E-05	6.32E-09	5.35E-06	2.96E-06
Chlorobenzene	5.41E-03	1.34E-04	8.73E+02	3.65E+00	1.43E-06	1.37E-09	5.36E-06	3.86E-06
Chloroethane	7.78E-03	9.56E-05	1.26E+03	2.90E+00	6.37E-05	7.72E-09	5.34E-06	3.26E-06
Chloroform	7.71E-03	1.72E-04	1.24E+03	4.41E+00	8.63E-06	1.74E-09	5.36E-06	4.12E-06
Chloromethane	7.78E-03	9.56E-05	1.26E+03	2.90E+00	6.37E-05	7.72E-09	5.34E-06	3.26E-06
cis-1,2-Dichloroethene	5.45E-03	1.47E-04	8.81E+02	3.92E+00	7.33E-06	1.65E-09	5.35E-06	3.96E-06
1,3-dichloropropene	4.64E-03	7.06E-05	7.49E+02	2.40E+00	1.85E-05	3.45E-09	5.34E-06	2.98E-06
Ethylbenzene	5.56E-03	9.42E-05	8.97E+02	2.87E+00	1.91E-06	2.05E-09	5.36E-06	3.42E-06
Methylene Chloride	7.48E-03	2.48E-04	1.21E+03	5.92E+00	1.10E-05	1.50E-09	5.36E-06	4.44E-06
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	5.26E-03	1.49E-04	8.50E+02	3.95E+00	3.05E-07	1.13E-09	5.36E-06	3.98E-06
Tetrachloroethene	5.33E-03	7.49E-05	8.61E+02	2.49E+00	8.87E-06	3.80E-09	5.35E-06	3.05E-06
Toluene	6.45E-03	1.14E-04	1.04E+03	3.26E+00	3.57E-06	2.08E-09	5.36E-06	3.65E-06
trans-1,2-Dichloroethene	5.24E-03	9.90E-05	8.46E+02	2.96E+00	1.13E-05	2.56E-09	5.35E-06	3.47E-06
Trichloroethene	5.85E-03	9.43E-05	9.45E+02	2.87E+00	5.36E-06	2.68E-09	5.36E-06	3.40E-06
Vinyl chloride	7.85E-03	9.15E-05	1.27E+03	2.82E+00	6.33E-05	6.83E-09	5.34E-06	3.23E-06
Xylene (total)	5.78E-03	1.06E-04	9.33E+02	3.10E+00	1.60E-06	1.97E-09	5.36E-06	3.57E-06
Acenapthene	3.13E-03	1.11E-03	5.05E+02	2.31E+01	1.14E-09	4.75E-10	5.35E-06	5.13E-06
Acenaphthylene	3.13E-03	1.11E-03	5.05E+02	2.31E+01	1.14E-09	4.75E-10	5.35E-06	5.13E-06
2-Methylnaphthalene	4.37E-03	4.88E-04	7.06E+02	1.07E+01	1.75E-08	6.51E-10	5.36E-06	4.86E-06
Naphthalene	4.37E-03	4.88E-04	7.06E+02	1.07E+01	1.75E-08	6.51E-10	5.36E-06	4.86E-06

TABLE O-3-4a, CONT

CHEMICAL	C_{source} - Soil (g/cm3)	C_{source} - GW (g/cm3)	CS (g/g)	CGW (g/cm3)	T_D -SOIL	T_D -GW
1,1,1-Trichloroethane	2.76E+00	7.05E-01	1	1	5.40E+08	5.12E+10
1,1,2,2-Tetrachloroethane	2.04E-02	1.41E-02	1	1	7.30E+10	6.25E+11
1,1,2-Trichloroethane	9.15E-02	3.74E-02	1	1	1.63E+10	3.31E+11
1,1-Dichloroethane	7.26E-01	2.30E-01	1	1	2.05E+09	1.14E+11
1,1-Dichloroethene	1.70E+00	1.07E+00	1	1	8.74E+08	3.15E+10
1,2-Dichlorobenzene	1.87E-02	7.79E-02	1	1	7.96E+10	2.43E+11
1,2-Dichloroethane	2.07E-01	4.01E-02	1	1	7.16E+09	2.91E+11
1,2-Dichloropropane	3.04E-01	1.15E-01	1	1	4.91E+09	1.82E+11
1,3-Dichlorbenzene	9.74E-03	7.80E-02	1	1	1.52E+11	2.03E+11
1,4-Dichlorobenzene	2.39E-02	9.96E-02	1	1	6.23E+10	2.14E+11
2-Butanone	1.08E-02	1.10E-03	1	1	1.38E+11	5.19E+12
2-Hexanone	6.28E-01	6.36E-02	1	1	2.37E+09	1.14E+11
4-Methyl-2-Pentanone	6.28E-01	6.36E-02	1	1	2.37E+09	1.14E+11
Acetone	2.08E-02	1.59E-03	1	1	7.11E+10	3.56E+12
Benzene	4.59E-01	2.28E-01	1	1	3.24E+09	1.09E+11
Bromomethane	2.33E+00	2.67E-01	1	1	6.38E+08	9.59E+10
Carbon tetrachloride	8.82E-01	1.25E+00	1	1	1.69E+09	3.11E+10
Chlorobenzene	9.86E-02	1.52E-01	1	1	1.51E+10	1.59E+11
Chloroethane	3.06E+00	1.20E+00	1	1	4.85E+08	2.64E+10
Chloroform	4.18E-01	1.50E-01	1	1	3.55E+09	1.33E+11
Chloromethane	3.06E+00	1.20E+00	1	1	4.85E+08	2.64E+10
cis-1,2-Dichloroethene	5.02E-01	1.67E-01	1	1	2.97E+09	1.34E+11
1,3-dichloropropene	1.49E+00	7.26E-01	1	1	1.00E+09	5.66E+10
Ethylbenzene	1.28E-01	3.23E-01	1	1	1.16E+10	9.94E+10
Methylene Chloride	5.49E-01	8.98E-02	1	1	2.70E+09	1.71E+11
Methyl tertiary butyl ether	0.00E+00	0.00E+00	1	1	#DIV/0!	#DIV/0!
Styrene	2.17E-02	1.13E-01	1	1	6.88E+10	1.97E+11
Tetrachloroethene	6.21E-01	7.54E-01	1	1	2.40E+09	5.17E+10
Toluene	2.07E-01	2.72E-01	1	1	7.20E+09	1.01E+11
trans-1,2-Dichloroethene	8.04E-01	3.85E-01	1	1	1.86E+09	8.00E+10
Trichloroethene	3.42E-01	4.22E-01	1	1	4.36E+09	7.59E+10
Vinyl chloride	3.01E+00	1.11E+00	1	1	4.93E+08	2.96E+10
Xylene (total)	1.04E-01	2.76E-01	1	1	1.44E+10	1.05E+11
Acenapthene	1.36E-04	6.36E-03	1	1	1.11E+13	1.17E+12
Acenaphthylene	1.36E-04	6.36E-03	1	1	1.11E+13	1.17E+12
2-Methylnaphthalene	1.49E-03	1.98E-02	1	1	1.00E+12	5.23E+11
Naphthalene	1.49E-03	1.98E-02	1	1	1.00E+12	5.23E+11

TABLE O-3-4a, CONT

CHEMICAL	Is T>T_p-SOIL ?	Is T>T_p-GW ?	E-SOIL	E-GW	$C_{sat,pea}$ - SOIL (kg/m3)	$C_{sat,pea}$ - GW (kg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)
1,1,1-Trichloroethane	NO	NO	NA	NA	1.47E-02	2.24E-03	6.79E+01	4.47E+02
1,1,2,2-Tetrachloroethane	NO	NO	NA	NA	1.09E-04	7.05E-05	9.14E+03	1.42E+04
1,1,2-Trichloroethane	NO	NO	NA	NA	4.90E-04	1.75E-04	2.04E+03	5.71E+03
1,1-Dichloroethane	NO	NO	NA	NA	3.88E-03	8.57E-04	2.57E+02	1.17E+03
1,1-Dichloroethene	NO	NO	NA	NA	9.10E-03	3.42E-03	1.10E+02	2.92E+02
1,2-Dichlorobenzene	NO	NO	NA	NA	1.00E-04	3.27E-04	9.96E+03	3.06E+03
1,2-Dichloroethane	NO	NO	NA	NA	1.11E-03	1.90E-04	9.00E+02	5.25E+03
1,2-Dichloropropane	NO	NO	NA	NA	1.63E-03	4.67E-04	6.15E+02	2.14E+03
1,3-Dichlorbenzene	NO	NO	NA	NA	5.23E-05	3.44E-04	1.91E+04	2.90E+03
1,4-Dichlorobenzene	NO	NO	NA	NA	1.28E-04	4.03E-04	7.80E+03	2.48E+03
2-Butanone	NO	NO	NA	NA	5.77E-05	5.84E-06	1.73E+04	1.71E+05
2-Hexanone	NO	NO	NA	NA	3.36E-03	3.28E-04	2.98E+02	3.05E+03
4-Methyl-2-Pentanone	NO	NO	NA	NA	3.36E-03	3.28E-04	2.98E+02	3.05E+03
Acetone	NO	NO	NA	NA	1.12E-04	8.45E-06	8.95E+03	1.18E+05
Benzene	NO	NO	NA	NA	2.46E-03	8.67E-04	4.07E+02	1.15E+03
Bromomethane	NO	NO	NA	NA	1.24E-02	1.00E-03	8.04E+01	9.97E+02
Carbon tetrachloride	NO	NO	NA	NA	4.72E-03	3.70E-03	2.12E+02	2.70E+02
Chlorobenzene	NO	NO	NA	NA	5.28E-04	5.87E-04	1.89E+03	1.70E+03
Chloroethane	NO	NO	NA	NA	1.63E-02	3.91E-03	6.12E+01	2.55E+02
Chloroform	NO	NO	NA	NA	2.24E-03	6.18E-04	4.46E+02	1.62E+03
Chloromethane	NO	NO	NA	NA	1.63E-02	3.91E-03	6.12E+01	2.55E+02
cis-1,2-Dichloroethene	NO	NO	NA	NA	2.69E-03	6.61E-04	3.72E+02	1.51E+03
1,3-dichloropropene	NO	NO	NA	NA	7.95E-03	2.16E-03	1.26E+02	4.63E+02
Ethylbenzene	NO	NO	NA	NA	6.87E-04	1.10E-03	1.46E+03	9.05E+02
Methylene Chloride	NO	NO	NA	NA	2.94E-03	3.99E-04	3.40E+02	2.51E+03
Methyl tertiary butyl ether	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	NO	NO	NA	NA	1.16E-04	4.50E-04	8.61E+03	2.22E+03
Tetrachloroethene	NO	NO	NA	NA	3.33E-03	2.30E-03	3.01E+02	4.35E+02
Toluene	NO	NO	NA	NA	1.11E-03	9.94E-04	9.03E+02	1.01E+03
trans-1,2-Dichloroethene	NO	NO	NA	NA	4.30E-03	1.33E-03	2.33E+02	7.49E+02
Trichloroethene	NO	NO	NA	NA	1.83E-03	1.43E-03	5.46E+02	6.97E+02
Vinyl chloride	NO	NO	NA	NA	1.61E-02	3.58E-03	6.22E+01	2.79E+02
Xylene (total)	NO	NO	NA	NA	5.55E-04	9.86E-04	1.80E+03	1.01E+03
Acenapthene	NO	NO	NA	NA	7.28E-07	3.26E-05	1.37E+06	3.06E+04
Acenaphthylene	NO	NO	NA	NA	7.28E-07	3.26E-05	1.37E+06	3.06E+04
2-Methylnaphthalene	NO	NO	NA	NA	7.99E-06	9.62E-05	1.25E+05	1.04E+04
Naphthalene	NO	NO	NA	NA	7.99E-06	9.62E-05	1.25E+05	1.04E+04

Table O-3-4b
EXPOSURE PARAMETERS

PARAMETER	SYMBOL	VALUE	UNITS	SOURCE
TARGET CANCER RISK	TRc	1E-05	unitless	IDEM, 1997
TARGET NON-CANCER RISK	TRnc	1	unitless	IDEM, 1997
CANCER SLOPE FACTOR	CSF	chemical-specific	(mg/kg/day)-1	IDEM, 1997 (1)
INHALATION RATE	IR	15	m^3/day	IDEM, 1997
BODY WEIGHT	BW	70	kg	IDEM, 1997
REFERENCE DOSE	RfD	chemical-specific	mg/kg/day	IDEM, 1997 (1)
EXPOSURE FREQUENCY	EF	350	days/year	IDEM, 1997
EXPOSURE DURATION	ED	30	years	IDEM, 1997
AVERAGING TIME				
CANCER	AT	70	years	IDEM, 1997
NONCANCER	AT	30	years	IDEM, 1997

IDEM, 1997. Risk-Integrated System of Cleanups, Indiana Department of Environmental Management Office of Response. October, 1997. Values are for occupational worker.
VF values are derived in "Vapor Migration to Indoor Air" Model.
(1) Values for chemicals not published in IDEM were obtained from IRIS or HEAST.

EQUATIONS

$$\text{RBSLcancer (mg/m3)} = \frac{\text{TRc x BW x AT x 365 days/yr}}{\text{IR x ED x EF x CSF}}$$

$$\text{RBSLnon-cancer (mg/m3)} = \frac{\text{TRnc x BW x AT x 365 days/yr x RfD}}{\text{IR x ED x EF}}$$

SSL - soil (mg/kg) = VF (m3/kg) x RBSL (mg/m3)
SSL - gw (mg/L) = VF (m3/L) x RBSL (mg/m3)
(where 1 kg water = 1 L)

Note:
For noncarcinogenic effects: AT = ED
RBSL = Risk Based Screening Level
CSF = Cancer Slope Factor
RfD = Reference Dose

Table O-3-4b
CARCINOGENIC EFFECTS

COMPOUND	INHALATION CSF (mg/kg-day)^-1	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	NC	NC	6.79E+01	4.47E+02	NC	NC
1,1,2,2-Tetrachloroethane	2.00E-01	5.68E-04	9.14E+03	1.42E+04	5.19E+00	8.05E+00
1,1,2-Trichloroethane	5.60E-02	2.03E-03	2.04E+03	5.71E+03	4.14E+00	1.16E+01
1,1-Dichloroethane	NC	NC	2.57E+02	1.17E+03	NC	NC
1,1-Dichloroethene	1.80E-01	6.31E-04	1.10E+02	2.92E+02	6.93E-02	1.84E-01
1,2-Dichlorobenzene	NC	NC	9.96E+03	3.06E+03	NC	NC
1,2-Dichloroethane	9.10E-02	1.25E-03	9.00E+02	5.25E+03	1.12E+00	6.56E+00
1,2-Dichloropropane	6.80E-02	1.67E-03	6.15E+02	2.14E+03	1.03E+00	3.58E+00
1,3-Dichlorbenzene	NC	NC	1.91E+04	2.90E+03	NC	NC
1,4-Dichlorobenzene	2.40E-02	4.73E-03	7.80E+03	2.48E+03	3.69E+01	1.18E+01
2-Butanone	NC	NC	1.73E+04	1.71E+05	NC	NC
2-Hexanone	NC	NC	2.98E+02	3.05E+03	NC	NC
4-Methyl-2-Pentanone	NC	NC	2.98E+02	3.05E+03	NC	NC
Acetone	NC	NC	8.95E+03	1.18E+05	NC	NC
Benzene	2.90E-02	3.92E-03	4.07E+02	1.15E+03	1.59E+00	4.52E+00
Bromomethane	NC	NC	8.04E+01	9.97E+02	NC	NC
Carbon tetrachloride	5.30E-02	2.14E-03	2.12E+02	2.70E+02	4.54E-01	5.79E-01
Chlorobenzene	NC	NC	1.89E+03	1.70E+03	NC	NC
Chloroethane	NC	NC	6.12E+01	2.55E+02	NC	NC
Chloroform	8.10E-02	1.40E-03	4.46E+02	1.62E+03	6.25E-01	2.27E+00
Chloromethane	6.30E-03	1.80E-02	6.12E+01	2.55E+02	1.10E+00	4.60E+00
cis-1,2-Dichloroethene	NC	NC	3.72E+02	1.51E+03	NC	NC
1,3-dichloropropene	1.30E-01	8.74E-04	1.26E+02	4.63E+02	1.10E-01	4.04E-01
Ethylbenzene	NC	NC	1.46E+03	9.05E+02	NC	NC
Methylene chloride	1.60E-03	7.10E-02	3.40E+02	2.51E+03	2.41E+01	1.78E+02
Methyl tertiary butyl ether	NC	NC	#DIV/0!	#DIV/0!	NC	NC
Styrene	NC	NC	8.61E+03	2.22E+03	NC	NC
Tetrachloroethene	2.00E-03	5.68E-02	3.01E+02	4.35E+02	1.71E+01	2.47E+01
Toluene	NC	NC	9.03E+02	1.01E+03	NC	NC
trans-1,2-Dichloroethene	NC	NC	2.33E+02	7.49E+02	NC	NC
Trichloroethene	6.00E-03	1.89E-02	5.46E+02	6.97E+02	1.03E+01	1.32E+01
Vinyl chloride	3.00E-01	3.79E-04	6.22E+01	2.79E+02	2.35E-02	1.06E-01
Xylene (total)	NC	NC	1.80E+03	1.01E+03	NC	NC
Acenapthene	NC	NC	1.37E+06	3.06E+04	NC	NC
Acenaphthylene	NC	NC	1.37E+06	3.06E+04	NC	NC
2-Methylnaphthalene	NC	NC	1.25E+05	1.04E+04	NC	NC
Naphthalene	NC	NC	1.25E+05	1.04E+04	NC	NC

NC = Not Carcinogenic

Table O-3-4b
NONCARCINOGENIC EFFECTS

COMPOUND	INHALATION RfD (mg/kg-day)	RBSL (mg/m3)	VF-SOIL (m3/kg)	VF-GW (m3/L)	SSL - SOIL (mg/kg)	SSL - GW (mg/L)
ORGANICS						
1,1,1-Trichloroethane	2.90E-01	1.41E+00	6.79E+01	4.47E+02	9.58E+01	6.31E+02
1,1,2,2-Tetrachloroethane	ND	ND	9.14E+03	1.42E+04	ND	ND
1,1,2-Trichloroethane	4.00E-03	1.95E-02	2.04E+03	5.71E+03	3.97E+01	1.11E+02
1,1-Dichloroethane	5.00E-01	2.43E+00	2.57E+02	1.17E+03	6.26E+02	2.84E+03
1,1-Dichloroethene	9.00E-03	4.38E-02	1.10E+02	2.92E+02	4.81E+00	1.28E+01
1,2-Dichlorobenzene	2.00E-01	9.73E-01	9.96E+03	3.06E+03	9.69E+03	2.98E+03
1,2-Dichloroethane	2.90E-03	1.41E-02	9.00E+02	5.25E+03	1.27E+01	7.41E+01
1,2-Dichloropropane	4.00E-03	1.95E-02	6.15E+02	2.14E+03	1.20E+01	4.17E+01
1,3-Dichlorbenzene	3.00E-02	1.46E-01	1.91E+04	2.90E+03	2.79E+03	4.24E+02
1,4-Dichlorobenzene	8.00E-01	3.89E+00	7.80E+03	2.48E+03	3.04E+04	9.67E+03
2-Butanone	2.90E-01	1.41E+00	1.73E+04	1.71E+05	2.45E+04	2.42E+05
2-Hexanone	2.30E-02	1.12E-01	2.98E+02	3.05E+03	3.33E+01	3.42E+02
4-Methyl-2-Pentanone	2.30E-02	1.12E-01	2.98E+02	3.05E+03	3.33E+01	3.42E+02
Acetone	1.00E-01	4.87E-01	8.95E+03	1.18E+05	4.35E+03	5.76E+04
Benzene	ND	ND	4.07E+02	1.15E+03	ND	ND
Bromomethane	1.43E-03	6.96E-03	8.04E+01	9.97E+02	5.60E-01	6.94E+00
Carbon tetrachloride	5.70E-04	2.77E-03	2.12E+02	2.70E+02	5.87E-01	7.49E-01
Chlorobenzene	2.00E-02	9.73E-02	1.89E+03	1.70E+03	1.84E+02	1.66E+02
Chloroethane	2.86E+00	1.39E+01	6.12E+01	2.55E+02	8.52E+02	3.56E+03
Chloroform	1.00E-02	4.87E-02	4.46E+02	1.62E+03	2.17E+01	7.88E+01
Chloromethane	ND	ND	6.12E+01	2.55E+02	ND	ND
cis-1,2-Dichloroethene	1.00E-02	4.87E-02	3.72E+02	1.51E+03	1.81E+01	7.36E+01
1,3-dichloropropene	2.00E-02	9.73E-02	1.26E+02	4.63E+02	1.22E+01	4.50E+01
Ethylbenzene	1.00E+00	4.87E+00	1.46E+03	9.05E+02	7.08E+03	4.41E+03
Methylene Chloride	3.00E+00	1.46E+01	3.40E+02	2.51E+03	4.96E+03	3.66E+04
Methyl tertiary butyl ether	8.57E-01	4.17E+00	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Styrene	1.00E+00	4.87E+00	8.61E+03	2.22E+03	4.19E+04	1.08E+04
Tetrachloroethene	1.00E-02	4.87E-02	3.01E+02	4.35E+02	1.46E+01	2.12E+01
Toluene	4.00E-01	1.95E+00	9.03E+02	1.01E+03	1.76E+03	1.96E+03
trans-1,2-Dichloroethene	2.00E-02	9.73E-02	2.33E+02	7.49E+02	2.26E+01	7.29E+01
Trichloroethene	6.00E-03	2.92E-02	5.46E+02	6.97E+02	1.59E+01	2.03E+01
Vinyl chloride	ND	ND	6.22E+01	2.79E+02	ND	ND
Xylene (total)	2.00E-01	9.73E-01	1.80E+03	1.01E+03	1.75E+03	9.87E+02
Acenapthene	6.00E-02	2.92E-01	1.37E+06	3.06E+04	4.01E+05	8.95E+03
Acenaphthylene	6.00E-02	2.92E-01	1.37E+06	3.06E+04	4.01E+05	8.95E+03
2-Methylnaphthalene	4.00E-02	1.95E-01	1.25E+05	1.04E+04	2.44E+04	2.02E+03
Naphthalene	4.00E-02	1.95E-01	1.25E+05	1.04E+04	2.44E+04	2.02E+03

ND = No data available
Value for 4-methyl-2-pentanone used for 2-hexanone
Value for napthalene used for 2-methylnaphthalene

TABLE O-3-4c
TIER I SCREENING LEVELS FOR SOIL AND GROUNDWATER
VAPOR MIGRATION TO INDOOR AIR

COMPOUND	CANCER SSL - GW (mg/L)	NON-CANCER SSL - GW (mg/L)	SELECTED SSL - GW (mg/L)
ORGANICS			
1,1,1-Trichloroethane	NC	6.31E+02	6.31E+02
1,1,2,2-Tetrachloroethane	8.05E+00	ND	8.05E+00
1,1,2-Trichloroethane	1.16E+01	1.11E+02	1.16E+01
1,1-Dichloroethane	NC	2.84E+03	2.84E+03
1,1-Dichloroethene	1.84E-01	1.28E+01	1.84E-01
1,2-Dichlorobenzene	NC	2.98E+03	2.98E+03
1,2-Dichloroethane	6.56E+00	7.41E+01	6.56E+00
1,2-Dichloropropane	3.58E+00	4.17E+01	3.58E+00
1,3-Dichlorbenzene	NC	4.24E+02	4.24E+02
1,4-Dichlorobenzene	1.18E+01	9.67E+03	1.18E+01
2-Butanone	NC	2.42E+05	2.42E+05
2-Hexanone	NC	3.42E+02	3.42E+02
4-Methyl-2-Pentanone	NC	3.42E+02	3.42E+02
Acetone	NC	5.76E+04	5.76E+04
Benzene	4.52E+00	ND	4.52E+00
Bromomethane	NC	6.94E+00	6.94E+00
Carbon tetrachloride	5.79E-01	7.49E-01	5.79E-01
Chlorobenzene	NC	1.66E+02	1.66E+02
Chloroethane	NC	3.56E+03	3.56E+03
Chloroform	2.27E+00	7.88E+01	2.27E+00
Chloromethane	4.60E+00	ND	4.60E+00
cis-1,2-Dichloroethene	NC	7.36E+01	7.36E+01
1,3-dichloropropene	4.04E-01	4.50E+01	4.04E-01
Ethylbenzene	NC	4.41E+03	4.41E+03
Methylene chloride	1.78E+02	3.66E+04	1.78E+02
Methyl tertiary butyl ether	NC	NA	NA
Styrene	NC	1.08E+04	1.08E+04
Tetrachloroethene	2.47E+01	2.12E+01	2.12E+01
Toluene	NC	1.96E+03	1.96E+03
trans-1,2-Dichloroethene	NC	7.29E+01	7.29E+01
Trichloroethene	1.32E+01	2.03E+01	1.32E+01
Vinyl chloride	1.06E-01	ND	1.06E-01
Xylene (total)	NC	9.87E+02	9.87E+02
Acenapthene	NC	8.95E+03	8.95E+03
Acenaphthylene	NC	8.95E+03	8.95E+03
2-Methylnaphthalene	NC	2.02E+03	2.02E+03
Naphthalene	NC	2.02E+03	2.02E+03

NC = Not Carcinogenic

APPENDIX O-4

SOIL GAS SAMPLING

TECHNICAL MEMORANDUM

SUBJECT: Soil Gas Sampling

PROJECT: AlliedSignal Industrial Complex, South Bend, Indiana

PREPARED BY: Peter Kaczor, ABB Environmental Services, Inc. (ABB)

DATE: February 13, 1998

INTRODUCTION

As part of the Risk Assessment for the AlliedSignal Industrial Complex, South Bend, Indiana, a screening level analytical model was used to develop risk-based screening levels for volatile organic compound (VOC) migration to indoor air. Based upon the screening level model, VOC migration to indoor air was identified as an on-site future potential risk. In ABB's experience, the screening level model for VOC migration to indoor air was based upon very conservative assumptions and tended to significantly overestimate the risk from this potential exposure pathway. The model involved estimating a "volatilization factor" that is based upon an estimate of the partitioning of the chemical between the sorbed, dissolved, and vapor phase. Furthermore, the equation assumed no degradation of the chemical as it diffused to the ground surface.

Considering this, ABB collected soil gas samples to provide a more accurate indication of the concentrations of VOCs in on-site soil gas. Collection and analysis of soil gas limited the site-specific calculation to estimating the diffusion through the foundation or concrete floor and the atmospheric dispersion in the enclosed space.

APPROACH

On-site soil gas samples were collected at 12 locations. Available site analytical data were reviewed to determine areas which exceeded the Tier 1 Risk-Based Screening Levels (RBSLs) for VOC migration to indoor air. Areas which grossly exceeded the RBSLs (i.e., Area 3/11, Former Disposal Area/Carbon Brake Expansion) or were well below the RBSLs were not sampled. Areas which had borderline RBSL exceedances were chosen to determine if, based on the soil gas sampling results, these areas could be considered as being not of concern. The three areas selected for sampling were (1) Area 5 - Plant 6/16 Central, (2) Area 13 - Plant 10, and (3) Area 15 - Plant 1 Former Metal Stamping Operations.

ABB Environmental Services, Inc.
39255 Country Club Drive B-25 • Farmington Hills, Michigan 48331-3490
Phone (248) 489-8040 • FAX (248) 489-8048

The EMFLUX® passive soil gas sampling systems by Quaddrel Services, Inc. (Quaddrel). were employed. This technology was suited to the data needs because it is well-tested for chlorinated solvents and because it seeks to define potential maximum concentrations. This is accomplished by collecting data over a period of theoretical maximum soil gas movement (based upon models of earth tides). Quaddrel utilized a computer modeling program to determine the timeframe of maximum soil gas movement for the South Bend area. Based upon the earth tide information, subsurface collectors were placed into the ground and left for a period of 72 hours.

To target a broad range of compounds from vinyl chloride to acenaphtylene effectively, two different adsorbents were employed. The lighter compounds were targeted with an adsorbent particularly suited for analysis by U.S. Environmental Protection Agency (USEPA) Method 8260 (Modified), and the remaining heavier compounds were targeted with an adsorbent suited to USEPA Method 8260/8270 (Modified).

In areas of concrete flooring (Plant 1), the concrete was first cored using a hammer drill and then the collectors were displaced into the soil beneath the concrete surface. A temporary concrete patch was placed into the core hole to seal off the sampler for the 72-hour period. A hand auger was utilized to place the samplers at a minimum depth of three inches in surface soil in the Plant 6/16 courtyard. One quality control sample was collected by opening a separate sampler vial during the period of time necessary to emplace and retrieve a soil gas sampler. This data was used to determine if samplers were detecting VOCs in ambient air during their emplacement and retrieval.

After the 72-hour sampling period, samplers were removed and shipped back to Quaddrel where one collection media was desorbed and analyzed for selected VOCs by USEPA Method 8260 (Modified) and a second collection media was desorbed and analyzed for selected semi-volatiles by USEPA Method 8260/8270 (Modified). Samples were analyzed for the site-specific analytes that had potential for volatile emissions to indoor air (i.e., Henry's Law constant greater than 1×10^{-5} atm-m^3/mole and a molecular weight of less than 200 g/mole).

RESULTS

Soil gas sampling results and associated field documentation included as Attachment 1 to this Technical Memorandum.

ATTACHMENT 1

Soil Gas Sampling Results

ABB Environmental Services, Inc.
39255 Country Club Drive B-25 • Farmington Hills, Michigan 48331-3490
Phone (248) 489-8040 • FAX (248) 489-8048

Quadrel Services Inc.
Tel: (301) 874-5510 Fax: (301) 874-5567
1896 Urbana Pike, Suite 20, Clarksburg, MD 20871

January 13, 1998

Mr. Peter Kaczor
ABB Environmental Services, Inc.
39255 Country Club Road
Suite B-25
Farmington Hills, MI 48331

Dear Pete:

Enclosed are two copies of the final report covering our recent EMFLUX® Soil-Gas Survey of the Allied Signal Site in South Bend, Indiana. If you have any questions about the report or data, please give us a call.

We look forward to working with you again in the future.

Sincerely,

Bruce Tucker for

Harry O'Neill
Vice President

Enclosures

QUADREL

Quadrel Report No. QS2792

EMFLUX® Passive, Non-Invasive Soil-Gas Survey

ALLIED SIGNAL SITE
SOUTH BEND, INDIANA

Prepared for

ABB Environmental Services, Inc.
39255 Country Club Road
Suite B-25
Farmington Hills, MI 48331

by

Quadrel Services, Inc.
1896 Urbana Pike
Suite 20
Clarksburg, MD 20871

January 16, 1998

EMFLUX® Survey Number: OS2792

Allied Signal Site
South Bend, Indiana

This EMFLUX® Soil-Gas Survey Report has been prepared for ABB Environmental Services, Inc. (ABB) by Quadrel Services, Inc. (Quadrel) in accordance with the terms of Purchase Order No. SE725235 dated November 13, 1997. Quadrel's principal technical contact at ABB for this project has been Mr. Peter Kaczor.

1. **Objectives**

To screen the Allied Signal Site for the presence of targeted compounds in the gas phase. Results will be used to profile contamination in soil and/or ground water at the site, thereby determining the distribution and relative strength of detected contaminants.

2. **Target Compounds**

This survey targeted the 29 compounds listed in **Attachments 1-A and 1-B**, which also supplies the resulting laboratory data in nanograms (ng) of specific compound per cartridge. To target a broad range of compounds from Vinyl Chloride to Acenaphthylene effectively, two different adsorbents were employed. The lighter compounds were targeted with an adsorbent particularly suitable for analysis by EPA Method 8260 (Modified), and the remaining heavier compounds were targeted with an adsorbent suited to EPA Method 8260/8270 (Modified).

3. **Survey Description**

• No. of Field Samples:	20
• No. of Ambient-Air Control Samples:	2
• No. of Trip Blanks:	2
• Total No. of EMFLUX® Cartridges:	24

Note: Two field samples were collected at each sample location, with one adsorbent cartridge targeting the lighter compounds and the other targeting the heavier compounds. An ambient-air control sample and a trip blank were included with each batch of adsorbent cartridges.

4. **Field Work**

Quadrel provided ABB an EMFLUX® Field Kit with the equipment needed to conduct a 10-point EMFLUX® Soil-Gas Survey with two collectors at each location. Collectors were deployed on December

12, 1997 and retrieved December 15, 1997. **Attachment 2** describes the field procedures used. Deployment and retrieval times will be found in the Field Deployment Report (**Attachment 3**).

5. **Laboratory Analysis and Reporting Dates**

A. **Maryland Spectral Services, Inc. (MSS)**

- MSS received 12 sample cartridges for analysis on December 18, 1997.
- EMFLUX® samples cartridges were thermally desorbed, then analyzed using gas chromatography/mass spectrometry (GC/MS) equipment, in accordance with EPA Method 8260 (Modified), as described in **Attachment 4-A**. MSS analyzed each cartridge for 10 targeted compounds.
- MSS completed the analysis on December 18, 1997.
- Quadrel received MSS data on December 20, 1997.

B. **DataChem Laboratories, Inc. (DCL)**

- DCL received 12 sample cartridges for analysis on December 18, 1997.
- EMFLUX® samples cartridges were thermally desorbed, then analyzed using gas chromatography/mass spectrometry (GC/MS) equipment, in accordance with EPA Method 8260/8270 (Modified), as described in **Attachment 4-B**. DCL analyzed each cartridge for 19 targeted compounds.
- DCL completed the analysis on December 23, 1997.
- Quadrel received DCL data on December 31, 1997.

- Quadrel provided preliminary results to ABB on January 6, 1998.

6. **Data Treatment**

- **Table 1** provides the survey results in soil-gas concentrations in nanograms per liter (ng/L, or parts per trillion). Laboratory values were converted to soil-gas concentrations using the following formula:

$$C = 10^3 KW/TR$$

where:

where:	C	=	Avg. soil-gas conc. in collector (ng/L)
	K	=	Cartridge collection constant (1.0 sec/cm³)
	W	=	Contaminant mass (ng)
	T	=	Collection period (sec)
	R	=	Adsorbent recovery factor (decimal fraction)

The specific collection period for each sample is given in the Field Deployment Reports. Adsorbent recovery factors are provided in **Attachment 5**. The values in **Table 1** have been corrected for the appropriate recovery factors.

__Note__: Quadrel's derivation of the EMFLUX® cartridge collection constant, K, involved (i) adoption of 0.05 cm^2/sec as a typical diffusion coefficient, D, for VOCs in free air and (ii) evaluation of experimental laboratory data to determine the ratio between collection area, A, and diffusion distance, Z. The latter relationship, based on work done to date, appears to be A/Z = 20.2 cm. Given these values, Quadrel has computed the value of the constant to be:

$$
\begin{aligned}
K &= 1/[D(A/Z)] \text{ sec/cm}^3 \\
&= 1/[0.05(20.2)] \text{ sec/cm}^3 \\
&= 1/1.01 \text{ sec/cm}^3 \\
&\approx 1.0 \text{ sec/cm}^3
\end{aligned}
$$

- **Data Compatibility Equation**. It is important to note that when sample locations are covered with or near the edge of an artificial surface (*e.g.*, asphalt or concrete), sample measurements are often increased significantly. This can be attributed to the fact that gas rising from sources beneath impermeable caps tends to reach equilibrium in relatively short periods of time and that, once equilibrium is reached, the soil-gas concentration measured at any point in a vertical line between source and cap is theoretically the same. Thus, a reading taken immediately below an impermeable surface is much higher than it would be in the absence of such a cap.

In this survey, samples 15GP005, 15GP013, 15GP012, 14GP031, 13GP003, 05GP070, and 13GP006 were collected beneath concrete caps. Typically, when an EMFLUX® Survey is performed on a site which is partially covered by an impermeable cap, the values recorded beneath or near the edge of a cap should be arithmetically adjusted for comparison with values recorded in uncapped areas. As information concerning depth to contaminant source becomes available to ABB, Quadrel recommends using the following formula to make such corrections.

$$C_{(a)} = C_{(c)} Z_{(c)} / Z_{(s)}$$

where:

$C_{(a)}$ = Estimated *uncapped* measurement (ng)

$C_{(c)}$ = Measurement in Collector (ng)

$Z_{(c)}$ = Depth of Collector (cm)

$Z_{(s)}$ = Known or assumed depth to source (cm)

This calculation assumes that concentration gradients are linear with depth from source to surface, an assumption deemed acceptable by Quadrel on the basis of literature reviews and previous experience.

7. **Report Notes and Quality Assurance/Quality Control Factors**

- **Tables 1** provides survey results in soil-gas concentrations by sample-point number and compound name. The quantitation levels (Q.L.) represent values above which quantitative laboratory results can be achieved within specified limits of precision and with a high degree of confidence. The quantitation level of each compound, therefore, provides a reliable basis for comparison of the relative strength of individual detections of that compound.

- The **Chain-of-Custody** form, which was shipped with the samples for this survey, is supplied as **Attachment 6**.

- **Laboratory QA/QC procedures** included standards and blanks appropriate to the EPA Methods employed. Field work and reporting were done in accordance with Quadrel's Quality Assurance Program Plan. MSS and DCL performed analyses under each laboratorys' own Quality Assurance Plan.

- **QA/QC Contaminant Corrections.** The laboratory data in **Attachment 1** are not corrected for contamination found on QA/QC samples (*e.g.*, method blanks, trip blanks, ambient-air control samples). In general, subsequent handling of QA/QC contamination depends upon the circumstances and origin of the sample; in this case, the corrections noted below and in **Section 6** (except those required for Data Compatability) were made when **Table 1** was created and are incorporated therein. The corrective conventions cited below have, in Quadrel's experience, proved highly useful in deriving accurate and reproducible interpretations of survey data. *No other methods thus far tested have produced comparable levels of quality.*

  Laboratory method blanks are run each day with project samples to identify contamination present in the laboratory. If contamination is detected on a method blank, detections of identical compounds on samples analyzed the same day are considered to be suspect and are flagged both in the laboratory report and in converted soil-gas concentration data. The laboratory method blank analyzed by MSS in connection with the present samples revealed no contamination; the laboratory method blank analyzed by DCL recorded 35 ng of Benzene.

  The trip blank is an EMFLUX® cartridge prepared, transported, and analyzed with other samples but intentionally not exposed. Although reported in the laboratory data, contamination on this field QA/QC sample is subtracted from measurements of the same compounds on both field and control samples during data interpretation. Here, the trip blank analyzed by MSS (so labeled in **Attachment 1-A**) recorded none of the targeted compounds, indicating that the survey site itself is the source of similar detected contaminants. The trip blank analyzed by DCL (so labeled in **Attachment 1-B**) recorded 28 ng of benzene. These values were subtracted from similar compound measurements on field and control samples prior to converting field sample detections to soil-gas concentrations.

Control samples are field QA/QC samples which serve to identify compounds present in ambient air during deployment and retrieval of collection devices. During data interpretation, contamination found on the control samples is subtracted from measurements of the same compounds on field samples prior to their conversion to soil-gas concentrations. The control sample analyzed by MSS (labeled as 14QC031 in **Attachment 1-A**) recorded none of the 10 contaminants targeted with this analytical method. Following correction for contamination on the trip blank, the control sample analyzed by DCL (also labeled as 14QC031 in **Attachment 1-B**) did not record any of the 19 targeted contaminants above the reported quantitation level.

- **Survey findings** are relative exclusively to this project and should not routinely be compared with results of other EMFLUX® Surveys. *To establish a relationship between reported soil-gas concentrations and actual subsurface contaminant concentrations, which will indicate those detections representing significant subsurface contamination, Quadrel recommends the guidelines on the inside front cover of this report.*

- The following **Attachments** are included:

1-A. Maryland Spectral Services, Inc. Laboratory Report
1-B. DataChem Laboratories, Inc. Laboratory Report
2. EMFLUX® Field Procedures
3. Field Deployment Reports
4-A Maryland Spectral Services, Inc. Laboratory Procedures
4-B. DataChem Laboratories, Inc. Laboratory Procedures
5. Adsorbent Recovery Factors
6. Chain-of-Custody Forms

Table 1

Soil-Gas Concentrations (ng/L)
Allied Signal Site
South Bend, Indiana

SAMPLE LOCATION	Q.L.	15GP005	15GP013	15GP012	14GP031	13GP003
CONTAMINANTS						
Benzene	0.15	--	1.07 B	0.63 B	0.37 B	0.57 B
Toluene	0.13	0.78	0.94	0.62	0.42	0.17
Ethylbenzene	0.10	0.14	--	--	--	--
Xylenes (total)	0.10	0.65	0.54	0.50	0.18	--
Total BTEX	0.10	1.57	2.55	1.75	0.97	0.74
2-Butanone	0.13	0.85	0.23	0.32	0.27	--
Carbon Tetrachloride	0.18	--	--	--	--	--
Chloroform	0.13	--	0.98	--	--	1.49
Chloromethane	0.19	--	3.34	1.75	--	4.90
1,1-Dichloroethane	0.15	2.50	172.25	1.46	2.74	161.36
1,2-Dichloroethane	0.20	--	0.76	--	--	--
1,1-Dichloroethene	0.10	0.65	16.76	0.33	0.47	93.40
1,2-Dichloroethene (total)	0.13	--	67.82	0.69	--	10.24
1,2-Dichloropropane	0.14	--	0.54	--	--	--
4-Methyl-2-Pentanone	0.13	0.92	0.20	0.56	0.22	--
Tetrachloroethene	0.10	2.25	7.80	4.91	3.64	4.07
1,1,1-Trichloroethane	0.16	33.34	367.08	1.63	8.89	1167.20
1,1,2-Trichloroethane	0.13	--	--	--	--	--
Trichloroethene	0.14	5.30	6.25	5.04	3.39	2.08
Vinyl Chloride	0.24	--	2.85	--	--	2.54

NOTES:
1) Values listed under "Q.L." are reported soil-gas concentration quantitation levels.
2) "--" denotes absence of detections above the reported quantitation level.
3) "B" denotes compound detected on daily method blank.

Table 1
(continued)
Soil-Gas Concentrations (ng/L)
Allied Signal Site
South Bend, Indiana

SAMPLE LOCATION	Q.L.	05GP070	13GP006	05GP006	05GP008	05GP009
CONTAMINANTS						
Benzene	0.15	0.27 B	0.75 B	--	--	--
Toluene	0.13	0.23	0.21	0.73	--	0.25
Ethylbenzene	0.10	--	--	--	--	0.16
Xylenes (total)	0.10	0.12	0.10	0.26	--	0.73
Total BTEX	0.10	0.62	1.06	0.99	--	1.14
2-Butanone	0.13	--	--	--	--	--
Carbon Tetrachloride	0.18	0.27	--	--	--	--
Chloroform	0.13	3.43	2.17	--	--	--
Chloromethane	0.19	2.53	--	1.08	--	--
1,1-Dichloroethane	0.15	222.86	274.35	--	--	--
1,2-Dichloroethane	0.20	--	--	--	--	--
1,1-Dichloroethene	0.10	75.11	124.25	--	--	--
1,2-Dichloroethene (total)	0.13	34.70	74.63	--	--	--
1,2-Dichloropropane	0.14	--	--	--	--	--
4-Methyl-2-Pentanone	0.13	--	--	--	--	--
Tetrachloroethene	0.10	1.14	1.06	--	--	--
1,1,1-Trichloroethane	0.16	61.57	1351.66	0.26	--	--
1,1,2-Trichloroethane	0.13	--	0.81	--	--	--
Trichloroethene	0.14	9.02	16.35	2.26	0.29	1.18
Vinyl Chloride	0.24	3.45	3.36	--	--	--

NOTES:
1) Values listed under "Q.L." are reported soil-gas concentration quantitation levels.
2) "--" denotes absence of detections above the reported quantitation level.
3) "B" denotes compound detected on daily method blank.

Attachment 1-A

Maryland Spectral Services, Inc.
Laboratory Report

MARYLAND SPECTRAL SERVICES, INC.
1500 Caton Center Drive Baltimore, MD 21227

VOLATILE ORGANICS BY EPA GC/MS METHOD MODIFIED 8260

CLIENT SAMPLE ID:	15GP005 QS2792	15GP013 QS2792	15GP012 QS2792	14GP031 QS2792	14QC031 QS2792	13GP003 QS2792
LAB SAMPLE ID:	97121832	97121833	97121834	97121835	97121836	97121837
RECEIVED DATE:	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97
ANALYSIS DATE:	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97
FILE NAME:	121832	121833	121834	121835	121836	121837
INSTRUMENT ID:	MSD	MSD	MSD	MSD	MSD	MSD
UNITS:	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP
VOLATILE COMPOUNDS						
Carbon Tetrachloride	25 U	25 U	25 U	25 U	25 U	25 U
Chloroform	25 U	183	25 U	25 U	25 U	281
Chloromethane	50 U	865	454	50 U	50 U	1280
1,1-Dichloroethane	424	29000	246	463	25 U	27400
1,2-Dichloroethane	25 U	93	25 U	25 U	25 U	25 U
1,1-Dichloroethene	169	4340	87	121	25 U	24400
1,2-Dichloroethene (total)	25 U	13000	133	25 U	25 U	1980
1,1,1-Trichloroethane	5300	58000	258	1410	25 U	186000
Vinyl Chloride	50 U	590	50 U	50 U	50 U	530

CLIENT SAMPLE ID:	05GP070 QS2792	13GP006 QS2792	05GP006 QS2792	05GP008 QS2792	05GP009 QS2792	TRIP-BLANK QS2792
LAB SAMPLE ID:	97121838	97121839	97121840	97121841	97121842	97121843
RECEIVED DATE:	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97
ANALYSIS DATE:	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97	12/18/97
FILE NAME:	121838	121839	121840	121841	121842	121843
INSTRUMENT ID:	MSD	MSD	MSD	MSD	MSD	MSD
UNITS:	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP	NG/TRAP
VOLATILE COMPOUNDS						
Carbon Tetrachloride	37	25 U	25 U	25 U	25 U	25 U
Chloroform	645	408	25 U	25 U	25 U	25 U
Chloromethane	660	50 U	282	50 U	50 U	50 U
1,1-Dichloroethane	37800	46500	25 U	25 U	25 U	25 U
1,2-Dichloroethane	25 U	25 U	25 U	25 U	25 U	25 U
1,1-Dichloroethene	19600	32400	25 U	25 U	25 U	25 U
1,2-Dichloroethene (total)	6700	14400	25 U	25 U	25 U	25 U
1,1,1-Trichloroethane	9800	215000	41	25 U	25 U	25 U
Vinyl Chloride	720	700	50 U	50 U	50 U	50 U

B - Detected in lab blank. U - Below reported quantitation level. J - Estimated value.

MARYLAND SPECTRAL SERVICES, INC.
1500 Caton Center Drive Baltimore, MD 21227

VOLATILE ORGANICS BY EPA GC/MS METHOD MODIFIED 8260

CLIENT SAMPLE ID: VBLK1219D1

LAB SAMPLE ID: METHOD_BLANK
RECEIVED DATE:
ANALYSIS DATE: 12/18/97
FILE NAME: 1218VBLKD1
INSTRUMENT ID: MSD
UNITS: NG/TRAP

VOLATILE COMPOUNDS		
Carbon Tetrachloride	25	U
Chloroform	25	U
Chloromethane	50	U
1,1-Dichloroethane	25	U
1,2-Dichloroethane	25	U
1,1-Dichloroethene	25	U
1,2-Dichloroethene (total)	25	U
1,1,1-Trichloroethane	25	U
Vinyl Chloride	50	U

B - Detected in lab blank. U - Below reported quantitation level. J - Estimated value.

DataChem Laboratories
Analytical Report for Quadrel Services

Project Number: 2792
Units: ng/sample

DCL Sample Number:	BLANK	97I26961	97I26962	97I26963	97I26964	97I26965	97I26966	97I26967	97I26968	97I26969	
Quadrel Sample Number:	BLANK	15GP005	15GP013	15GP012	14GP031	14QC031	13GP003	05GP070	13GP006	05GP006	
Date Analyzed:	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	12/23/97	
Time analyzed:	2:15 pm	2:58 pm	3:42 pm	4:25 pm	5:09 pm	5:53 pm	6:36 pm	7:20 pm	8:03 pm	8:47 pm	RL
2-Butanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25
Benzene	ND	ND	200 B	130 B	88 B	34 B	120 B	71 B	150 B	45 B	25
1,2-Dichloropropane	ND	410	94	180	ND	53	45	27	35	88	25
Trichloroethene	ND	270	260	83	110	ND	2800	330	480	120	25
4-Methyl-2-Pentanone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25
2-hexanone	ND	ND	480	26	ND	ND	220	28	440	ND	25
Tetrachloroethene	ND	1700	3800	660	860	ND	3500	3500	4200	290	25
Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25
Ethyl benzene	ND	160	43	59	51	ND	ND	ND	ND	ND	25
m & p-Xylene	ND	ND	1200	110	50	ND	650	680	1600	ND	25
Styrene	ND	ND	64	ND	ND	ND	ND	ND	34	ND	25
1,1,2,2-Tetrachloroethane	ND	7200	7300	4700	5300	490	8600	8600	12000	4800	25
o-Xylene	35	ND	200	130	88	34	120	71	150	45	25
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25
2-Methylnaphthalene	ND	ND	97	ND	ND	ND	ND	ND	ND	ND	25
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	25

Footnotes: B = found in blank. ND = Not Detected. RL = Reporting limit.

Comments: Methyl-t-butyl ether was not included in the analytical standard.

DataChem Laboratories
Analytical Report for Quadrel Services

Project Number: 2792
Units: ng/sample

DCL Sample Number:	97126970	97126971	97126972	
Quadrel Sample Number:	05GP008	05GP009	RIP BLANK	
Date Analyzed:	12/23/97	12/23/97	12/23/97	
Time analyzed:	9:31 pm	10:14 pm	10:58 pm	
				RL
2-Butanone	ND	ND	ND	25
Benzene	29 B	45 B	28 B	25
1,2-Dichloropropane	ND	ND	ND	25
Trichlorocthene	51	210	ND	25
4-Methyl-2-Pentanone	ND	ND	ND	25
Toluene	ND	48	ND	25
2-hexanone	ND	ND	ND	25
Tetrachloroethene	ND	ND	ND	25
Chlorobenzene	ND	ND	ND	25
Ethyl benzene	ND	42	ND	25
m & p-Xylene	ND	190	ND	25
Styrene	ND	ND	ND	25
1,1,2,2-Tetrachloroethane	ND	ND	ND	25
o-Xylene	ND	ND	ND	25
Naphthalene	ND	ND	ND	25
2-Methylnaphthalene	ND	ND	ND	25
Acenaphthylene	ND	ND	ND	25

Footnotes: B = found in blank. ND = Not Detected. RL = Reporting limit.

Comments: Methyl-t-butyl ether was not included in the analytical standard.

Attachment 2

FIELD PROCEDURES FOR EMFLUX® SOIL-GAS SURVEYS

The following field procedures are routinely used during EMFLUX® Soil-Gas Surveys. Modifications can be and are incorporated from time to time in response to individual project requirements. In all instances, Quadrel adheres to EPA-approved Quality Assurance and Quality Control practices.

A. Field personnel carry EMFLUX® system components and support equipment to the site and deploy the EMFLUX® Collectors in a prearranged survey pattern. Although EMFLUX® Collectors require only one person for emplacement and retrieval, the specific number of field personnel required depends upon the scope and schedule of the project. Each Collector emplacement generally takes less than two minutes.

B. For those sample locations covered with soils or vegetation, a field technician clears vegetation and debris exposing the ground surface. Using a hammer and a ¾-inch-diameter pointed metal stake, the technician creates a hole approximately three inches deep. For those locations covered with an asphalt or concrete cap, the field technician drills a 1½-inch-diameter hole through the cap to the soils beneath. (If necessary, the Collector can be sleeved with a ¾-inch i.d. copper pipe for either capped or uncapped locations).

C. The technician then removes the solid plastic cap from an EMFLUX® Collector (a glass vial containing an adsorbent cartridge with a length of wire attached to the vial for retrieval) and replaces it with a Sampling Cap (a plastic cap with a hole covered by screen meshing). The technician inserts the Collector, with the Sampling Cap end facing down, into the hole (see **attached figure**). The Collector is then covered with either local soils for uncapped locations or, for capped locations, aluminum foil and a concrete patch. The Collector's location, time and date of emplacement, and other relevant information are recorded on the Field Deployment Form.

D. As a quality-control check during emplacement and retrieval, the technician takes periodic ambient-air control samples and records the date, time, and location of each. (One or more trip blanks are also included as part of the quality-control procedures).

E. Once all EMFLUX® Collectors have been deployed, field personnel schedule Collector recovery (approximately 72 hours after emplacement) and depart, taking all no-longer-needed equipment and materials with them).

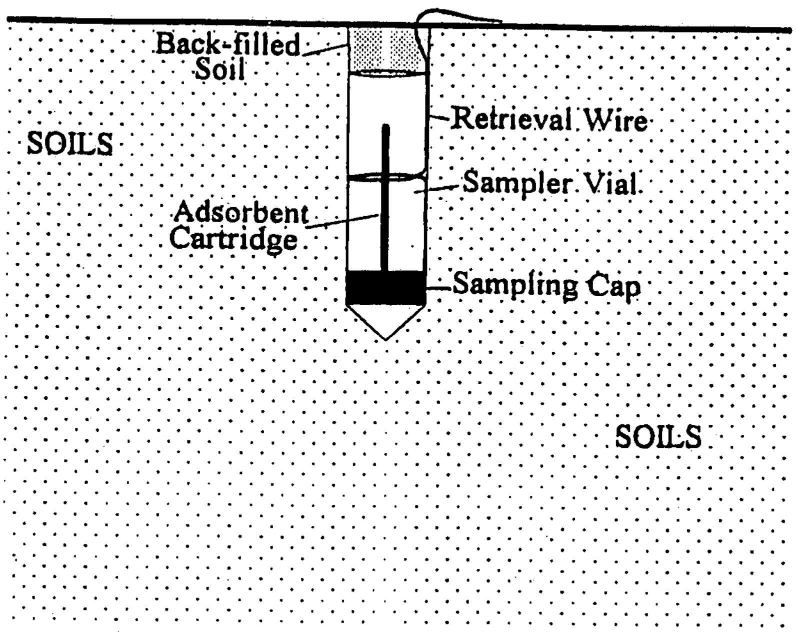
F. Field personnel retrieve the Collectors at the end of the 72-hour exposure period. At each location, a field technician withdraws the Collector from its hole and wipes the outside of the vial clean using gauze cloth; following removal of the Sampling Cap, the threads of the vial are also cleaned. A solid plastic cap is screwed onto the vial and the sample location number is written on the label. The technician then records sample-point location, date, time, etc. on the Field Deployment Form.

G. Sampling holes are refilled with soil, sand, or other suitable material. If Collectors have been installed through asphalt or concrete, the hole if filled to grade with a plug of cold patch or cement.

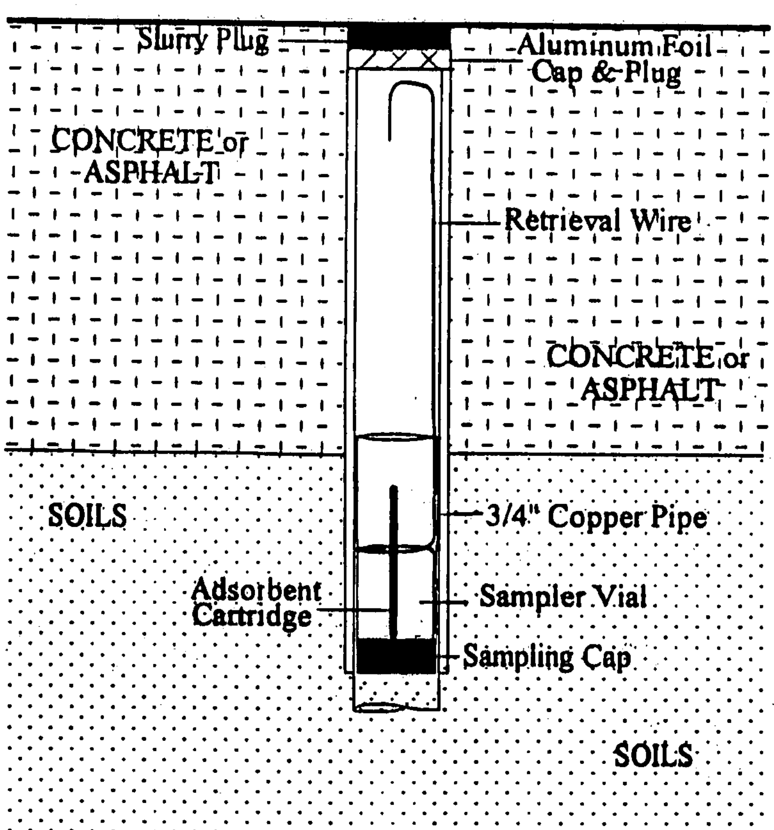
H. Following retrieval, field personnel ship or carry the EMFLUX® Collectors to analytical laboratories under contract to Quadrel Services. The remaining equipment is returned to Quadrel's preparation facility.

EMFLUX® COLLECTOR

DEPLOYMENT THROUGH SOILS



DEPLOYMENT THROUGH AN ASPHALT/CONCRETE CAP



Attachment 3

Field Deployment Reports

White

QUADREL SERVICES, INC.
FIELD DEPLOYMENT REPORT

PROJECT #: 2792	CLIENT: ABB	SITE: AlliedSignal South Bend

INDIVIDUAL SAMPLE INFORMATION

EMPLACEMENT DATE: 12/12/97	RETRIEVAL DATE: 12/15/97

SAMPLE NUMBER	TIME		FIELD NOTES (e.g., asphalt/concrete covering, description of sample location, cartridge/vial condition)
	Emplaced	Retrieved	
15GP005	1711 hrs	1734 hrs	concrete, inside abandoned building, vial in good condition
15GP013	1724	1721	
15GP012	1732	1743	
14GP031	1738	1751	
14QC031	(1742)	(1754)	Quality control sample, vial in good condition
13GP003	1748	1822	concrete, inside abandoned building, vial in good condition
05GP070	1752	1831	
13GP006	1811	1837	
05GP006	1828	1849	Soil, snow-covered. Soil saturated upon retrieval due to melted snow
05GP008	1840	1904	Soil/peastone, snow-covered. Vial in good condition
05GP009	1845	1911	Soil/peastone, snow-covered. Vial in good condition
Trip Blank	–	–	Do not open

GREEN/Yellow

QUADREL SERVICES, INC.
FIELD DEPLOYMENT REPORT

PROJECT #: 2792	CLIENT: ABB	SITE: AlliedSignal South Bend

INDIVIDUAL SAMPLE INFORMATION

EMPLACEMENT DATE: 12/12/97	RETRIEVAL DATE: 12/15/97

SAMPLE NUMBER	TIME Emplaced	TIME Retrieved	FIELD NOTES (e.g., asphalt/concrete covering, description of sample location, cartridge/vial condition)
15GP005	1711 hrs	PK ~~1724~~ 1734	concrete inside abandoned building, vial in good condition
15GP013	1724	1721	
15GP012	1732	1743	
14GP031	1738	1751	
14QC031	(1742)	(1754)	Quality control, vial in good condition
13GP003	1748	1822	concrete, inside abandoned building, vial in good condition
05GP070	1752	1831	
13GP006	1811	1837	
05GP006	1828	1849	Soil, snow-covered. Soil saturated upon retrieval due to melted snow
05GP003	1840	1904	Soil/peastone, snow-covered, vial in good condition
05GP009	1845	1911	Soil/peastone, snow-covered, vial in good condition
TripBlank	—	—	Do not open

Attachment 4-A

LABORATORY PROCEDURES
FOR EMFLUX® ADSORBENT CARTRIDGES

Maryland Spectral Services, Inc.

Following are laboratory procedures used with the EMFLUX® Soil-Gas System, a screening technology for expedited site investigation. After exposure, EMFLUX® cartridges are analyzed using U.S. EPA Method 8260 as described in the Solid Waste Manual (SW-846), a purge-and-trap capillary gas chromatographic/mass spectrometric method, modified to accommodate high- temperature thermal desorption of the adsorbent cartridges. This procedure is summarized as follows:

A. The adsorbent cartridges are thermally desorbed at 300°C for 11 minutes in a 40 mL/min helium flow, through 5 mL of reagent water spiked with 250 ng of internal standards and surrogates held in the sparging vessel. Any analytes in the helium stream are adsorbed onto a standard three-component trap (Tenax, silica gel, coconut charcoal).

B. Following cryofocusing, the three-component trap is thermally desorbed at 220°C onto a Supelco VOCOL 105 m, 0.5 mm ID, 3.00 micron filament thickness capillary column, per the U.S. EPA CLP Statement of Work (SOW) for the method.

C. Following the SOW, the GC/MS is scanned between 35 and 260 Atomic Mass Units (AMU) at one second per scan.

D. BFB tuning criteria and initial calibration are per the EPA CLP 2/88 guidelines, with an 18-hour tune window. A laboratory blank is analyzed after the daily standard to determine that the system is contaminant-free.

E. The instrumentation used for these analyses includes:

- Finnigan Model OWA 1050 Gas Chromatograph/Mass Spectrometer;
- Tekmar Model 6016 Aero Trap Autosampler;
- Tekmar Model LSC 2000 Liquid Sample Concentrator; and
- Tekmar Model ALS 2016 Autosampler.

Attachment 4-B

LABORATORY PROCEDURES
FOR EMFLUX® ADSORBENT CARTRIDGES

DataChem Laboratories, Inc.

Following are laboratory procedures used with the EMFLUX® Soil-Gas System, a screening technology for soil-gas emission detection. After exposure, EMFLUX® cartridges are analyzed using a Dynatherm ACEM 900 Desorption System and an HP 5890 or equivalent gas chromatograph/mass spectrometer (GC/MS), modified to accommodate high-temperature thermal desorption of the adsorbent cartridges. A summary of the procedure follows.

A. The adsorbent cartridges are thermally desorbed at 350°C for five minutes using the ACEM 900. The gases are then refocused on a built-in multibed focusing trap.

B. Following refocusing, the sample is desorbed from the multibed trap onto a cryo-cooled Alltech AT-1 30-meter, 0.32-mm, 1μm-film-thickness column (or equivalent column) for analysis.

C. The GC/MS is scanned between 35 and 300 Atomic Mass Units (AMU) at one second or less per scan, using 70 volts (nominal) electron energy in the electron-impact mode.

D. Prior to sample analysis, the GC/MS is hardware-tuned, using a 1,000-ng injection of 4-bromofluorobenzene, to meet the established criteria. Sample analysis does not begin until the criteria are satisfied.

E. The instrumentation used for these analyses includes the:

- HP 5890 Gas Chromatograph/Mass Spectrometer; and the

- Dynatherm ACEM 900 Desorption System.

Attachment 5

ADSORBENT RECOVERY FACTORS

Quadrel maintains an ongoing laboratory-based program to quantify recovery factors for the adsorbents used in EMFLUX® field collection devices. This program is designed to determine adsorbent affinity (a combination of attraction and retention characteristics) for a broad spectrum of compounds, including each of the VOCs targeted in this survey. The adsorbent with the highest overall affinity for the targeted VOCs was utilized for this survey, and the recovery factors of those compounds that were detected are as follows:

Compound	Percent Recovered
Benzene	62
2-Butanone	72
Carbon Tetrachloride	53
Chloroform	72
Chloromethane	1
1,1-Dichloroethane	65
1,2-Dichloroethane	47
1,1-Dichloroethene	1
1,2-Dichloroethene	74
1,2-Dichloropropane	69
Ethylbenzene	1
4-Methyl-2-Pentanone	75
Tetrachloroethene	94
Toluene	74
1,1,1-Trichloroethane	61
1,1,2-Trichloroethane	76
Trichloroethene	68
Vinyl Chloride	80
Xylenes (total)	1

Attachment 6

Chain-of-Custody Form

QUADREL SERVICES, INC.
CHAIN-OF-CUSTODY FORM

PROJECT NUMBER: 2792	PROJECT NAME:
LOCATION:	CLIENT: ABR Environmental Svs, Inc
TARGET COMPOUNDS: 8260/8270 / Green-Yellow Label	

SAMPLE NUMBER	LAB ID No. (for lab use only) UESH	REMARKS Condition of sample or vial	Retrieval Date	Retrieval Time	Init.
15GP005	971218-32	Concrete / Good	12/15/97	1734	PK
15GP013	33			1721	PK
15GP012	34			1743	PK
14GP031	35			1751	PK
14QC031	36	Quality control		(1754)	PK
13GP003	37	Concrete / good		1822	PK
05GP070	38			1822	PK
13GP006	39			1831	PK
05GP006	40	Soil, snow-covered, saturated at retrieval / good		1849	PK
05GP008	41	Soil + peastone, snow-covered / good		1904	PK
05GP009	42	Soil + peastone, snow-covered / good	12/15/97	1911	PK
Trip blank	43	Good	—	—	—

RELINQUISHED BY Signature	RELINQUISHED BY Printed Name	DATE	TIME	RECEIVED BY Signature	RECEIVED BY Printed Name
[signature]	Steve Thornlin	12/17/97	1530	[signature]	
Client FedEx SOT	E MACINNIS MSS	12/18/97	1145	Client FedEx SOT [signature]	

APPENDIX O-5

VALDOSE ZONE SOIL LEACHING MODEL

ABB TECHNICAL MEMORANDUM

SUBJECT: Valdose Zone Soil Leaching Model

PROJECT: AlliedSignal Industrial Complex, South Bend, Indiana

PREPARED BY: Ron Lewis, ABB Environmental Services, Inc. (ABB)

DATE: February 13, 1998

INTRODUCTION

As part of the risk assessment for the AlliedSignal Industrial Complex, modeling of potential effects of constituents in vadose zone soils leaching to groundwater has been performed to identify acceptable residual concentrations in soil to be protective of groundwater at a selected point of compliance at the downgradient limits of Kennedy Park, i.e., along West Westmoor Street. While the facility currently operates extraction systems designed for containment of impacted groundwater, this modeling has been performed to estimate potential impacts on groundwater under natural (i.e., non-pumping) conditions. The modeling has been performed to be conservative in nature, employing models consistent with the Indiana Department of Environmental Management's (IDEM's) Risk Integrated System of Cleanups (RISC) guidance (October 21, 1997 draft), site-specific data where available, and default values as suggested by the guidance for other model input parameters. The models included in IDEM's RISC guidance are also consistent with U.S. Environmental Protection Agencies' (USEPA's) Soil Screening Level Guidance (USEPA, 1996a) and ASTM's "Standard Guide for Risk-Based Corrective Action Applied to Petroleum Release Sites" (ASTM, 1996). While the AlliedSignal facility has chlorinated solvents as well as petroleum release products, the models used are valid for both classes of compounds. The site conceptual model, the model equations and the basis for the use of site-specific or default values are described in the following sections.

CONCEPTUAL MODEL

Operations in several areas of the facility have resulted in releases of chemicals to the subsurface. These chemicals, associated with the soil, may be leached to groundwater percolation of infiltration and/or by the rising and falling of the water table into zones with residual impacts. The resultant leachate undergoes mixing with groundwater passing beneath the source area. Dilution occurs within a vertical mixing zone

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Phone (248) 489-8040 • FAX (248) 489-8048

thickness which is determined by vertical dispersion and the relative flux rates of the infiltrating leachate and the groundwater passing through the mixing zone. Extensive studies by the USEPA have determined both an equation for the mixing zone thickness and a default relationship with the total horizontal area of the impacted soil. The constituents in groundwater then may migrate further downgradient toward potential receptors.

The plume migrating in groundwater undergoes further decreases in concentration (attenuation), primarily through the mechanisms of dispersion, retardation, and degradation. These processes usually result in concentrations reaching acceptable criteria at some distance downgradient of the source area. If this occurs before a compliance boundary is reached, then the site residual concentrations in soil pose no further significant threat to groundwater. If the criteria are not achieved at a compliance boundary, then the modeling may be applied to estimate a soil target concentration at, or below which, groundwater will be protected. These soil targets may also provide a basis for evaluating remedial alternatives.

MODELS

The expressions used in modeling the leaching to groundwater with subsequent plume migration include: a leachate concentration estimate; an estimate of the mixing zone thickness and resultant mixing zone dilution factor; and an attenuation dilution factor for plume migration that includes dispersion and degradation mechanisms. These are described individually in the following paragraphs.

Leaching Model

The leaching model component is derived from an overall mass balance for the total contaminant mass in a representative volume of soil, and the partitioning of the contaminant between the soil, soil moisture, and soil air phases of the soil volume. Conceptually, the total mass of contaminant in the soil volume is assumed to be distributed according to a linear equilibrium soil-water partition coefficient (K_d, cc/g) and equilibrium water-air partitioning described by the dimensionless Henry's Law Constant. Each of these component concentrations multiplied by the respective volume fraction, or bulk density for the soil, is summed to give the total concentration, but may also be substituted for by the soil-water and water-air relationships to derive the concentration associated with each particular phase when the total concentration is known (usually expressed as the micrograms (ug) contaminant divided by the dry weight of the sample). The equation may be expressed as (IDEM, 1997):

$$Cs = Cw[K_d + (\theta_w + \theta_a H') / P_b]$$

where

Cs = concentration in soil, mg/kg

Cw = concentration in leachate, mg/L

K_d = soil-water partition coefficient, kg/L

P_b = dry soil bulk density, kg/L

θ_w = fraction water-filled porosity, L water/L soil

θ_a = fraction air-filled porosity, L air/L soil

and $K_d = f_{oc}\ K_{oc}$

where f_{oc} = fraction organic carbon

K_{oc} = organic carbon partition coefficient, kg/L

for organic compounds.

For a given compound and given soil characteristics, the relationship of concentrations in soil and soil moisture is most sensitive to fraction organic carbon.

DILUTION FACTOR IN THE MIXING ZONE

The dilution factor (DF) in the mixing zone where the leachate meets and mixes with groundwater is given by (IDEM, 1997; USEPA, 1996a):

$$DF = 1 + (Kid)/(IL)$$

where

$$d = (0.0112\ L^2)^{1/2} + d_a\ [\ 1 - \exp(\ -LI/Kid_a)\ ]$$

and where:

K = hydraulic conductivity, m/yr

i = hydraulic gradient, m/m

d = mixing zone thickness, m

I	=	recharge rate, m/yr
L	=	source length in direction of flow, m
d_a	=	aquifer thickness, m

Alternatively, the USEPA, in its soil screening level guidance, has developed default dilution factors based on an extensive analysis of source area size. These default values appear in Table 9-1 of the IDEM RISC draft guidance (1997), and are 30 for source areas between 0.1 and 0.25 acres, 20 for areas between 0.25 and 0.5 acres, and 10 for areas greater than 0.5 acres.

GROUNDWATER ATTENUATION MODEL

A plume migrating in groundwater typically undergoes attenuation through the processes of retardation, dilution through dispersion, and loss of contaminant mass through degradation. The USEPA SSL guidance (1996a) and ASTM Standard Guidance (RBCA) (1996) employ an equation developed by Domenico to evaluate these processes. This is also the basis of a model used in the BIOSCREEN modeling system (1996b) referenced in IDEM draft guidance (1997). The model calculates estimated maximum steady-state concentrations along a plume centerline as a function of the dispersion parameters, the reaction rate, and the distance to a point of compliance and retarded groundwater velocity. The equation is:

$$C(x)/C_{source} = \exp\{x\,(1 - (1+(4\lambda\alpha_x/U_c))^{1/2})/2\alpha_x\}\ \mathrm{erf}[S_w/4(\alpha_y x)^{1/2}]\ \mathrm{erf}[S_d/4(\alpha_z x)^{1/2}]$$

where:

$C(x)$	=	dissolved concentration along centerline of plume at distance x, mg/L
C_{source}	=	dissolved concentration at downgradient edge of source area, mg/L
x	=	distance downgradient from source area, ft
exp	=	exponential function, base e
λ	=	first-order chemical or biodegradation rate, 1/day
α_x	=	longitudinal dispersivity, ft; default is x/10
α_y	=	transverse dispersivity, ft; default is $\alpha_x/3$
α_z	=	vertical dispersivity, ft; default is $\alpha_x/20$
U_c	=	retarded contaminant migration rate, ft/d (further defined below)
erf	=	the error function

The retarded groundwater velocity, U_c, or migration rate of the plume, is given by:

$$U_c = Ki/nR_c$$

where:

	K	= the aquifer hydraulic conductivity, ft/d
	I	= the aquifer hydraulic gradient, ft/ft
	n	= the aquifer effective porosity
and	R_c	= the retardation factor = $1 + P_bK_d/n$.

The degradation/dispersion model equation has three terms. The first, the "exp" term, accounts for degradation in the x-direction. It calculates the steady-state concentration at x along the plume centerline. When the reaction rate is zero, the whole argument of the "exp" term is zero, and that factor becomes 1, i.e., no degradation. The first "erf" term accounts for the lateral dispersion (spread) of the plume as it migrates downgradient. The second "erf" term accounts for the vertical dispersion of the plume Since the plume mixing zone thickness for most plumes at the AlliedSignal Complex equal or exceed the limited thickness of the aquifer (approximately 16 feet) at the selected downgradient boundary (Kennedy Park), no further vertical dispersion is likely to occur, and the vertical dispersion term has been set to 1 in the evaluation of groundwater impacts from source area soils.

Note that this degradation/dispersion model also assumes a constant source concentration, while in reality, source area concentrations in most areas are likely to be decreasing due to volatilization, leaching and degradation losses. While a constant source assumption may be appropriate for short distances and travel times, retarded travel times for some of the site plumes are on the order of 10 to 20 years over which significant decreases in source area concentrations may occur. Hence, the equation may be regarded as conservative in this respect.

MODEL INPUTS

Some soil and aquifer property estimates were made based on site-specific data. These include: soil bulk density of 1.66 g/cc; total porosity of 0.39; air-filled porosity in the vadose zone of 0.26 cc/cc; moisture fraction in the vadose zone of 0.13 cc/cc; fraction organic carbon of 0.006; hydraulic conductivity of 128 ft/d; and hydraulic gradient varying from 0.002 to 0.0025 ft/ft.

The fraction organic carbon varies from a high in the source area to a low in relatively uncontaminated areas (i.e., downgradient aquifer). The average value seems appropriate to use over the long pathway, especially since much of the pathway is through the facility where several areas of the subsurface have been affected. Actually, higher retardation and partitioning would occur likely in the source area, while lesser retardation might occur further downgradient.

The hydraulic gradient as currently interpreted is locally highly influenced by the extraction well systems. The average hydraulic gradient under non-pumping conditions was estimated by taking the maximum water levels at the western end of the facility and the minimum water levels recorded at the furthest downgradient wells and dividing by the distance along this pathway. The result also agrees with approximate regional gradient. The overall gradient appears to be slightly higher for Areas of Concern (AOCs) on the east end of the facility when compared to those in the west and central portions.

Mixing zone thickness and mixing dilution factors were evaluated using the site-specific equations. However, mixing zone thickness for most of the source areas were calculated as probably greater than the known or estimated upper aquifer thickness. Hence, the site-specific mixing zone thickness defaulted to the actual aquifer thickness, ranging from 6 to 20 feet in most areas. The mixing zone dilution factors were estimated as ranging between 5 and 30 under varying assumptions for infiltration rate. Since many source areas are covered by buildings or by pavement, actual infiltration rates may be much less, but typically are unknown or difficult to estimate. Actual mechanisms of leaching in some areas may involve the rising and falling of the water table in an impacted area. Due to this uncertainty, it seemed more appropriate to use the IDEM RISC default dilution factors in this general approach. Since most areas are interpreted to be greater than 0.5 acres, the default dilution factor is 10 for most sources.

Since most of the site plumes commingle, it is not possible to clearly define individual plumes, and hence to determine site-specific values for dispersivity. Therefore, the USEPA and ASTM guidance default values dependent on site scale have been adopted.

Attempts were made to derive site-specific degradation rates for the evaluation. However, while there were evidences of degradation occurring, the data could not be meaningfully related for the few pairs of monitoring locations that could be identified as being likely directly downgradient of each other, and away from local pumping systems that would allow accurate estimates of travel times between wells to be made. In addition, only a very few compounds at low concentrations were detected in these wells, which meant that site-specific rate constants could not be determined for most of the compounds being evaluated in any case. Conservative reaction rates for constituents in groundwater were available for most compounds in Howard (1991). For the chlorinated compounds, which are of greater concern, these rates correspond well to rates reported for various field studies of natural attenuation of chlorinated solvents conducted by or reported by USEPA (1996) (see Attachment 1). Rates used for dichloroethene (DCE) 1,2-DCE and vinyl chloride (half lives of eight years) are likely conservative as they correspond to anaerobic conditions. At downgradient locations, aerobic conditions are likely to be re-established, and degradation rates for these daughter products of tetrachlorethe (PCE) and trichlorethene (TCE) are known to be much greater in these types of environments. Other chemical-specific data used in the leaching model are also listed in Attachment 1.

MODELING RESULTS

The modeling calculations were incorporated into Excel spreadsheets for each of 14 identified source areas (see Attachment 2). Under the assumed conditions, source area soil targets protective of groundwater were derived for each of the compounds identified as having potential risk. These soil targets can be compared with maximum and average detections within the source area (included as the last two columns of the spreadsheets).

In many of the areas, the estimated soil targets were less than either or both of the observed concentrations. A summary of the results for each area is presented in Attachment 3. Note that for a few exceedences, the frequency of detection was quite low, indicating that the likelihood of impact is probably much lower than the modeling would suggest. Due to the lower frequency of detection, it may be worthwhile to revisit these areas to define a smaller source area, or treat them as hot spots.

Attachment 4 provides a comparisons between observed soil concentrations, the model's estimated impacts on groundwater at the source area, and the observed concentrations in groundwater at or immediately downgradient of source areas. While the size of some of the source areas may interfere with a direct correlation of these compound concentrations, they may be considered in a general or qualitative sense. Results generally indicate significant degradation of compounds within the source area, and that the leaching/dilution model results generally overpredict impacts to groundwater when compared with the observed results. These observations tend to support the conservativeness of the evaluation and the estimated soil targets protective of groundwater.

REFERENCES

ASTM, 1996. "Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites". Designation E 1739-95. 1996 Annual Book of ASTM Standards, Section 11: Water and Environmental Technology. Volume 11.04, ASTM, West Conshohocken, PA.

Howard, P., et al., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers, Chelsea, MI.

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USEPA, 1990. Basics of Pump-and-Treat Ground-Water Remediation Technology. EPA/600/8-90/003.

USEPA, 1996a. Soil Screening Guidance: User's Guide, EPA/540/R-96/018. April 1996.

USEPA, 1996b. BIOSCREEN, Natural Attenuation Decision Support System, User's Manual Version 1.3. EPA/600/R-96/087, August 1996.

Wilson, J., et al., 1995. Review of Intrinsic Bioremediation of TCE in Groundwater at Picatinny Arsenal New Jersey and St. Joseph Michigan. EPA/600/A-95/096.

Attachment 1
Chemical-Specific Data for Modeling
AlliedSignal Industrial Complex
South Bend, Indiana

Compound	K_{oc} L/kg	H' (dim)	Half-life years	Comments
1,3,5-trimethylbenzene	832	0.341	0.153	Notes 1+2; $t_{1/2}$ = 1,2,4-TMB
1,2,4-trimethylbenzene	472	0.118	0.153	Notes 1+2
tetrachloroethylene	364	0.754	2	
trichloroethylene	126	0.422	4.5	
toluene	182	0.272	0.0767	
ethylbenzene	363	0.323	0.625	
cis-1,2-dichloroethylene	35.5	0.167	8	
vinyl chloride	18.6	1.11	8	
1,1,1-trichloroethane	110	0.705	1.5	
1,1-dichloroethylene	58.9	1.07	0.36	
1,2-dichloroethane	17.4	0.0401	1	
n-propylbenzene	459	0.274	1	Notes 1+2; $t_{1/2}$ ~ xylenes
xylenes	363	0.213	1	
benzene	58.9	0.228	2	
naphthalene	1300	0.0198	0.71	

Notes:
1. Expression for K_{oc} : $\log(K_{oc}) = -0.55 \log(S) + 3.64$ where S is solubility in mg/L
2. Expression for H' : $H' = 16.04(MW)(VP)/(S)(T)$ where MW is molecular weight, VP is vapor pressure, mm Hg; S is solubility in mg/L; and T is degreees Kelvin.
3. Sources of data for K_{oc} and H':
   USEPA, 1996. Soil Screening Guidance: User's Guide
   USEPA, 1990. Basics of Pump-and Treat Ground-Water Remediation Technology EPA/600/8-90/003
4. Sources of data for half-lives:
   Howard, P., et al., 1991. Handbook of Environmental Degradation Rates. Lewis Publishers.
   Wilson, J., et al., 1995. Review of Intrinsic Bioremediation of TCE in Groundwater at Picatinny Arsenal, New Jersey and St. Joseph, Michigan. EPA/600/A-95/096.

ATTACHMENT 2

MODELING RESULTS

Site: Area 311 - Former Disposal Area/Carbon Brake

Input data:

Length(ft):	510	Width(ft):	300	Area(ac):	3
Dist (x,ft):	4100	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	410	alphay(ft):	136.67	alphaz(ft):	20.50
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
1,3,5-trimeth benz	832	0.341	22.248	0.030	10	5.124	0.100	0.1125	56	1.7E-56	10.000	3.02E+58	44	9.8
1,2,4-trimeth benz	472	0.118	13.054	0.050	10	2.929	0.100	0.1125	56	3.5E-43	10.000	8.38E+44	88	13.6
tetrachloroethylene	364	0.754	10.296	0.064	10	2.380	0.100	0.1125	730	1.88E-10	0.005	6.33E+08	170	19.84
trichloroethylene	126	0.422	4.218	0.156	10	0.900	0.100	0.1125	1642	0.000143	0.005	3.15E+02	1500	67.24
toluene	182	0.272	5.648	0.116	10	1.213	0.100	0.1125	28	3.83E-40	1.000	3.16E+40	150	22.65
ethylbenzene	363	0.323	10.270	0.064	10	2.307	0.100	0.1125	228	8.37E-19	0.700	1.93E+19	74	11.14
cis-1,2-DCE	35.5	0.167	1.907	0.344	10	0.317	0.100	0.1125	2920	0.0113	0.070	1.97E+01	56	7.32
1,1,1-TCA	110	0.705	3.809	0.172	10	0.849	0.100	0.1125	546	2.34E-07	0.200	7.25E+06	290	15.55
1,1-DCE	58.9	1.07	2.504	0.262	10	0.599	0.100	0.1125	132	3.88E-12	0.007	1.08E+10	6.9	2.54
1,2-DCA	17.4	0.0401	1.444	0.454	10	0.189	0.100	0.1125	365	1.37E-05	0.005	6.88E+02	0.3	0.21
vinyl chloride	18.6	1.11	1.475	0.445	10	0.364	0.100	0.1125	2920	0.017763	0.002	4.10E-01	0.67	0.67

Site: Area 4/16 - Former I-Beam Bldg

Input data:

Length(ft):	410	Width(ft):	300	Area(ac):	1.37
Dist (x,ft):	2200	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	220	alphay(ft):	73.33	alphaz(ft):	11.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Ave det mg/kg
Trichloroethylene	126	0.422	4.22	0.156	10	0.900	0.187	0.2085	1642	0.003123	0.005	14.42	0.19	0.19
Tetrachloroethylene	364	0.754	10.30	0.064	10	2.380	0.187	0.2085	730	2.17E-07	0.005	5.49E+05	0.14	0.14

Site: Area 5 - Plant 6/16, Central - Former USTs

Input data:

Length(ft):	300	Width(ft):	300	Area(ac):	1.52
Dist (x,ft):	1500	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	150	alphay(ft):	50.00	alphaz(ft):	7.50
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
1,1-DCE	58.9	1.07	2.504	0.262	10	0.599	0.274	0.3016	132	6.55E-07	0.007	64033.00	0.17	0.17
Benzene	58.9	0.228	2.504	0.262	10	0.467	0.274	0.3016	730	0.006066	0.005	3.85	5	2
Ethylbenzene	363	0.323	10.270	0.064	10	2.307	0.274	0.3016	228	7.08E-11	0.700	2.28E+11	230	43.8
n-propylbenzene	459	0.274	12.722	0.052	10	2.875	0.274	0.3016	365	1.66E-09	0.700	1.22E+10	23	7

Site: Area 5, Plant 6/16, North - Former USTs

Input data:

Length(ft):	100	Width(ft):	380	Area(ac):	0.77
Dist (x,ft):	1200	foc:	0.008	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	120	alphay(ft):	40.00	alphaz(ft):	6.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
benzene	58.9	0.228	2.504	0.262	10	0.467	0.434	0.4606	730	0.017435	0.005	1.34	80	80
1,2,4-trimeth benz	472	0.118	13.054	0.050	10	2.929	0.434	0.4606	56	1.36E-22	10.000	2.15E+24	280	55.9
ethylbenzene	363	0.323	10.270	0.064	10	2.307	0.434	0.4606	228	1.72E-09	0.700	9.40E+09	280	50.8
naphthalene	1300	0.0198	34.200	0.019	10	7.881	0.434	0.4606	258	8.04E-17	0.307	3.01E+17	30	17.7
toluene	182	0.272	5.648	0.116	10	1.213	0.434	0.4606	28	5.93E-21	1.000	2.04E+21	700	159.8
xylenes	363	0.213	10.270	0.064	10	2.290	0.434	0.4606	365	2.25E-07	10.000	1.02E+09	720	127.8

Site: Area 5, Plant 19 - Former USTs

Input data:

Length(ft):	305	Width(ft):	200	Area(ac):	0.74
Dist (x,ft):	3400	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	340	alphay(ft):	113.33	alphaz(ft):	17.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.156	10	0.900	0.081	0.0912	1642	0.000269	0.005	167.37	0.39	0.39
Ethylbenzene	363	0.323	10.270	0.064	10	2.307	0.081	0.0912	228	3.42E-17	0.700	4.73E+17	84	32.63

Site: Area 5, Plant 14 - Former USTs

Input data:

Length(ft):	200	Width(ft):	300	Area(ac):	0.84
Dist (x,ft):	3200	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.68	gradient:	0.002
alphax(ft):	320	alphay(ft):	106.67	alphaz(ft):	16.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
n-propylbenzene	459	0.274	12.722	0.052	10	2.875	0.128	0.1436	365	1.85E-14	0.700	1.09E+15	20	20

Site: Area 6/16 - Former Rail Supply Line

Input data:

Length(ft):	160	Width(ft):	150	Area(ac):	0.45
Dist (x,ft):	1600	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	160	alphay(ft):	53.33	alphaz(ft):	8.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Ave det mg/kg
1,3,5-trimeth benz	832	0.341	22.248	0.030	20	5.124	0.128	0.1436	56	4.84E-35	10.000	2.12E+37	580	194.3
1,2,4-trimeth benz	472	0.118	13.054	0.050	20	2.929	0.128	0.1436	56	9.77E-27	10.000	6.00E+28	870	290.5
tetrachloroethylene	364	0.754	10.296	0.064	20	2.380	0.128	0.1436	730	1.92E-06	0.005	1.24E+05	0.23	0.18
trichloroethylene	126	0.422	4.218	0.156	20	0.900	0.128	0.1436	1642	0.005458	0.005	1.65E+01	7.6	2.7
toluene	182	0.272	5.648	0.116	20	1.213	0.128	0.1436	28	7.67E-25	1.000	3.16E+25	1200	400.4
xylenes	363	0.213	10.270	0.064	20	2.290	0.128	0.1436	365	4.12E-09	10.000	1.11E+11	2500	501
ethylbenzene	363	0.323	10.270	0.064	20	2.307	0.128	0.1436	228	1.42E-11	0.700	2.27E+12	600	200.3
cis-1,2-DCE	35.5	0.167	1.907	0.344	20	0.317	0.128	0.1436	2920	0.052698	0.070	8.43E+00	$\boxed{190}$	$\boxed{29.8}$

Site: Area 7, Plant 7 - SWMU 19

Input data:

Length(ft):	75	Width(ft):	150	Area(ac):	0.22
Dist (x,ft):	2200	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.68	gradient:	0.0025
alphax(ft):	220	alphay(ft):	73.33	alphaz(ft):	11.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Tetrachloroethylene	364	0.754	10.296	0.080	30	2.380	0.093	0.104	730	6.76E-07	0.005	5.28E+05	1.4	0.49

Site: **Area 8 - Former Stormwater Drainage System**

Input data:

Length(ft):	80	**Width(ft):**	875	**Area(ac):**	1.48
Dist (x,ft):	2200	**foc:**	0.006	**K (ft/d):**	128
poros:	0.39	**rhob(g/cc):**	1.66	**gradient**	0.002
alphax(ft):	220	**alphay(ft):**	73.33	**alphaz(ft):**	11.00
theta(a):	0.26	**theta(w):**	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.156	10	0.900	0.545	0.5591	1642	0.008374	0.005	5.38	3.3	3.3
cis-1,2-DCE	35.5	0.167	1.907	0.344	10	0.317	0.545	0.5591	2920	0.146744	0.070	1.51	6.4	3.27
1,1,1-TCA	110	0.705	3.809	0.172	10	0.849	0.545	0.5591	546	9.54E-05	0.200	17798.38	7.2	3.9
1,1-DCA	31.6	0.23	1.807	0.363	10	0.304	0.545	0.5591	154	2.68E-06	2.090	2.37E+06	57	28.6

Site: Area 13 - Former Electroplating

Input data:

Length(ft):	350	Width(ft):	370	Area(ac):	2.25
Dist (x,ft):	2100	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.0025
alphax(ft):	210	alphay(ft):	70.00	alphaz(ft):	10.50
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.195	10	0.900	0.241	0.267	1642	0.008911	0.005	5.05	2.6	1.03

Site: Area 14 - Former Paint/Degrease East

Input data:

Length(ft):	310	Width(ft):	250	Area(ac):	1.24
Dist (x,ft):	1700	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.0025
alphax(ft):	170	alphay(ft):	56.67	alphaz(ft):	8.50
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.195	10	0.900	0.201	0.2238	1642	0.012734	0.005	3.54	2300	92.9
cis-1,2-DCE	35.5	0.167	1.907	0.430	10	0.317	0.201	0.2238	2920	0.094417	0.070	2.35	570	114.4
1,1,1-TCA	110	0.705	3.809	0.215	10	0.849	0.201	0.2238	546	0.00046	0.200	3692.72	1500	1500
1,1-DCA	31.6	0.23	1.807	0.454	10	0.304	0.201	0.2238	154	3.02E-05	2.090	2.10E+05	880	880
Vinyl chloride	18.6	1.11	1.475	0.556	10	0.364	0.201	0.2238	2920	0.113476	0.002	0.06	320	320

Site: Area 14 - Plant 1 - Former Paint/Degrease (Central)

Input data:

Length(ft):	250	Width(ft):	200	Area(ac):	0.83
Dist (x,ft):	1700	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.0025
alphax(ft):	170	alphay(ft):	56.67	alphaz(ft):	8.50
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.22	0.195	10	0.900	0.161	0.18	1642	0.010241	0.005	4.40	0.62	0.24
Tetrachloroethylene	364	0.754	10.30	0.080	10	2.380	0.161	0.18	730	7.52E-06	0.005	15830.78	0.51	0.315

Site: Area 14 - Plant 1 - West Paint/Degrease Ops

Input data:

Length(ft):	200	Width(ft):	250	Area(ac):	0.81
Dist (x,ft):	2000	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.002
alphax(ft):	200	alphay(ft):	66.67	alphaz(ft):	10.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.156	10	0.900	0.171	0.191	1642	0.00386	0.005	11.66	40	4.8

Site: Area 15 - Former Metal Stamping Operations

Input data:

Length(ft):	250	Width(ft):	550	Area(ac):	2.55
Dist (x,ft):	1800	foc:	0.006	K (ft/d):	128
poros:	0.39	rhob(g/cc):	1.66	gradient:	0.0025
alphax(ft):	180	alphay(ft):	60.00	alphaz(ft):	9.00
theta(a):	0.26	theta(w):	0.13		

Compound	Koc(cc/g)	H'	Retard fac	Retard vel	Def DAF	Leaching Model Cs/Cw	Sw factor	Erf Sw factor	Howard $t_{1/2}$ days	Disp DF Howard	Ground-water targ mg/L	Soil Targ Howard mg/kg	Observed Concs Max mg/kg	Observed Concs Ave det mg/kg
Trichloroethylene	126	0.422	4.218	0.195	10	0.900	0.418	0.445	1642	0.022084	0.005	2.04	5	1.5
cis-1,2-DCE	35.5	0.167	1.907	0.430	10	0.317	0.418	0.445	2920	0.179146	0.070	1.24	0.53	0.28
1,1,1-TCA	110	0.705	3.809	0.215	10	0.849	0.418	0.445	546	0.000705	0.200	2409.34	2.2	1.3
Tetrachloroethylene	364	0.754	10.296	0.080	10	2.380	0.418	0.445	730	1.26E-05	0.005	9456.29	35	6.4

Attachment 3
Comparison of Maximum and Average Hits to Targets
AlliedSignal Industrial Complex
South Bend, Indiana

Area		Compound	Result	Comment
3/11	Area 3/11	trichloroethene	max > targ	
		cis-1,2-dichloroethene	max > targ	
		vinyl chloride	both > targ	only 1 detect in 60 samples
5	Plant 19 USTs	None		
5	Plant 14 USTs	None		
4/16	I-Beam Building	None		
6/16	Former Rail Supply	cis-1,2-dichloroethene	both > targ	
7	Plant 7 SWMU	None		
5	Plant 6/16 USTs, North	benzene	both > targ	only 1 detect in 17 samples
5	Plant 6/16 USTs, Central	benzene	max > targ	only 4 detects in 43 samples
14	Plant 1 Painting and Degreasing, West	trichloroethene	max > targ	
8	I-Beam Drainage System	cis-1,2-dichloroethene	both > targ	only 2 detects in 21 samples
15	Metal Stamping Operations	trichloroethene	max > targ	
14	Plant 1 Painting and Degreasing, Central	None		
13	Former Electroplating Area	None		
14	Painting/Degreasing	trichloroethene	both > targ	
		cis-1,2-dichloroethene	both > targ	
		vinyl chloride	both > targ	only 1 detect in 29 samples

APPENDIX O-6

MUNICIPAL WELL SURVEY

ABB TECHNICAL MEMORANDUM

SUBJECT: Municipal Well Survey

PROJECT: AlliedSignal Industrial Complex, South Bend, Indiana

PREPARED BY: Peter Kaczor, Geologist, ABB Environmental Services, Inc.

DATE: February 13, 1998

INTRODUCTION

In the Spring of 1997, a review of the Indiana Department of Natural Resource's (IDNR's) water well record files was completed as part of a Voluntary Site Investigation (VSI) at the AlliedSignal Industrial Complex South Bend, Indiana. The water well records indicated that groundwater immediately downgradient of the site is not used as a drinking water source. The IDNR records indicated that residential wells are located one half mile northwest (sidegradient) of the site and municipal water wells are located more than one mile east (sidegradient) of the site. A municipal water supply survey was conducted by ABB Environmental Services, Inc. (ABB) to further support this information.

APPROACH

To determine the appropriate boundary for the survey, ABB consulted with the Indiana Department of Environmental Management (IDEM) Leaking Underground Storage Tank (LUST), Resource Conservation and Recovery Act (RCRA), and Voluntary Remediation Program (VRP) programs. The LUST program stated a one-mile radius for residential wells and a two-mile radius for municipal wells should be considered; however, this boundary was impractical given the large population density in the area. Guidance for the IDEM RCRA program and VRP states that the radius is determined on a case-by-case basis dependent upon site-specific conditions.

The area of the municipal well survey encompassed two blocks beyond the estimated extent of the off-site plume or the property boundary (which ever was greater). The area chosen was based upon the premise that an evaluation of potential receptors is necessary only within and adjacent to the groundwater plume. The proposed boundary was chosen with consideration that a) the extent of the groundwater plume is reasonably characterized; b) groundwater quality data indicate plume stability at its leading edge; and c) a VOC recovery system is in place at the Complex.

ABB Environmental Services, Inc.
39255 Country Club Drive B-25 • Farmington Hills, Michigan 48331-3490
Phone (248) 489-8040 • FAX (248) 489-8048

To complete the survey, a list of addresses within the area was obtained by reviewing City of South Bend tax records and planning maps. The list of addresses was provided to the local water company (South Bend Water Works), who then reviewed the list and indicated which address were connected to the municipal water supply. ABB then conducted a door-to-door survey of those addresses which were listed as not connected to the municipal supply. Residents were asked if a private well exists at the residence (or business) or if the water is obtained from the municipal supply.

RESULTS

The list of addresses within the study area is included as Attachment 1. Included on the tables is the information provided to the South Bend Water Works, their comments regarding connection to the municipal water supply and results of the door-to-door survey. Addresses listed as being not connected to the municipal water supply were found to be either vacant lots or were actually connected according to the resident, with the exception of two addresses. Several inquiry attempts were made to the residences located at 2606 Linden and 2428 Lawton during the door-to-door survey, but no one answered the door during each visit. The well survey is considered complete because these addresses are located sidegradient of the identified plume all other residences in the surrounding area are connected to the municipal water supply.

Municipal Water Well Survey
AlliedSignal Industrial Complex, South Bend, Indiana

Owner's Name	Address			Connected to City Water? Yes	No	Field Observations
Richard & Julie Long	18	3000 BL Rogers	South Bend, IN 46628			
Lois Ann Sanders	2529	Bertrand	South Bend, IN 46628	X		
St Joseph County	2523	Bertrand	South Bend, IN 46628			
Housing Authority SB	2523	Bertrand	South Bend, IN 46628	X		
Blair & Tracey Carlstrom	2513	Bertrand	South Bend, IN 46628	X		
Denis & Gertrude Pettitt	2509	Bertrand	South Bend, IN 46628	X		
G & M Properties	2503	Bertrand	South Bend, IN 46628		X	Vacant lot
Gene & Mary Poston	2501	Bertrand	South Bend, IN 46628	X		
Lavera Armstrong	2429	Bertrand	South Bend, IN 46628		X	Vacant lot
Carey & Jennie Payton	2425	Bertrand	South Bend, IN 46628	X		
Annie Collins & Traci Williams	2421	Bertrand	South Bend, IN 46628	X		
G & M Properties	2409	Bertrand	South Bend, IN 46628	X		
Lieutenant Mitchell	2409	Bertrand	South Bend, IN 46628			House boarded up
Arnulfo & Petra Moreno	2610	Bertrand	South Bend, IN 46628	X		
Arnold & Petra Moreno	2606	Bertrand	South Bend, IN 46628	X		
Pinkie Newman	756	Eclipse	South Bend, IN 46628	X		
Steven Kronewitter & Roger Gree	2917	Frederickson	South Bend, IN 46628	X		
Samuel Elking & Tracy Damp	2913	Frederickson	South Bend, IN 46628	X		
Richard Marshall Jr.	2909	Frederickson	South Bend, IN 46628	X		
Maria Cabral	2905	Frederickson	South Bend, IN 46628	X		
Norma Sills & Deborah Wright	2901	Frederickson	South Bend, IN 46628	X		
Rose E. Kish	2817	Frederickson	South Bend, IN 46628	X		
Robert & Joan Ciesiolka	2811	Frederickson	South Bend, IN 46628	X		
Michelle Hilliard	2805	Frederickson	South Bend, IN 46628	X		
Darrell Preston	2801	Frederickson	South Bend, IN 46628	X		
Alex & Loretta Wasowski	2922	Frederickson	South Bend, IN 46628	X		
Willie B. Dixon Jr.	2918	Frederickson	South Bend, IN 46628	X		
William M. Vanderbeck	2914	Frederickson	South Bend, IN 46628	X		
Security Pacific Natl Bank	2910	Frederickson	South Bend, IN 46628	X		
Todd & Penny Sheneman	2906	Frederickson	South Bend, IN 46628	X		
Dru Ann Dean	2902	Frederickson	South Bend, IN 46628	X		
Mary E. Free	2818	Frederickson	South Bend, IN 46628	X		
James & Shantel Monroe	2814	Frederickson	South Bend, IN 46628	X		
Arthur J. Bell	2810	Frederickson	South Bend, IN 46628	X		
Judy Pugsley & Sally Curl	2806	Frederickson	South Bend, IN 46628	X		
Wayne & Alice Farrington	2802	Frederickson	South Bend, IN 46628	X		
Cornelius & Mary Niezgodski	2733	Frederickson	South Bend, IN 46628	X		
Ina Pruitt	2729	Frederickson	South Bend, IN 46628	X		
John & Judith Bikowski	2725	Frederickson	South Bend, IN 46628	X		
John & Althea Price	2721	Frederickson	South Bend, IN 46628	X		
Kathleen Kintz	2717	Frederickson	South Bend, IN 46628	X		
Joseph & Mavis Slazewski	2713	Frederickson	South Bend, IN 46628	X		
Juarez Roberto & Erasmo Trevino	2709	Frederickson	South Bend, IN 46628	X		
Frank & Ruth Goheen	2705	Frederickson	South Bend, IN 46628	X		
Moore & Moore Properties	2701	Frederickson	South Bend, IN 46628	X		
Admistrator of Veterans Affairs	2730	Frederickson	South Bend, IN 46628	X		
Brian Lichkay	2726	Frederickson	South Bend, IN 46628	X		
Marvin Johnson	2722	Frederickson	South Bend, IN 46628	X		
Glenn & Teri Davis	2718	Frederickson	South Bend, IN 46628	X		
John & Matilda Kurdys	2714	Frederickson	South Bend, IN 46628	X		
Robert & Catherine Heide	2710	Frederickson	South Bend, IN 46628	X		
Star Properties LLC	2706	Frederickson	South Bend, IN 46628	X		
Jean Lake	2702	Frederickson	South Bend, IN 46628	X		
Julius & Alice Wentland	2629	Frederickson	South Bend, IN 46628	X		
Bankers Trust Co of California	2625	Frederickson	South Bend, IN 46628	X		
Barbara Poindexter	2621	Frederickson	South Bend, IN 46628	X		
Edward & Helen Nowak	2617	Frederickson	South Bend, IN 46628	X		
Leo & Marie Czarnecki	2615	Frederickson	South Bend, IN 46628	X		
Allen Richard Maciulski	2609	Frederickson	South Bend, IN 46628	X		
Rita Donnelly	2605	Frederickson	South Bend, IN 46628	X		
Enewanah Tahmir	2601	Frederickson	South Bend, IN 46628	X		
Ruth Hemingway	2630	Frederickson	South Bend, IN 46628	X		
Lincoln Shrider	2628	Frederickson	South Bend, IN 46628	X		
Rita Shane	2622	Frederickson	South Bend, IN 46628	X		
Henry & Mary Lou Chrobot	2618	Frederickson	South Bend, IN 46628	X		
John & Maria Piotrowiak	2614	Frederickson	South Bend, IN 46628	X		

Municipal Water Well Survey
AlliedSignal Industrial Complex, South Bend, Indiana

Owner's Name	Address			Connected to City Water? * Yes	No	Field Observations
Jerry Jerome & Debbie Clark	2610	Frederickson	South Bend, IN 46628	X		
Thomas & Myrna Bladecki	2606	Frederickson	South Bend, IN 46628	X		
Frank & Genevieve Wukovits	2602	Frederickson	South Bend, IN 46628	X		
Lula Edwards	2530	Frederickson	South Bend, IN 46628	X		
Theresa Wroblewski	2526	Frederickson	South Bend, IN 46628	X		
Gloria Whittaker	2522	Frederickson	South Bend, IN 46628	X		
William & Geraldine Lynch	2514	Frederickson	South Bend, IN 46628	X		
Richard & Lillian Nowak	2510	Frederickson	South Bend, IN 46628	X		
Terry & Sharon Preston	2506	Frederickson	South Bend, IN 46628	X		
Fred & Mary Pruitt	2502	Frederickson	South Bend, IN 46628	X		
Administrator of Veterans Affairs	2634	Frederickson	South Bend, IN 46628	X		
Mary Alexander	2430	Frederickson	South Bend, IN 46628	X		
Eric Avery & Phyllis Parker	2426	Frederickson	South Bend, IN 46628	X		
Walter & Wanda Nowak	2422	Frederickson	South Bend, IN 46628	X		
Teachers Credit Union	2418	Frederickson	South Bend, IN 46628	X		
Clifforn Bingham	2414	Frederickson	South Bend, IN 46628	X		
Oscar & Rhonda Washington	2404	Frederickson	South Bend, IN 46628	X		
Julie A. Smith	2529	Frederickson	South Bend, IN 46628		X	Connected to city water
Marie Taylor	2525	Frederickson	South Bend, IN 46628	X		
Tamara Bushard	2521	Frederickson	South Bend, IN 46628	X		
Matthew & Emily Reisman	2517	Frederickson	South Bend, IN 46628	X		
Lisa Stewart	2513	Frederickson	South Bend, IN 46628	X		
Karen Hubbard & Diatra White	2509	Frederickson	South Bend, IN 46628	X		
Ben & Margaret Miles	2505	Frederickson	South Bend, IN 46628	X		
Henry & Maxine Preston	2501	Frederickson	South Bend, IN 46628	X		
Milton Dean	2433	Frederickson	South Bend, IN 46628	X		
Louise Bailey	18 2400Blk	Frederickson	South Bend, IN 46628	X		
Scott & Deborah Rutledge	2425	Frederickson	South Bend, IN 46628	X		
Marvin Stanley	2421	Frederickson	South Bend, IN 46628	X		
Paul & Laveta Stuckman	2417	Frederickson	South Bend, IN 46628	X		
Merle & Phyllis Fuelling	2413	Frederickson	South Bend, IN 46628	X		
Mervin D. Lung	3029	Fredrickson	South Bend, IN 46628	X		
Michael B. Roseman	3021	Fredrickson	South Bend, IN 46628	X		
Richard & Rita Kalicki	3017	Fredrickson	South Bend, IN 46628	X		
James & Benita Hannah	3013	Fredrickson	South Bend, IN 46628	X		
Beth A. Beiersdorf	3009	Fredrickson	South Bend, IN 46628	X		
Casimer & Gert Wolkiewicz	3005	Fredrickson	South Bend, IN 46628	X		
Richard & Natalie Mrozinski	3001	Fredrickson	South Bend, IN 46628	X		
Civil City of South Bend	232	Fremont	South Bend, IN 46628		X	Vacant lot
Wilma Cramer & Joann Persinger	615	Goodland	South Bend, IN 46628	X		
Carl & Mary Lou Egyhazi	804	Goodland	South Bend, IN 46628	X		
Jerome McMahon	133	Kaley	South Bend, IN 46619		X	Connected to city water
James & Kathleen Clark	2615	Kenwood	South Bend, IN 46628	X		
Ina Inez Goss	2609	Kenwood	South Bend, IN 46628	X		
Carlton Gill	2607	Kenwood	South Bend, IN 46628	X		
Sarah Jones	2614	Kenwood	South Bend, IN 46628	X		
Larry Dean Biesbrouck	2610	Kenwood	South Bend, IN 46628	X		
Earl & Louisa Fuller	2606	Kenwood	South Bend, IN 46628	X		
Amos & Jean Nichols	2602	Kenwood	South Bend, IN 46628	X		
George & Maudessa Thomas	2415	Lawton	South Bend, IN 46628	X		
Johnnie Bowles	2421	Lawton	South Bend, IN 46628	X		
Victoria Parks	2423	Lawton	South Bend, IN 46619	X		
William Welsch	2424	Lawton	South Bend, IN 46619	X		
George & Maudessa	2428	Lawton	South Bend, IN 46628		X	No answer at house
James & Elner Troupe	2501	Lawton	South Bend, IN 46628	X		
Kinnucan Family LTD Partner.	2502-2526	Lawton	South Bend, IN 466628			Connected to city water
William & Florine Jones	2517	Lawton	South Bend, IN 46628	X		
Kinnucan Family LTD Partner.	2529	Lawton	South Bend, IN 46628		X	Vacant lot
Veterans of Foreign Wars of USA	2602	Lawton	South Bend, IN 46628		X	Vacant lot
Roosevelt & Marie Walker	2615	Lawton	South Bend, IN 46628	X		
Allen Redding	2625	Lawton	South Bend, IN 46628	X		
Robert Hecklinski	2611	Linden	South Bend, IN 46628			
Phillip Smith	2626	Linden	South Bend, IN 46628		X	Vacant Lot
Wheels Auto Inc.	2618	Linden	South Bend, IN 46628		X	Connected to city water
Robert & Frances Brooks	2610	Linden	South Bend, IN 46628		X	Connected to city water
Willie Frank & Wardean Allen	2606	Linden	South Bend, IN 46628		X	No answer at house

Owner's Name	Address			Connected to City Water?* Yes	No	Field Observations
Oscar & Misirie Williams	2602	Linden	South Bend, IN 46628		X	Connected to city water
G & M Properties	2526	Linden	South Bend, IN 46628		X	Vacant lot
Sheila Vanlue	2518	Linden	South Bend, IN 46628		X	Connected to city water
Mary Washington & Lucille Belton	2516	Linden	South Bend, IN 46628		X	Connected to city water
Gary Campbell	2510	Linden	South Bend, IN 46628		X	Connected to city water
Henrietta Soleta & A. Justin	2506	Linden	South Bend, IN 46628		X	Water meter on house
Ellis & Zenovia Allen	2502	Linden	South Bend, IN 46628	X		Connected to city water
G & M Properties	2432	Linden	South Bend, IN 46628		X	Vacant lot
City of South Bend	2428	Linden	South Bend, IN 46628		X	Vacant lot
G & M Properties	2422	Linden	South Bend, IN 46628		X	Vacant lot
City of South Bend	2418	Linden	South Bend, IN 46628		X	Vacant lot
Jacqueline Jones	2414	Linden	South Bend, IN 46628	X		
Eric & Robin Coleman	2410	Linden	South Bend, IN 46628	X		
Steve & Mary Gaul	2406	Linden	South Bend, IN 46628	X		
Buford & Ernestine Freeman	3026	Longley	South Bend, IN 46628	X		
Kelvin L. Wilson	3018	Longley	South Bend, IN 46628	X		
Janet Kay Stalker	3012	Longley	South Bend, IN 46628	X		
Hap R. Kitchen Sr.	3006	Longley	South Bend, IN 46628	X		
Florida M. Smith	3002	Longley	South Bend, IN 46628	X		
Patricia A .Byrd	401	N. Bendix	South Bend, IN 46620	X		
John & Sheila Redding	202	N. Kaley	South Bend, IN 46619		X	Vacant lot
James Louis & Annie L. Harris	228	N. Meade St.	South Bend, IN 46628	X		
Northern Indiana Commuter	307	N. Michigan	South Bend, IN 46614		X	Vacant lot
Loyal & Sally Woodson	311	N. Olive	South Bend, IN 46628	X		
Percy Reed	229	N. Olive	South Bend, IN 46628	X		
Dora E. Scott & Jewell Scott	225	N. Olive	South Bend, IN 46628	X		
Indiana United Corporation	221	N. Olive	South Bend, IN 46628		X	Vacant lot
William Welsch	201	N. Olive	South Bend, IN 46628	X		
Durell & Ora Mae Glispie	515	Olive	South Bend, IN 46619		X	Vacant lot
Beverly Ann Benjamin	759	Olive	South Bend, IN 46628	X		
Bennie & Angelia Diggins	755	Olive	South Bend, IN 46628	X		
Indiana United Corporation	755	Olive	South Bend, IN 46628	X		
Michael Sutherland	747	Olive	South Bend, IN 46628	X		
Bernard Leyba	801	Olive	South Bend, IN 46628	X		
Bernard Leyba	807	Olive	South Bend, IN 46628	X		
Michael, Ben & Bernard Leyba	815	Olive	South Bend, IN 46628	X		
Harold Dorsey	511	Olive	South Bend, IN 46628	X		
Loyal & Sally Woodson	231	Olive	South Bend, IN 46628		X	Vacant lot
Celofus Shurn	217	Olive	South Bend, IN 46628	X		
Bonita Bigham	2517	Orange	South Bend, IN 46628	X		
Ramon & Augustina Rodela	2722	Prast	South Bend, IN 46628	X		
Robert B. Kirchbaum	3030	Prast	South Bend, IN 46628	X		
Sharon R. Rothfuss	3026	Prast	South Bend, IN 46628	X		
Joseph Van Overberghe	3022	Prast	South Bend, IN 46628	X		
Eugene C. Pawlak	3018	Prast	South Bend, IN 46629	X		
John L. Staniszewski	3014	Prast	South Bend, IN 46630	X		
Larry A. & Karen J. King	3010	Prast	South Bend, IN 46631	X		
Wesley R. & Shirley L. Godwin	3006	Prast	South Bend, IN 46632	X		
Greater New Vision Missionary	3002	Prast	South Bend, IN 46633	X		
David & Ericka Williams	2924	Prast	South Bend, IN 46628	X		
Lois A. Veen	2918	Prast	South Bend, IN 46628	X		
Alice Karczewski	2914	Prast	South Bend, IN 46628	X		
Harry & Dorothy Barczykowski	2910	Prast	South Bend, IN 46628	X		
Louis W. Szalay	2906	Prast	South Bend, IN 46628	X		
Bendix Corp.	2902	Prast	South Bend, IN 46628	X		
Sally Karczewski	2818	Prast	South Bend, IN 46628	X		
William & Mary Hall	2814	Prast	South Bend, IN 46628	X		
Donald & Jean Rose Gruza	2810	Prast	South Bend, IN 46628	X		
Inez M. King	2806	Prast	South Bend, IN 46628	X		
Noel & William Craig	2802	Prast	South Bend, IN 46628	X		
Virdo Walker	2734	Prast	South Bend, IN 46628	X		
Cyrus & Shirley King	2730	Prast	South Bend, IN 46628	X		
Ramon & Augustina Rodela	2726	Prast	South Bend, IN 46628		X	Garage at this address
Alfred & Marlene Freeman	2718	Prast	South Bend, IN 46628	X		
Joslyn Freeman	2714	Prast	South Bend, IN 46628	X		
Imre & Gyongyi Vincen	2706	Prast	South Bend, IN 46628	X		

Municipal Water Well Survey
AlliedSignal Industrial Complex, South Bend, Indiana

Owner's Name	Address			Connected to City Water?* Yes	No	Field Observations
Robert Laskowski	2702	Prast	South Bend, IN 46628	X		
Harry Simpson	2630	Prast	South Bend, IN 46628	X		
Louis Soos	2622	Prast	South Bend, IN 46628	X		
John & Esther Bertman	2618	Prast	South Bend, IN 46628	X		
William & Alice Lipka	2614	Prast	South Bend, IN 46628	X		
John & Evelyn Czuk	2610	Prast	South Bend, IN 46628	X		
Jos & Rose Manuszak	2606	Prast	South Bend, IN 46628	X		
Boston Properties Inc.	2602	Prast	South Bend, IN 46628	X		
Casimer & Edna Mezykowski	2530	Prast	South Bend, IN 46628	X		
Lela Roberts	2526	Prast	South Bend, IN 46628	X		
Walter & Lucille Deranek	2522	Prast	South Bend, IN 46628	X		
Galinda Phillips	2518	Prast	South Bend, IN 46628	X		
William Hill	2514	Prast	South Bend, IN 46628	X		
Glenn & Barbara Hall	2510	Prast	South Bend, IN 46628	X		
George Reese	2506	Prast	South Bend, IN 46628	X		
George F. Reese	2400 Blk	Prast	South Bend, IN 46628		X	Vacant lot
Jean Ntakirutimana	2436	Prast	South Bend, IN 46628	X		
Charles & Hattie Pryor	2432	Prast	South Bend, IN 46628	X		
Richard & Lucille Adamski	2428	Prast	South Bend, IN 46628	X		
Donnabelle Marvin	2424	Prast	South Bend, IN 46628	X		
Milton Dean & Dean Shedric	2420	Prast	South Bend, IN 46628	X		
Carol Badur	2416	PRast	South Bend, IN 46628	X		
Jacob & Elsie Mitschelen	2422	Roger	South Bend, IN 46628	X		
Kelly Niezgodski	3017	Rogers	South Bend, IN 46628	X		
Jonathan Gonzalez	3013	Rogers	South Bend, IN 46628	X		
Mark Kimes	3005	Rogers	South Bend, IN 46628	X		
Sharon Weaver	3001	Rogers	South Bend, IN 46628	X		
Renew Inc.	3034	Rogers	South Bend, IN 46628	X		
John W. Bays Jr.	3026	Rogers	South Bend, IN 46628	X		
John T. Sergeant	3018	Rogers	South Bend, IN 46628	X		
Thomas B. Adams II	3010	Rogers	South Bend, IN 46628	X		
Housing Authority of SB	2532	Rogers	South Bend, IN 46628	X		
Agnes Geissler	2522	Rogers	South Bend, IN 46628	X		
Willian & Lorene Dixon	2518	Rogers	South Bend, IN 46628	X		
Housing Authority SB	2510	Rogers	South Bend, IN 46628	X		
Lizzie Mae Rucker	2502	Rogers	South Bend, IN 46628	X		
Dorothy Pope	2430	Rogers	South Bend, IN 46628	X		
Willie Parchman	2426	Rogers	South Bend, IN 46628	X		
J.C. & Marie Williams	2418	Rogers	South Bend, IN 46628	X		
Durell & Ora Mae Glispie	2418	Rogers	South Bend, IN 46628	X		
John Shambry & Mae Cornelious	2513	W. Lawton	South Bend, IN 46628	X		
Addie Shurn	2501	W. Orange	South Bend, IN 46628	X		
Rita Phillips	2515	W. Orange	South Bend, IN 46628	X		
Paul Rutherford	2521	W. Orange	South Bend, IN 46628	X		
Timothy & Pamela Jacks	2921	Westmoor	South Bend, IN 46628	X		
Deric & Tanya Garner	2917	Westmoor	South Bend, IN 46628	X		
Donna J. Parks	2913	Westmoor	South Bend, IN 46628	X		
Homer & Neva Cuthbertson	2909	Westmoor	South Bend, IN 46628	X		
Charlie McAllister Sr.	2905	Westmoor	South Bend, IN 46628	X		
Dan Kois	2901	Westmoor	South Bend, IN 46628	X		
Robert & Robbie Lynn Gunn	2813	Westmoor	South Bend, IN 46628	X		
Joseph & Stella Dobrzykowski	2811	Westmoor	South Bend, IN 46628	X		
Karen Kreuter	2805	Westmoor	South Bend, IN 46628	X		
JPV Inc.	2801	Westmoor	South Bend, IN 46628	X		
Theron & Hattie Brown	2729	Westmoor	South Bend, IN 46628	X		
Renew Inc	2725	Westmoor	South Bend, IN 46628	X		
Emery & Rosetta Butts	2723	Westmoor	South Bend, IN 46628	X		
Michael Crosz	2713	Westmoor	South Bend, IN 46628	X		
Larry & Barbara Donica	2709	Westmoor	South Bend, IN 46628	X		
Joseph Baraso	2705	Westmoor	South Bend, IN 46628	X		
Margaret Gorski	2701	Westmoor	South Bend, IN 46628	X		
John & Claudette Sass	2629	Westmoor	South Bend, IN 46628	X		
Robert & Karen McFarland	2625	Westmoor	South Bend, IN 46628	X		
John & Jeanette Perry	2621	Westmoor	South Bend, IN 46629		X	Connected to city water
Patrick & Debora Higgins	2617	Westmoor	South Bend, IN 46628	X		
Willie Burks	2615	Westmoor	South Bend, IN 46628	X		

Owner's Name	Address			Connected to City Water? *		Field Observations
				Yes	No	
Linda Doolen	2609	Westmoor	South Bend, IN 46628	X		
Dolores Borkowski	2605	Westmoor	South Bend, IN 46628	X		
Harry & Clementine Mrozinski	2601	Westmoor	South Bend, IN 46628	X		
Berald & Joan Kazmierczak	2529	Westmoor	South Bend, IN 46628	X		
James & Shirlene Gaddey	2525	Westmoor	South Bend, IN 46628	X		
Jerome Klawiter	2513	Westmoor	South Bend, IN 46628	X		
Robert & Dorothy Jeske	2509	Westmoor	South Bend, IN 46628	X		
Walter & Genevieve Dyszkiewicz	2505	Westmoor	South Bend, IN 46628	X		
Jerry & Bonnie Willis	2501	Westmoor	South Bend, IN 46628	X		
Yvonne Mourning	2429	Westmoor	South Bend, IN 46628	X		
Donald P. Smith	2425	Westmoor	South Bend, IN 46628	X		
Willie & Karen Brown	2421	Westmoor	South Bend, IN 46628	X		
Joyce Grady	2413	Westmoor	South Bend, IN 46628	X		
Ben & Bernice Sopczynski	2403	Westmoor	South Bend, IN 46628	X		
Steven & Mitzy Howard	2817	Westmore	South Bend, IN 46628	X		
Tim & Johnnie Miller	2417	Westmore	South Bend, IN 46628	X		

Note: * = As indicated in correspondence with South Bend Water Works, South Bend, Indiana

Municipal Water Well Survey
AlliedSignal Industrial Complex, South Bend, Indiana

Owner's Name	Address			Connected to City Water?* Yes	No	Field Observations
City of South Bend	2530	Bertrand	South Bend, IN 46628		X	Vacant lot
Edward & Andrea Washington	2526	Bertrand	South Bend, IN 46628	X		
Housing Authority SB	2524	Bertrand	South Bend, IN 46625	X		
Davene Capers	2518	Bertrand	South Bend, IN 46628	X		
Towanna Brooks	2515	Bertrand	South Bend, IN 46628		X	Connected to city water
Ellen Glispie	2508	Bertrand	South Bend, IN 46619	X		
Jacque & Rosemary Hudson	2506	Bertrand	South Bend, IN 46613	X		
St. Joseph County	V/L Adj 2502	Bertrand	South Bend, IN 46628		X	Vacant lot
James Smitherman	2430	Bertrand	South Bend, IN 46628	X		
Laura McDonald	18 Vac L110	Bertrand	South Bend, IN 46628		X	Vacant lot
Laura McDonald	2418	Bertrand	South Bend, IN 46628	X		
Rose Coles	2414	Bertrand	South Bend, IN 46628		X	Vacant lot
Richard Fox	2410	Bertrand	South Bend, IN 46628		X	Parking lot
James Smitherman	S SD Bertrand	E SD Fremont	South Bend, IN 46628		X	Connected to city water
Security Pacific Natl Bank	715	Goodland	South Bend, IN 46628	X		
Kathi & Carlton Gill	2525	Kenwood	South Bend, IN 46628	X		
Laura McDonald	2521	Kenwood	South Bend, IN 46628	X		
Silous & Jacki Anderson	2517	Kenwood	South Bend, IN 46628	X		
Earl & Esther Fisher	2515	Kenwood	South Bend, IN 46628	X		
Percy & Luberta Jones	2505	Kenwood	South Bend, IN 46628	X		
Durell & Ora Mae Glispie	2421	Kenwood	South Bend, IN 46628	X		
Durrell & Ora May Glispie	2417	Kenwood	South Bend, IN 46628	X		
Francis & Delores Jones	2413	Kenwood	South Bend, IN 46628	X		
Jerome & Delores Jones	2409	Kenwood	South Bend, IN 46628	X		
Jerome Jones	2405	Kenwood	South Bend, IN 46628	X		
Kathi & Carlton Gilll	18 Vac L89	Kenwood	South Bend, IN 46628			
Earl & Esther Fisher	18 Vac L94	Kenwood	South Bend, IN 46628		X	Vacant lot
ercy & Luberta Jones	18 Vac L96	Kenwood	South Bend, IN 46628		X	Vacant lot
chard Dougherty	2530	Kenwood	South Bend, IN 46628		X	Vacant lot
ichard Dougherty	18 Vac L67	Kenwood	South Bend, IN 46628	X		
Richard Dougherty	2522	Kenwood	South Bend, IN 46628		X	Vacant lot
Richard Dougherty	2520	Kenwood	South Bend, IN 46628		X	Associated with 2530 Linden; connected to city water
Richard & Dixie Dougherty	2518	Kenwood	South Bend, IN 46628		X	
Marilyn Ann Welch	2514 Vac Lot	Kenwood	South Bend, IN 46628		X	
Marily Ann Welch	2514	Kenwood	South Bend, IN 46628		X	Vacant lot
Michael Lee	2504	Kenwood	South Bend, IN 46628	X		
Eddie & Rosie Bailey	2502	Kenwood	South Bend, IN 46628	X		
Willie & Rosetta Corbitt	2430	Kenwood	South Bend, IN 46628	X		
Rachel Lee Givens	2426	Kenwood	South Bend, IN 46628	X		
Durell & Ora Mae Glispie	2422	Kenwood	South Bend, IN 46628	X		
Dianna Merriweather	2418	Kenwood	South Bend, IN 46628	X		
Michael Ampy	2414	Kenwood	South Bend, IN 46628	X		
Laura McDonald	2408	Kenwood	South Bend, IN 46628	X		
G & M Properties	2404	Kenwood	South Bend, IN 46628	X		
Int Free and Accepted	2429	Kenwood	South Bend, IN 46616		X	Vacant lot
Ben & Jesse Noell	2531	Linden	South Bend, IN 46628	X		
Raymond & Marie Taghon	2527	Linden	South Bend, IN 46628	X		
Linden Land Trust	2525	Linden	South Bend, IN 46616	X		
Housing Authority of SB	2519	Linden	South Bend, IN 46625	X		
G & M Properties	18 Vac L41	Linden	South Bend, IN 46625	X		
G & M Properties	2507	Linden	South Bend, IN 46619		X	Vacant lot
G & M Properties	2505	Linden	South Bend, IN 46625		X	Vacant lot
Housing Authority of South Bend	2503	Linden	South Bend, IN 46625		X	Vacant lot
James Clendenin	2429	Linden	South Bend, IN 46625		X	Connected to city water
Tracie Hoston	2425	Linden	South Bend, IN 46628	X		
St. Josephy County	2419	Linden	South Bend, IN 46628	X		
avid & Laura Melton	2417	Linden	South Bend, IN 46628		X	Vacant lot
ara Niles	18 Vac L49	Linden	South Bend, IN 46628	X		
					X	Vacant lot

Municipal Water Well Survey
AlliedSignal Industrial Complex, South Bend, Indiana

Owner's Name	Address			Connected to City Water? * Yes	No	Field Observations
Barbara Niles	2409	Linden	South Bend, IN 46628	X		
Michael & Carol Barcza	18 Vac L 51	Linden	South Bend, IN 46628		X	Vacant lot
Elizabeth Macan	3029	Longley	South Bend, IN 46628	X		
Jo Anne Podemski	3021	Longley	South Bend, IN 46628		X	Garage at this address
Joanne Pdemski	3019	Longley	South Bend, IN 46628	X		
Jo Anne Podemski	3017	Longley	South Bend, IN 46628	X		
Hugh Lambert	3013	Longley	South Bend, IN 46628	X		
Charles & Martin Moran	3003	Longley	South Bend, IN 46628	X		
Bendix Corp.	401 Lot 8 Lincoln	N. Bendix	South Bend, IN 46620	X		
Michael & Carol Barcza	323	N. Olive	South Bend, IN 46628	X		
Owen & Shirley Huffer	501	Olive	South Bend, IN 46628	X		
Johnny & Maggie Olive	401	Olive	South Bend, IN 46601		X	Vacant lot
Timothy Hancz	325	Olive	South Bend, IN 46628	X		
Kenneth Washington	3026	Westmoor	South Bend, IN 46628	X		
Timothy Scott	3018	Westmoor	South Bend, IN 46628	X		
Clinton & Ruth Mack	3010	Westmoor	South Bend, IN 46628	X		
Joe Jackson Sr.	3002	Westmoor	South Bend, IN 46628	X		

Note: * = As indicated in correspondence with South Bend Water Works, South Bend, Indiana

ABB

February 18, 1998

Mr. Ray White
AlliedSignal Inc.
Aerospace Equipment Systems
717 N. Bendix Drive
South Bend, Indiana 46620

Subject: Draft Human Health Risk Assessment
AlliedSignal Industrial Complex, South Bend, Indiana

Dear Mr. White:

The enclosed are three copies of the draft Human Health Risk Assessment (HHRA), Section 6.0 of the draft Voluntary Site Investigation (VSI) Report for the AlliedSignal Industrial Complex, South Bend, Indiana. The document is submitted for your review and comment.

In reviewing the document, please note:

1. With the inclusion of Appendix O, the current 3-ring binder for the VSI Report is to small. Also, the Table-of-Contents and Conclusions of the VSI Report should be updated. Considering this, we recommends that after reviewing the revised draft VSI Report and Section 6.0 HHRA, you return all three copies of these documents. ABB will then address all comments at once, revise the Table-of-Contents and Conclusions, and re-issue the report.

2. During final review, I noticed that it may be appropriate to develop two additional figures in support of the HHRA and Conclusions. One figure. Figure 6-3 would illustrate the points-of-compliance (POCs) selected for calculation of soil concentrations protective of off-site groundwater use. This figure is important because it indirectly illustrates the area which would require a water use restriction. The second figure, Figure 7-1 would illustrate soil source areas that exceeded the Tier II site-specific target levels. This second figure would, in essence, illustrate areas warranting additional consideration.

ABB appreciates the opportunity to prepare the HHRA. At our convenience, please contact me at (248) 489-8040 regarding the anticipated timeframe for review and revision of the report.

Sincerely,

ABB ENVIRONMENTAL SERVICES OF MICHIGAN, INC.

Donald A. Walsh, CPG
Project Manager

enclosure

ABB Environmental Services of Michigan Inc.

39255 Country Club Drive, B-25
Farmington Hills, MI 48331

Telephone (248) 489-8040
Fax (248) 489-8048

Attachment 4
Comparison of Observed and Estimated Groundwater Concentrations
AlliedSignal Industrial Complex
South Bend, Indiana

Area		Well	Compound	Observed Soil Concentration (mg/kg)			Groundwater Concentrations Estimated ug/L			Observed
				Max	Ave Hit	Ave All	Max	Ave Hit	Ave All	Ave 1997
3/11	Former Disposal Area/ Carbon Brake Expansion	MW-2	PCE	170	19.8	6	7142	832	252	ND
			TCE	1500	67.2	37.1	166667	7467	4122	70
			cis-1,2-DCE	56	7.3	2.1	17666	2303	662	2833
			1,1,1-TCA	290	15.5	6.5	34158	1826	766	780
			TEX	384	53.8	12.4	NC	NC	NC	ND
14	Former Painting/Degreasing	MW-7	TCE	40	4.8	4.1	4444	533	456	ND
13	Former Electroplating Operations	86-10	TCE	2.6	1	0.8	289	111	89	103
14	Former Painting/Degreasing	86-15	TCE	2300	92.9	83.3	255555	10322	9256	300