



Uploaded to the VFC Website

▶▶▶ February 2014 ◀◀◀

This Document has been provided to you courtesy of Veterans-For-Change!

Feel free to pass to any veteran who might be able to use this information!

For thousands more files like this and hundreds of links to useful information, and hundreds of "Frequently Asked Questions, please go to:

[Veterans-For-Change](http://www.veteransforchange.org)

*Veterans-For-Change is a A 501(c)(3) Non-Profit Organization
Tax ID #27-3820181
CA Incorporation ID #3340400
CA Dept. of Charities ID #: CT-0190794*

If Veterans don't help Veterans, who will?

We appreciate all donations to continue to provide information and services to Veterans and their families.

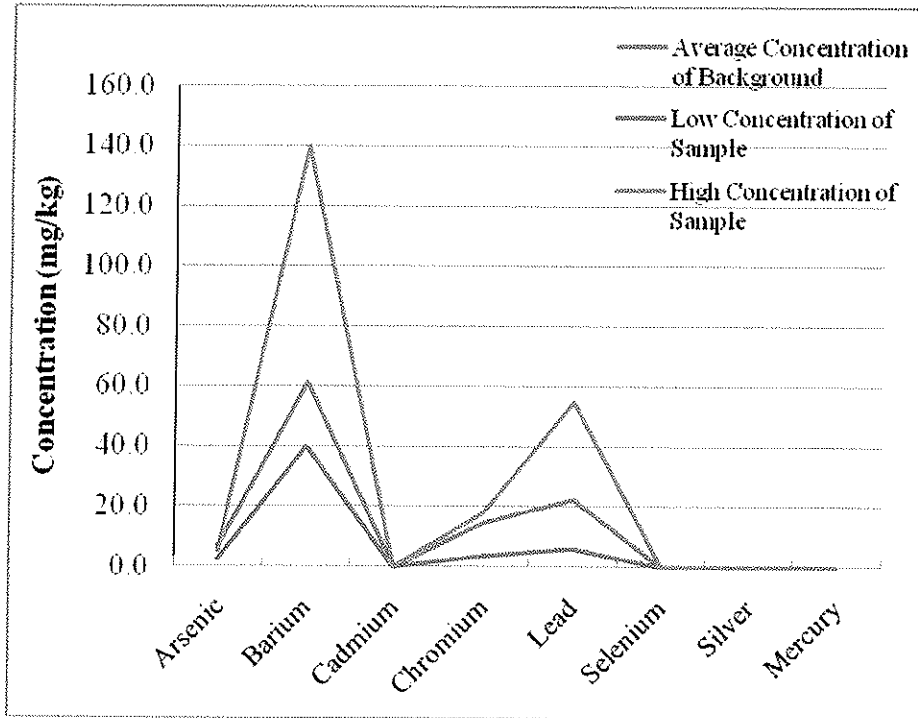
https://www.paypal.com/cgi-bin/webscr?cmd=_s-xclick&hosted_button_id=WGT2M5UTB9A78

Note:

VFC is not liable for source information in this document, it is merely provided as a courtesy to our members & subscribers.

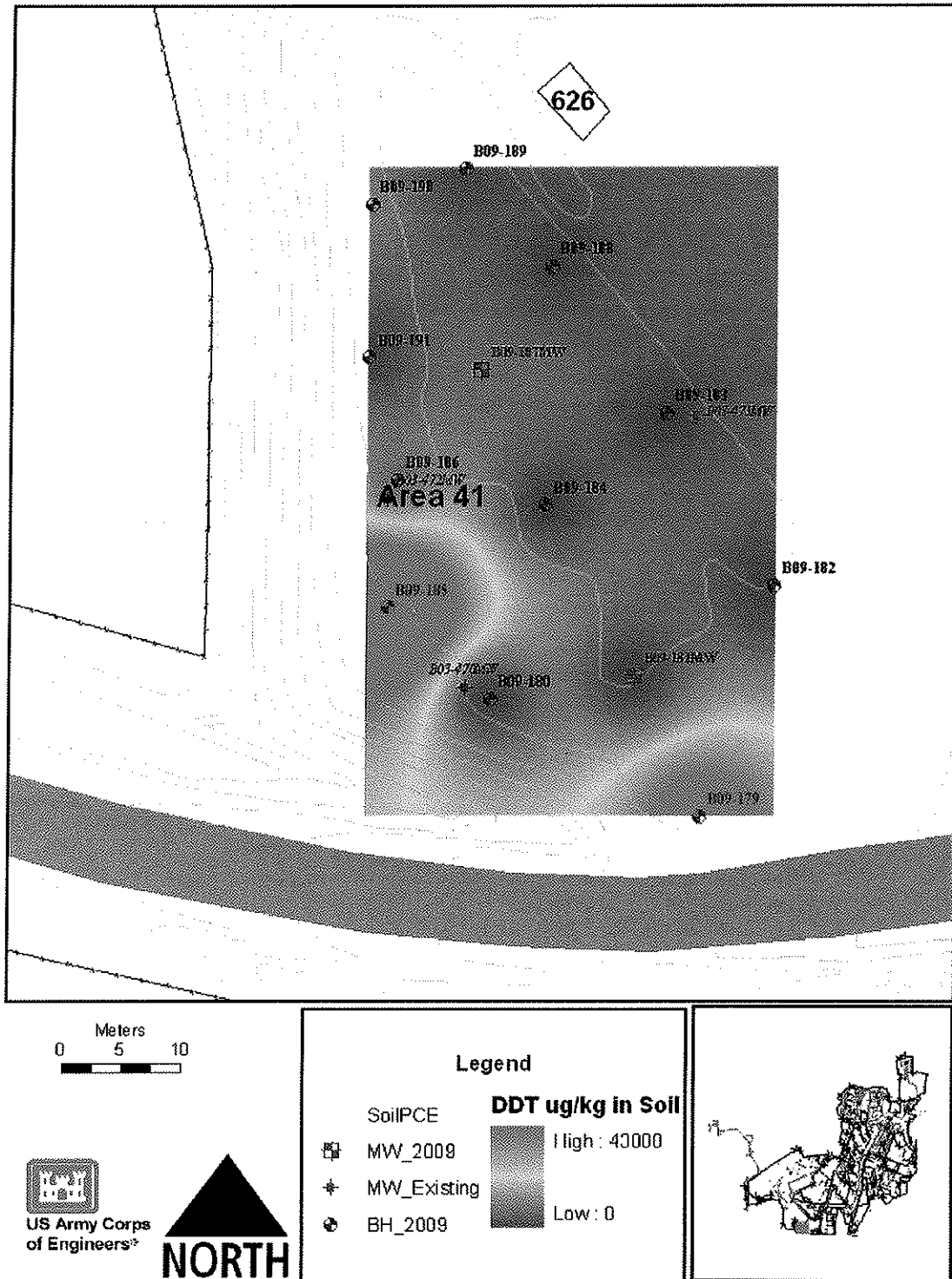


Figure 4-2. Metal Concentrations in Soil Samples against the Site Background Sample at Area 41 of Camp Carroll.



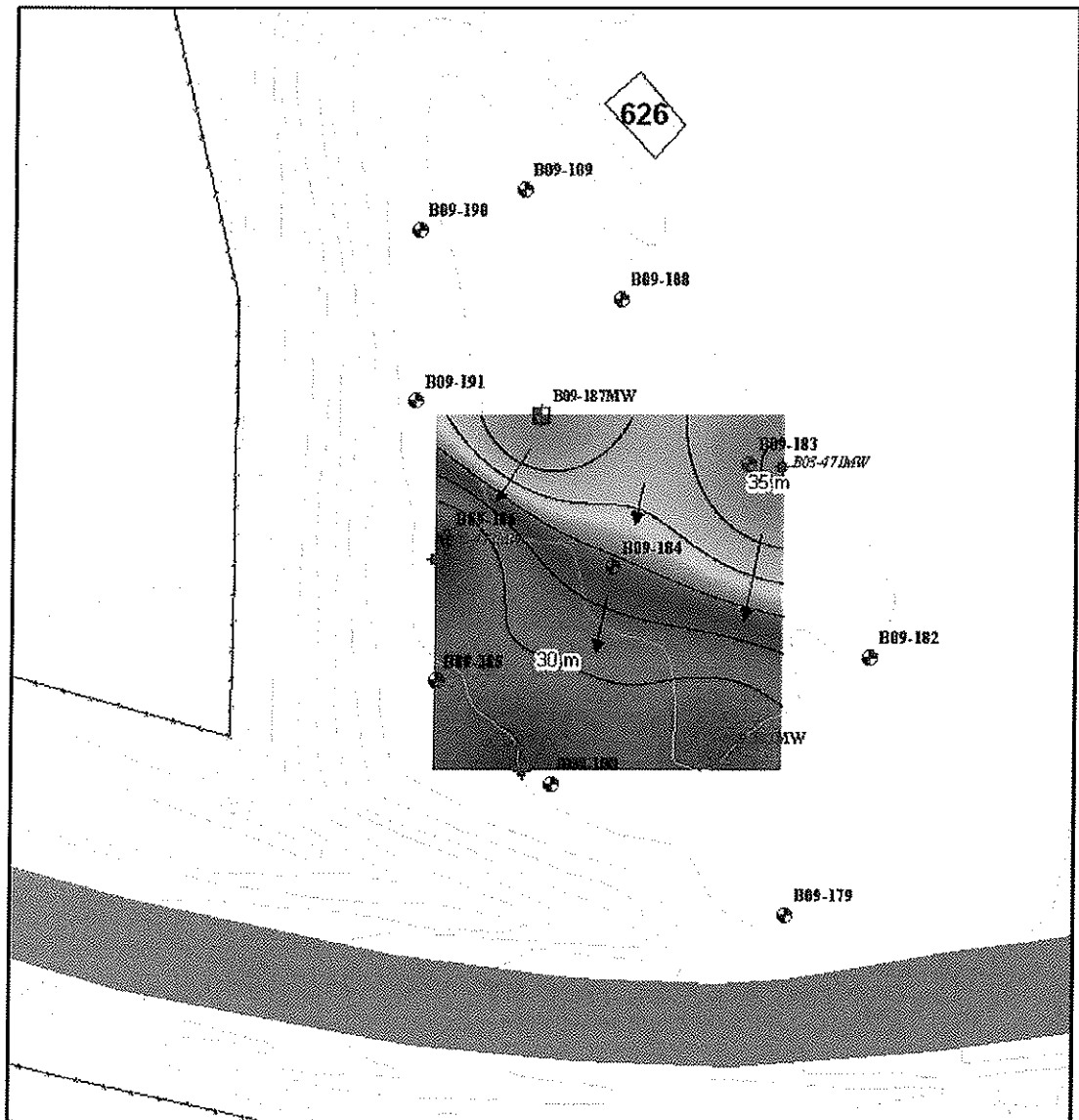
3901

Figure 4-3 DDT Concentration in Soil at Area 41 of Camp Carroll. Note that the Distribution of DDE and DDD is very similar to This Pattern.



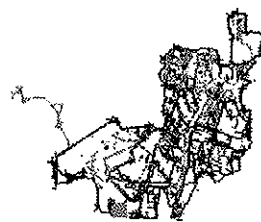
3902

Figure 4-4 Groundwater Flow Direction Contour Diagram at Area 41 of Camp Carroll.



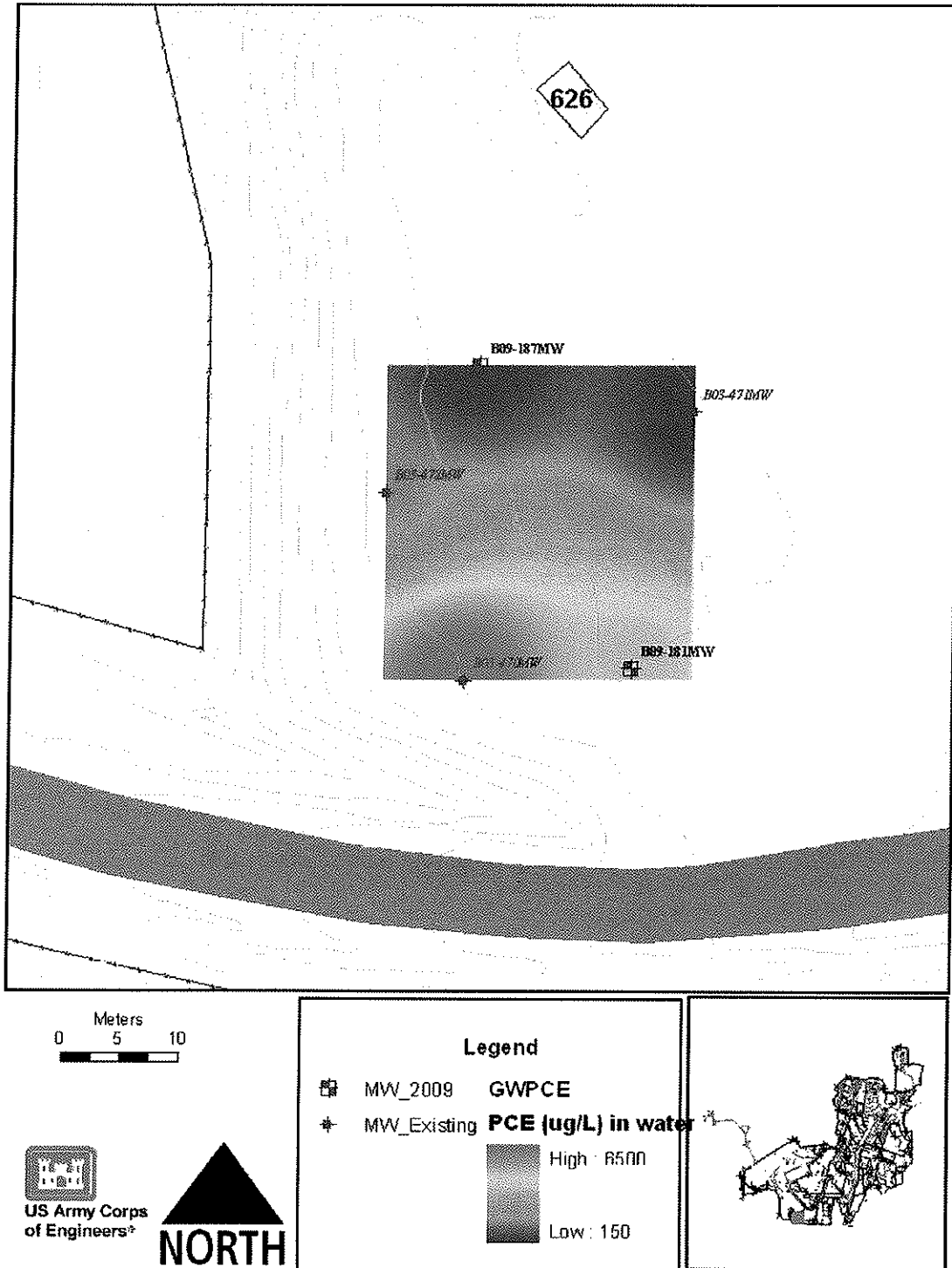
Legend

- GW_level **above sea level**
 - SoilPCE
 - MW_2009
 - MW_Existing
 - BH_2009
 - GWContour
- High: 35
Low: 29



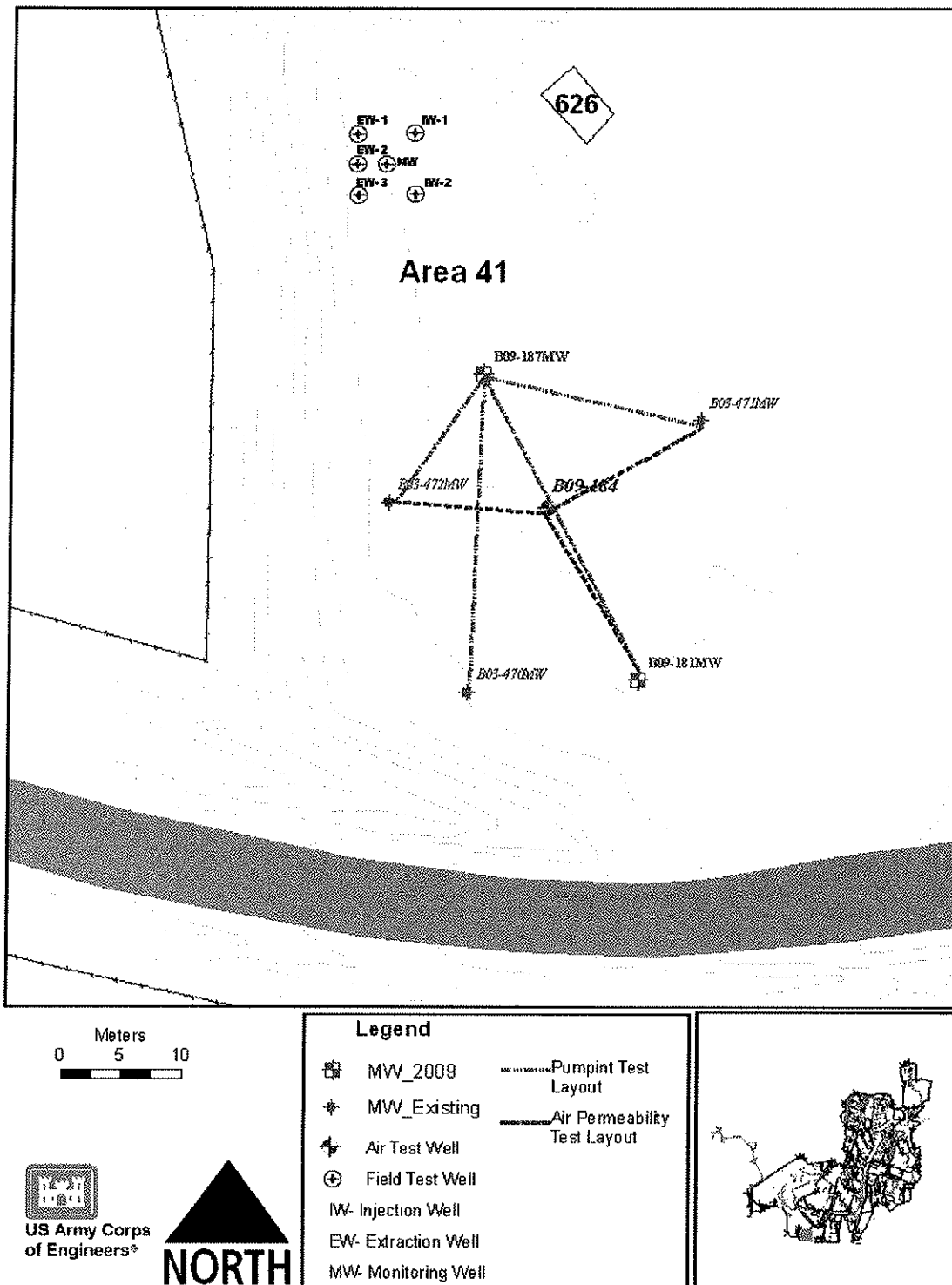
3903

Figure 4-5. PCE Concentration in the Subsurface Soil of Area 41 of Camp Carroll.



3904

Figure 4-6 Hydrologic, Air Permeability Test Layouts and Field Test Well Locations at Area 41 of Camp Carroll.



3905

5. References

- Department of Defense (DoD), 2009. DoD Quality Systems Manual for Environmental Laboratories, Version 4.1. Based on NELAC Voted Revision, June 5, 2003.
- DoD, 2005. Department of Defense Directive 4715.1E. Environment, Safety, and Occupational Health (ESOH), 19 March 2005.
- DoD, 1998. Department of Defense Instruction 4715.8, Environmental Remediation for DoD Activities Overseas, 2 February 1998.
- Samsung Corporation. 2004. *Camp Carroll Area D and Area 41 Site Investigation, Camp Carroll, Korea*. Prepared for US Army Corps of Engineers, Far East District, Contract #DACA81-00-D-0049, Delivery Order #24 July 2004
- United States Army Corp of Engineers (USACE), 2005. *Guidance for Evaluating Performance-Based Chemical Data, Manual EM 200-1-10*, US Army Corps of Engineers Manual dated June 30, 2005.
- USACE, 1997. *Engineer Manual EM 200-1-6, Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects*. US Army Corps of Engineers Manual dated October 10, 1997.
- USACE FED, 2009. *Work Plan for Environmental Site Investigation/Risk Assessment at Six Sites of Camp Carroll: Bachelor's Enlisted Quarters (BEQ) Hill, Area 41, Area D, Land Farm Building 565 and Building 326*. Prepared for: Environmental Division, DPW, Camp Carroll, USA Garrison Daegu IMKO-ADP-PWE (Mr. Kim Chom-Tong), UNIT#15748, APO AP 96260-5748, Prepared by: Geotechnical and Environmental Engineering Branch (Dr. U-Yong Chon), US Army Corps of Engineers, Far East District, January 6, 2009.
- United States Forces Korea Regulation 200-1, *United States Forces Korea Remediation Regulation*, 2 October 2007
- United States Forces Korea Pamphlet 200-1, *Environmental Governing Standards*, 25 March 2005
- US EPA, 1996. *Test Methods for Evaluating Solid Waste, SW-846*. 3rd ed. Final Update III. Washington. GPO. November.
- Woodward Clyde. 1992. *Baseline Groundwater Investigation, Camp Carroll*, 1992

Appendix I: Soil Borehole Logs

3907



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-179**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: 

DATE STARTED: **23 Feb 09**

FINISHED: **23 Feb 09**

DRILLER: 

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **6.0 m**

OVERBURDEN THICKNESS: **6.0 m**

DEPTH DRILLED: **6.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,882.6** E: **446,680.6**

GROUND ELEV.: **39.37 m**


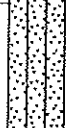
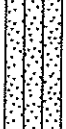
DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

b6
b6

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND: strong brown; moist; subangular (max.2cm); subangular fine to coarse Sand (max.4.8mm); no plasticity; medium dense; fill material (SM); no odor; contain organics.	%Recovery = 45 PID = 1.5ppm FC = F2	
1	S1					FILL	SILTY SAND: strong brown; moist; subangular (max.2cm); subangular fine to coarse Sand (max.4.8mm); no plasticity; medium dense; fill material (SM); no odor.	FC = F2	
2						SM	SILTY SAND: yellowish brown; moist; subangular fine gravel (max.1cm); subangular medium to coarse Sand (max.4.8mm); no plasticity; dense; residual soil; no odor.	FC = F3	
3	S2							%Recovery = 50 PID = 1ppm	
4								%Recovery = 48 PID = 3.5ppm	
5	S3								
6									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 8/28/11

3908



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-180**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED]

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER: [REDACTED]

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,892.3** E: **446,662.7**

GROUND ELEV.: **39.48 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

b6
b6

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND: grayish brown; moist; angular (max.2cm); subangular fine to coarse Sand (max.4.8mm); no plasticity; loose; fill material (SM); no odor; contain organics.	%Recovery = 46 PID = 0.3ppm FC = F3	
39						SM	SILTY SAND: brown; moist; subangular fine to coarse Sand (max.4.8mm); no plasticity; loose; residual soil; no odor.	FC = F3	
38	SI					SM	SILTY SAND: yellowish brown; moist; subangular fine to coarse Sand (max.4.8mm); no plasticity; medium dense; residual soil; no odor.	FC = F3	
37								%Recovery = 49 PID = 0.6ppm	
36									
4									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 3/28/11

3909



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-181MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR:  *b6*

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER:  *b6*

DRILLING METHOD/EQUIPMENT: **Drect-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **14.7 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **14.7 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,894.2** E: **446,674.8**




GROUND ELEV.: **39.78 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL ; grayish brown; moist; subangular (max.1.5cm); subangular fine to coarse Sand (max.4.8mm); no plasticity; very loose; fill material (SM); no odor; contain organics.	%Recovery = 46 PID = 19.2ppm FC = F3 FC = F3	
39	SI					SM	SANDY SILT ; brown; moist; subangular fine to coarse Sand (max.4.8mm); no plasticity; medium dense; residual soil; no odor.	FC = F3	
38							SILTY SAND ; yellowish brown; moist; subangular fine to coarse Sand (max.4.8mm); no plasticity; medium dense; residual soil; no odor.	%Recovery = 50 PID = 1.5ppm	
37	S						Soil drilling to install groundwater monitoring well without collection soil sample. No hard bedrock was not encountered...		
36									
35									
34									
33									
32									
31									
30									

ENVIRO-EXPLORATION LOG 03-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-181MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED]

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER: [REDACTED]

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **14.7 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **14.7 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,894.2** E: **446,674.8**

GROUND ELEV.: **39.78 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

b6
b7c

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
10									
29									
11									
28									
12									
27									
13									
26									
14									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 02/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-182**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED] *b6*

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER: [REDACTED] *b6*

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,901.8** E: **446,686.9**

GROUND ELEV.: **39.74 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL: grayish brown; moist; subangular (max. 2cm); subangular fine Sand; very loose; fill material (SM); no odor; contain organics.	%Recovery = 25 PID = 2.7ppm	
39						CL	SILTY SAND: yellowish brown; moist; subangular fine Sand; medium dense; fill material (SM); no odor.		
1	S1					ML	SANDY LEAN CLAY: reddish brown; moist; subangular fine Sand; medium stiff; fill material (SM); no odor.		
38						SM	SANDY SILT: yellowish brown; subangular medium Sand; medium dense; fill material (SM); no odor; contain wood material (1.3cm).		
2						SM	SILTY SAND: reddish brown; subangular medium Sand; dense; residual soil; no odor.	%Recovery = 50 PID = 0ppm	
37									
3									
36									
4									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-183**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED] *b6*

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER: [REDACTED] *b6*

DRILLING METHOD/EQUIPMENT: **Drect-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,916.2** E: **446,677.6**

GROUND ELEV.: **39.82 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA	
0						FILL	SILTY SAND WITH GRAVEL: dark brown; moist; subangular (max.2cm); subangular; very loose; fill material (SM); no odor; contain organics.	%Recovery = 50 PID = 0.1ppm		
					ML					
					SM	SILTY SAND: brown; moist; angular; fill material (SM); no odor. SANDY SILT: light yellowish brown; moist; medium stiff; residual soil; no odor. SILTY SAND: brown; moist; subangular medium Sand; no odor.				
39	s1					CL	LEAN CLAY: ligh olive brown; moist; (max.0.43mm); medium plasticity; very stiff; no odor.	%Recovery = 48 PID = 1.2ppm		
38						SM	SILTY SAND: ligh brown; moist; angular; residual soil; no odor.			
37	s2									
36										

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-184**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR:  *b6*

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER:  *b6*

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,908.5** E: **446,667.3**

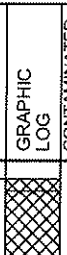

GROUND ELEV.: **39.79 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL: dark brown; moist; subangular (max.2.5cm); no plasticity; very loose; fill material (SM); no odor; contain organics. SANDY FAT CLAY: reddish brown; moist; subangular (max.2.5cm); high plasticity; medium soft; fill material (CH); no odor.	%Recovery = 40 PID = 0.7 ppm FC = F3 FC = F4	
39	S1					SM			FC = F3
38								%Recovery = 50 PID = 0 ppm	
37	S2					SM	SILTY SAND WITH GRAVEL: light brown; moist; subangular fine gravel (max.1cm); no plasticity; medium dense; residual soil; no odor.		
36						SM	SILTY SAND WITH GRAVEL: light brown; moist; subangular fine gravel (max.1cm); no plasticity; very dense; residual soil; no odor.		

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11

3914



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-185**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED] *b6*

DATE STARTED: **25 Feb 09**

FINISHED: **25 Feb 09**

DRILLER: [REDACTED] *b6*

DRILLING METHOD/EQUIPMENT: **Drect-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.45 m**

OVERBURDEN THICKNESS: **4.45 m**

DEPTH DRILLED: **4.45 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,900.0** E: **446,654.0**

GROUND ELEV.: **39.38 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL ; dark brown; moist; about 30%; about 40% fine to coarse Sand; about 30% Fines; very loose; fill material (SM); no odor; contain organics.	%Recovery = 43 PID = 162ppm FC = F3 FC = F4	
39						ML	SANDY SILT ; brown; moist; fine to coarse Sand; medium stiff; residual soil; weak solvent.		
1	s1					SM	SANDY SILT ; reddish brown; moist; fine to medium Sand; stiff; weak solvent.	FC = F4	
38						ML	SILT ; yellowish brown; moist; fine Sand; stiff; weak solvent.	%Recovery = 50 PID = 143ppm	
37									
36	s								
35	ss					ML	SILT ; yellowish brown; moist; fine Sand; very stiff; residual soil; weak solvent.	%Recovery = 50 PID = 72.4ppm	

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11

39/5



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-186**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: 

DATE STARTED: **25 Feb 09**

FINISHED: **25 Feb 09**

DRILLER: 

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **10.0 m**

OVERBURDEN THICKNESS: **10.0 m**

DEPTH DRILLED: **10.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,910.6** E: **446,654.8**

GROUND ELEV.: **39.57 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL: dark brown; moist; subangular (max.1.5cm); subangular fine to coarse Sand; very loose; fill material (SM); no odor; contain organics.	%Recovery = 50 PID = 98.4ppm	
39	s1					SM	SILTY SAND: reddish brown; moist; very loose; fill material (SM); no odor.		
1						SM	SILTY SAND: reddish brown; moist; medium dense; residual soil; weak solvent.		
38						SM	SILTY SAND: reddish brown; moist; loose; moderate solvent.		
2						SM	SILTY SAND: reddish brown; moist; subangular fine gravel; medium dense; moderate solvent.		
37						SM	SILTY SAND.	%Recovery = 50 PID = 219ppm	
36	s2								
4						SM	SILTY SAND.	%Recovery = 50 PID = 61.9ppm	
35						ML	SILT: grayish brown; moist; stiff; weak solvent.		
34	s3								
6								%Recovery = 45 PID = 132ppm	
33						ML	SILT: moist; very stiff; faint solvent.		
32	s4								
8						ML	SILT: moist; very stiff; no odor.	%Recovery = 50 PID = 13.5ppm	
31									
9	ss								
30									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-187MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED] *b6*

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: [REDACTED] *b6*

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **15.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **15.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,919.7** E: **446,661.6**

GROUND ELEV.: **39.80 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND: brown; moist; subangular (max.2cm); no plasticity; very loose; fill material (SM); no odor; contain organics.	%Recovery = 50 PID = 10.4ppm	
39						FILL	SILTY SAND: reddish brown; moist; no plasticity; loose; fill material (SM); no odor.		
39	S1					CL	SILTY SAND: dark brown; moist; no plasticity; medium dense; fill material (SM); no odor.		
38						SM	LEAN CLAY WITH SAND: reddish brown; moist; low plasticity; stiff; CL; no odor. SILTY SAND: yellowish brown; moist; no plasticity; medium dense; residual soil; weak solvent.		
37						SM	SILTY SAND: yellowish brown; no plasticity; medium dense; faint solvent.	%Recovery = 50 PID = 3.7ppm	
36	S2								
35							Soil drilling to install groundwater monitoring well without collection soil sample. No hard bedrock was not encountered....		
34									
33									
32									
31									
30									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-187MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: 

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: 

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **15.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **15.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,919.7** E: **446,661.6**

GROUND ELEV.: **39.80 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
10									
29									
11									
28									
12									
27									
13									
26									
14									
25									
15									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GST 6/28/11

3918



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-188**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: 

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: 

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **3.7 m**

OVERBURDEN THICKNESS: **3.7 m**

DEPTH DRILLED: **3.7 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,928.4** E: **446,667.7**





GROUND ELEV.: **39.82 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL: brown; moist; subangular (max.3.5cm); subangular; no plasticity; very loose; fill material (SM); no odor; contain organics.	%Recovery = 50 PID = 2.5ppm	
39	S1					SM	SILTY SAND: brown; moist; subangular; no plasticity; medium dense; residual soil; no odor.		
38						SM	SILTY SAND: light brown; moist; no plasticity; dense; residual soil; no odor.		
37	S2					SM	SILTY SAND: light brown; moist; subangular; no plasticity; very dense; residual soil; no odor.	%Recovery = 50 PID = 3.7ppm	

ENVIRO-EXPLORATION LOG 03-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-189**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR:

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER:

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,936.6** E: **446,660.4**

GROUND ELEV.: **39.62 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND: dark brown; moist; subangular; very loose; fill material (SM); no odor; contain organics.	%Recovery = 50 PID = 0.8ppm	
39						SM	SILTY SAND: brown; moist; medium dense; residual soil; no odor.		
38	SI					SM	SILTY SAND: light brown; dense; no odor.		
37						ML SM	SILT: dark brown; stiff; no odor. SILTY SAND: light brown; dense; no odor.	%Recovery = 50 PID = 1.7ppm	
36	SI					SM	SILTY SAND: reddish brown; subangular fine gravel (max. 1cm); dense; no odor.		

ENVIRO-EXPLORATION LOG 08-C36E AREA 41 CARROLL.GPJ USACE SKOREA.GDI 6/28/11



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-190**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED]

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: [REDACTED]

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **6.0 m**

OVERBURDEN THICKNESS: **6.0 m**

DEPTH DRILLED: **6.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,933.6**

E: **446,652.5**

GROUND ELEV.: **39.59 m**

DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

66
66

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND WITH GRAVEL: dark brown; moist; about 15% subangular (max. 3cm); about 65% subangular fine to medium Sand (max. 2mm); about 20% Fines; no plasticity; very loose; fill material (SM); no odor; contain organics. SILTY SAND: brown; moist; subangular fine to medium Sand (max. 2mm); no plasticity; loose; fill material (SM); no odor. SILTY GRAVEL WITH SAND: grayish brown; moist; subangular (max. 3cm); dense; fill material (SM); no odor. SILTY SAND: dark brown; moist; residual soil; weak solvent. SANDY SILT: reddish brown; moist; residual soil; weak solvent.	%Recovery = 43 PID = 24.6ppm FC = F3	
39					FILL				
1	S1					SM			
2						ML			
37						SM		%Recovery = 50 PID = 58.6ppm	
3	S2								
4									
5								%Recovery = 50 PID = 3.7ppm	
6									

ENVIRO-EXPLORATION LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11

3921



US Army Corps
Of Engineers

EXPLORATION LOG

HOLE NO. **B09-191**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: 

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: 

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **4.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **4.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,920.8** E: **446,652.3**

GROUND ELEV.: **39.54 m**









DATUM: **MSL**

GROUND COVER: **dirt**

CONTAMINATION: _____

TYPE OF HOLE: Piezometer Monitoring Well Test Pit Auger Hole other _____

b6
b6

ELEVATION / DEPTH (meters)	SAMPLE TYPE / NUMBER	GRAPHIC LOG	CONTAMINATED	BLOW COUNT	SPT N-VALUE	USCS / STRATA	DESCRIPTION OF MATERIALS	FIELD DATA	LAB DATA
0						FILL	SILTY SAND: grayish brown; moist; subangular; very loose; fill material (SM); no odor; contain organics.	%Recovery = 44 PID = 5.7ppm	
39						FILL	SANDY LEAN CLAY: reddish brown; moist; loose; fill material (CL); no odor.		
1	S1					SM	CLAYEY SAND WITH GRAVEL: dark brown; moist; angular; fill material (SC); no odor. SILTY SAND: reddish brown; moist; subangular fine gravel; medium dense; residual soil; no odor.		
38									
2									
37						SM	SILTY SAND: brown; moist; no odor.	%Recovery = 45 PID = 1.8ppm	
36									
4									

39 22

Appendix II: Monitoring Well Construction Logs



US Army Corps
Of Engineers

MONITORING WELL LOG

WELL NO. **B09-181MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR:

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER:

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **14.7 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **14.7 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,894.2** E: **446,674.8**

GROUND ELEV.: **39.78 m**

DATUM: **MSL**

GROUND COVER: **dirt**

TOP of WELL RISER CASING ELEV.: **39.71 m**

96
66

MONITORING WELL LOG 08-036E.AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11

ELEVATION / DEPTH (meters)	WELL GRAPHIC	GRAPHIC LOG	USCS / STRATA	SAMPLE NUMBER	Depth (m)	FIELD DATA	WELL CONSTRUCTION DETAILS
							<p>PROTECTIVE CASING Diameter: 30 cm Type: Manhole Interval: -0.02 to 0.18m</p>
39		FILL ML		1	1	%Recovery = 46 PID = 19.2ppm FC = F3 FC = F3	<p>WELL RISER CASING Diameter: 2 inch Type: Schedule 40 PVC Interval: -0.01 to 5.55m</p>
38		SM		2	2	%Recovery = 50 PID = 1.5ppm	<p>WELL SCREEN Diameter: 2 inch Type: 0.01 Slot Sch 40 Interval: 5.55 to 14.65m</p>
37					3		<p>WELL POINT Type: Schedule 40 PVC Interval: 14.65 to 14.8m</p>
36					4		<p>CONCRETE PAD Diameter: 0.3m Interval: -0.05 to 0.15m</p>
35					5		<p>GROUT Type: Portland Type II Interval: 0.0 to 3.0m Quantity: 10 bags of 20 kg</p>
34					6		<p>SEAL Type: Bentonite Interval: 3.0 to 3.5m Quantity: 1.5 gal</p>
33					7		<p>SAND PACK Type: medium sand Interval: 3.5 to 14.7m Quantity: 80 kg Grain Size: 0.4-1.2 mm</p>
32					8		
31					9		
30							

Remarks: ▽ Ground-water level at completion of borehole 03/03/09 11.2m
 ▼ Ground-water level on
 ▲ Product level on

Note:

3924



US Army Corps
Of Engineers

MONITORING WELL LOG

WELL NO. **B09-181MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR:

DATE STARTED: **24 Feb 09**

FINISHED: **24 Feb 09**

DRILLER:

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **14.7 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **14.7 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,894.2** E: **446,674.8**

GROUND ELEV.: **39.78 m**

DATUM: **MSL**

GROUND COVER: **dirt**

TOP of WELL RISER CASING ELEV.: **39.71 m**

b6
b6

ELEVATION / DEPTH (meters)	WELL GRAPHIC	GRAPHIC LOG	USCS / STRATA	SAMPLE NUMBER	FIELD DATA	WELL CONSTRUCTION DETAILS
29 -11 28 -12 27 -13 26 -14					Depth (m) 11 12 13 14	

Remarks: ▽ Ground-water level at completion of borehole 03/03/09 11.2m
 ▼ Ground-water level on
 ▲ Product level on

Note:
39.25

MONITORING WELL LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/28/11



US Army Corps
Of Engineers

MONITORING WELL LOG

WELL NO. **B09-187MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: **[REDACTED]**

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: **[REDACTED]**

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **15.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **15.0 m**

WATER DEPTH: **[REDACTED]**

COORDINATES: N: **3,982,919.7** E: **446,661.6**

GROUND ELEV.: **39.80 m**

DATUM: **MSL**

GROUND COVER: **dirt**

TOP of WELL RISER CASING ELEV.: **39.75 m**

ELEVATION / DEPTH (meters)	WELL GRAPHIC	GRAPHIC LOG	USCS / STRATA	SAMPLE NUMBER	Depth (m)	FIELD DATA	WELL CONSTRUCTION DETAILS
							<p>PROTECTIVE CASING Diameter: 30 cm Type: Manhole Interval: -0.02 to 0.18m</p>
39.1		FILL		1	1	%Recovery = 50 PID = 10.4ppm	<p>WELL RISER CASING Diameter: 2 inch Type: Schedule 40 PVC Interval: -0.01 to 6.1m</p>
38.2		CL					
37.2		SM		2	2	%Recovery = 50 PID = 3.7ppm	<p>WELL SCREEN Diameter: 2 inch Type: 0.01 Slot Sch 40 Interval: 6.1 to 15.2m</p>
36.4							
35.5							<p>WELL POINT Type: Schedule 40 PVC Interval: 15.2 to 15.32m</p>
35.0							<p>CONCRETE PAD Diameter: 0.3m Interval: -0.05 to 0.15m</p>
34.0							<p>GROUT Type: Portland Type II Interval: 0.0 to 4.5m Quantity: 10 bags of 20 kg</p>
33.0							<p>SEAL Type: Bentonite Interval: 4.5 to 5.0m Quantity: 1.5 gal</p>
32.0							<p>SAND PACK Type: medium sand Interval: 5.0 to 15.2m Quantity: 80 kg Grain Size: 0.4-1.2 mm</p>
31.0							
30.0							

Remarks: ▽ Ground-water level at completion of borehole 03/03/09 5.81m

▽ Ground-water level on

▲ Product level on

Note:

3926

MONITORING WELL LOG 08-036E AREA 41 CARROLL.GPJ USACE SIKOREA.GDT 6/28/11



US Army Corps
Of Engineers

MONITORING WELL LOG

WELL NO. **B09-187MW**

Far East
District



PROJECT: **ESI/RE at Area 41 of Camp Carroll**

LOCATION: **Camp Carroll**

G&EE NO.: **08-036E**

INSPECTOR: [REDACTED] *66*

DATE STARTED: **26 Feb 09**

FINISHED: **26 Feb 09**

DRILLER: [REDACTED] *66*

DRILLING METHOD/EQUIPMENT: **Direct-Push**

DRILLING AGENCY: **Far East District**

HOLE DIAMETER: **5 cm**

TOTAL DEPTH: **15.0 m**

OVERBURDEN THICKNESS: **4.0 m**

DEPTH DRILLED: **15.0 m**

WATER DEPTH: _____

COORDINATES: N: **3,982,919.7** E: **446,661.6**

GROUND ELEV.: **39.80 m**

DATUM: **MSL**

GROUND COVER: **dirt**

TOP of WELL RISER CASING ELEV.: **39.75 m**

ELEVATION / DEPTH (meters)	WELL GRAPHIC	GRAPHIC LOG	USCS / STRATA	SAMPLE NUMBER	FIELD DATA Depth (m)	WELL CONSTRUCTION DETAILS
29 —11 28 —12 27 —13 26 —14 25 —15	<p>Filter Pack</p> <p>Well Screen</p> <p>Well Bottom Borehole Bottom</p>				11 12 13 14 15	

Remarks: ▽ Ground-water level at completion of borehole 03/03/09 5.81m
 ▼ Ground-water level on
 ▲ Product level on

Note:

3927

MONITORING WELL LOG 08-036E AREA 41 CARROLL.GPJ USACE SKOREA.GDT 6/23/11

Appendix III: Hydrologic Test Result



US Army Corps of Engineers

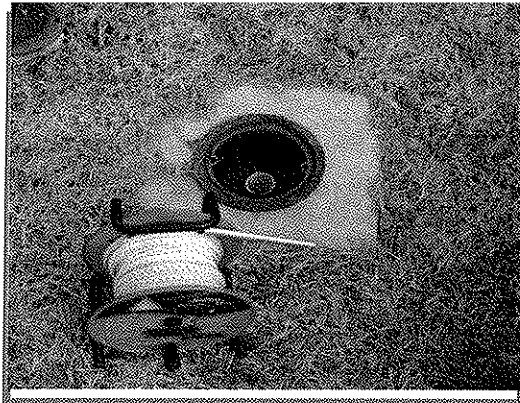
Far East District

Draft Final Report

FOR

TASK ORDER NO.0014

CAMP CARROLL REMEDIAL EVALUATION



Prepared for:

US Army Corps of Engineers, Far East District
Geotechnical and Environmental Engineering Branch
Unit #15546, APO AP 96205-5546

Contract # W912UM-07-D-0001
Task Order # 0014

Prepared by:



3929

Table of Contents

Section	Page
1. INTRODUCTION	2
1.1 Project Background	2
1.2 Project Progress	2
2. ANALYSIS METHOD	2
2.1 Slug test.....	2
2.2 Pumping test	4
3. ANALYSIS RESULT	5
3.1 Information of Monitoring Wells	5
3.2 Description for the slug test at Site.....	5
3.2.1 Area41	6
3.3 Description for the Pumping Test at Sites.....	7
3.3.1 Area41	7
3.4 Description for the Air permeability Test at Sites	11
3.4.1 Area41	11
3.5 Result.....	17
3.5.1 Slug test.....	17
3.5.2 Pumping test	17
3.5.3 Air permeability test	18

1. INTRODUCTION

1.1 Project Background

BEC has prepared this final report for the FED under contract NO. W912UM-07-D-0001, Task Order No.0014. This report summarizes the result to analyze for slug, pumping and air permeability test at Camp Carroll.

1.2 Project Progress

Field tests were performed in the camp Carroll during the period of 9 November, 2009 ~ 13 November, 2009(1st) and 22 February, 2010 ~ 25 February, 2010(2nd). Hydrologic field test was conducted at Area 41 of Camp Carroll such as slug, pumping, and air permeability tests. (Table 1).

2. ANALYSIS METHOD

2.1 Slug test

The slug test method involves the instantaneous injection or withdrawal of a volume or slug of water or solid cylinder of known volume. This is accomplished by displacing a known volume of water from a well and measuring the artificial fluctuation of the groundwater level. The primary advantages of using slug tests to estimate hydraulic conductivities are numerous. First, estimates can be made in-situ, thereby avoiding errors incurred in laboratory testing of disturbed soil samples. Second, tests can be performed quickly at relatively low costs because pumping and observation wells are not required. Lastly, the hydraulic conductivity of small discrete portions of an aquifer can be estimated (e.g., sand layers in a clay)(EPA,1994).

The most commonly used method for determining hydraulic conductivity in groundwater investigation is the Bouwer and Rice slug test shown schematic groundwater level drawdown zone through withdrawal of dummy(Hanmm et al, 2001).

Bouwer and Rice's expression for hydraulic conductivity (K) is:

$$K = \frac{r_c^2 \ln(R_e/R)}{2L_e} \frac{l}{T} \ln \frac{H_i}{H_0}$$

3931

Where:

K = hydraulic conductivity [ft/sec]

R_e = filter pack (borehole) radius [ft]

R = screen radius [ft]

r_c = casing radius [ft]

L_e = length of open screen (or borehole)[ft]

H_0 = drawdown at $t = 0$

H_t = drawdown at $t \geq H_0$

The simplest interpretation of piezometer recovery is that of Hvorslev(1951). The analysis assumes a homogenous, isotropic medium in which soil and water are incompressible(EPA,1994).

$$K = \frac{r^2 \ln(L/R)}{2L T_0} \quad \text{for } L/R > 8$$

Where:

K = hydraulic conductivity [ft/sec]

r = casing radius [ft]

L = length of open screen (or borehole)[ft]

R = filter pack (borehole) radius [ft]

T_0 = Basic Time Lag [sec]; value of t on semi-logarithmic

plot of $H-h/H-H_0$ vs. t , where $H-h/H-H_0 = 0.370$

H = initial water level prior to removal of slug

H_0 = water level at $t = 0$

h = recorded water level at $t > 0$

3932

2.2 Pumping test

The most reliable and commonly used method of determining aquifer characteristics is by controlled aquifer pumping tests. Groundwater flow varies in space and time and depends on the hydraulic properties of the rocks and the boundary conditions imposed on the groundwater system. Pumping tests provide results that are more representative of aquifer characteristics than those predicted by slug or bailer tests. Aquifer characteristics that may be obtained from pumping tests include hydraulic conductivity (K), transmissivity (T), specific yield (Sy) for unconfined aquifers, and storage coefficient (S) for confined aquifers(EPA,1994).

Pumping test is estimated by Cooper-Jacob method. The pumping curves were plotted drawdown as a function of the logarithm of elapsed time since pumping started. Employing the Jacob's Straight-Line method requires fitting a straight line through the straight section of the graph.

Pumping test is recorded the drawdown of well and pumping capacity. The drawdown (after start of pumping) and recovery (after stop of pumping) of the hydraulic head in the pumping well and surrounding monitoring wells are measured. Pumping capacity is constant that is recorded proper interval. Drawdown of well is recoded using DIVER and Interface meter.

Cooper-Jacob's expression for hydraulic conductivity (K) is:

$$T = \frac{2.3Q}{4\pi \Delta s} \quad S = \frac{2.25Tt_0}{r^2} \quad K = \frac{T}{b}$$

Where:

K = hydraulic conductivity [m/day]

T = transmissivity[m²/day]

Q = pumping capacity [m³]

Δs = Slope of the straight part of the drawdown on a semi-logarithmic graph (m)

T_0 = Basic Time Lag [sec]; value of t on semi-logarithmic

b = length of aquifer[m]

3933

3. ANALYSIS RESULT

3.1 Information of Monitoring Wells

Next is the information is performed at camp Carroll. The test is performed by in 9 Nov.~12 Nov and chosen one well that test is possible. The depth, natural groundwater level, radius, order of wells was checked before the test. Water level measured for time after injected the dummy using diver. If water level has been stable, withdrew the dummy so water level measured. Sometimes, rise up with diver when the dummy is withdrew that get tangled fixed each line of the dummy and diver in well. Also, water level after injected the dummy rose up more than natural groundwater level. It should pay attention to analysis of test result (Table 1).

Table 1. Information of slug test is performed wells

Site	Well No.	Time	Dummy	Well information			Remark	
				D ¹⁾ (m)	WR ²⁾ (mm)	NG ³⁾ (m)		
Area 41 (10 Nov.)	M03-471	1052	withdrawal	12.10	51	5.055	Diver rise up with dummy when it's withdrawal	
		1358	injection					
	M03-474	1415	withdrawal	15.40	51	5.065		
		1433	injection					
	M03-475	1445	withdrawal	15.00	51	10.635		
		1341	injection					
			1353	withdrawal				

1) well depth, 2) well radius, 3) natural groundwater level(blg)

3.2 Description for the slug test at Site

Slug test performed at the site. Generally, groundwater level showed a fluctuation by injection and withdrawal of dummy. Groundwater level data of withdrawal is less than a noise the groundwater level data of injection. Groundwater level had been stable within minutes beyond the stress(dummy). Some data of wells are distinct with other trend of wells. When the slug test analyzed the range of groundwater was assumed in the aquifer

The diagrams are plots of injection and withdrawal that slug test was performed each in the sites. Each plots of injection and withdrawal is the head (H/H₀) against the elapsed time. The Plots is drew the fitting line above interval which is consistent on head (H/H₀). The analysis for slug test needs the initial drawdown data of water level. Sometimes, the initial drawdown of water level have the noise of data to be different with general trend so the initial drawdown is selected by an analyst is based the hydrogeology. The slop(Δs) to need analysis can obtain from fitting line is drew on drawdown of water level.

3.2.1 Area41

The Slug test conducted B09-187(M03-474), B03-471 and B09-181(M03-475) in the Area41. The Groundwater level(blg) of MW(monitored wells) was checked from 5.06m to 10.64m and the depth of MW is from 12.10m to 15.40m.

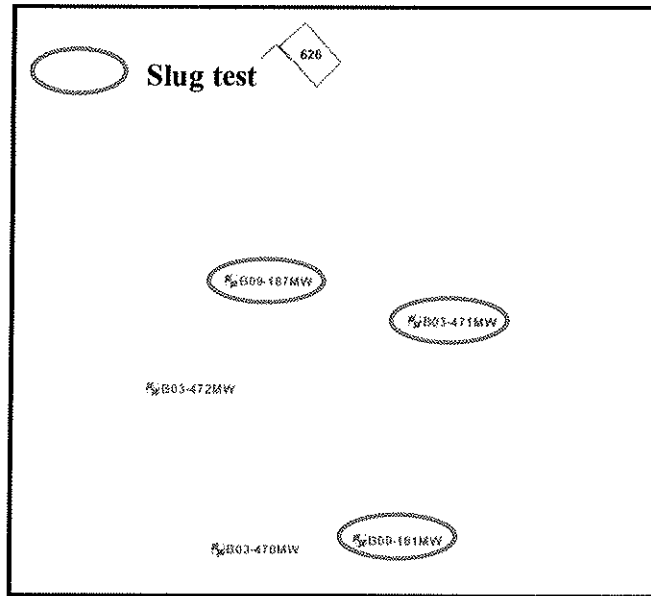
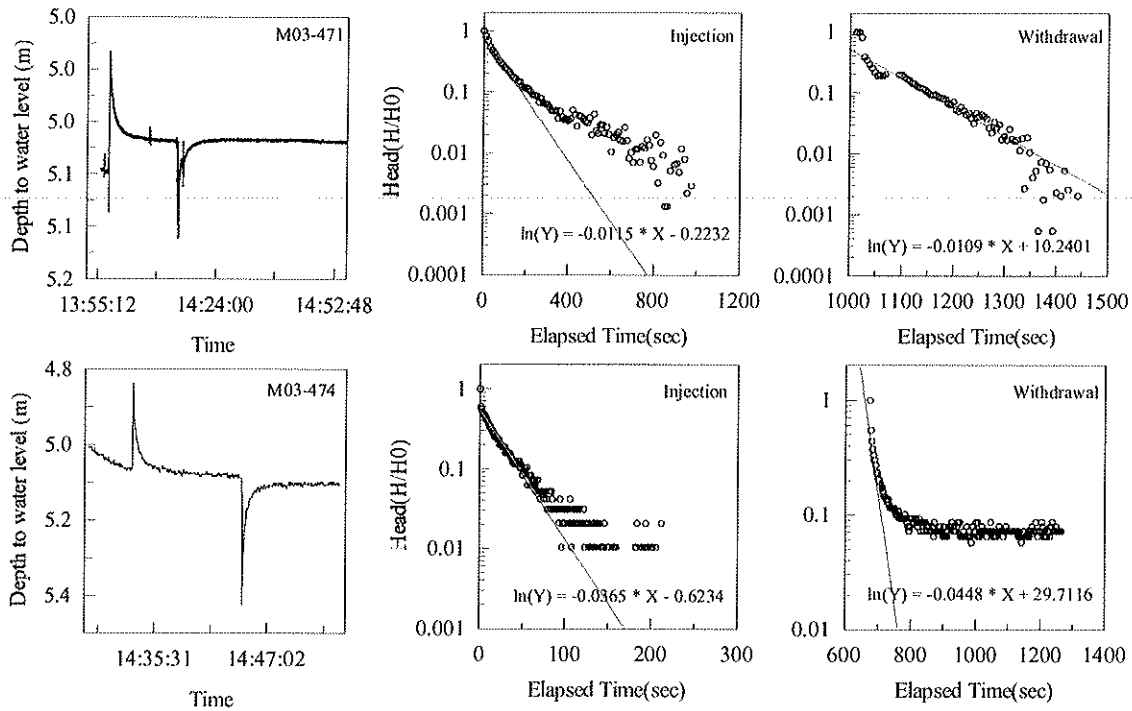


Figure 1 Location of Monitoring well conducted the slug test in the Area41



3935

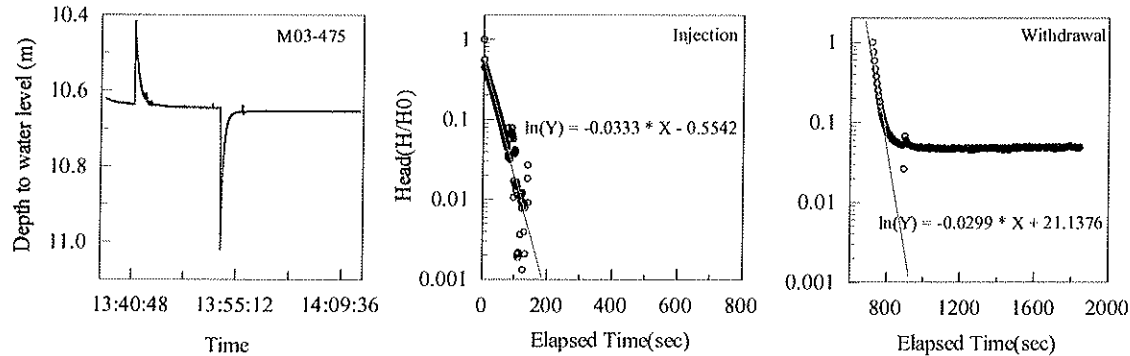


Figure 2 Curve-fitting results against elapsed time at constant slug tests in the Area41.

3.3 Description for the Pumping Test at Sites

Pumping test is performed at Area 41 of Camp Carroll (Table 1).

3.3.1 Area41

The pumping test was performed during the period of 25 February, 2010 ~ 26 February, 2010 (2nd). The pumping well is B07-187, the monitoring wells are MW1_B03-472, MW2_B03-470, MW3_B09-181 and MW4_B03-471. The start time of pumping is on Wednesday, Feb 25, at 11:48, stop time is on Thursday, Feb 25, at 20:28. The elapsed pumping time is about 8 hours. The pumping capacity is about 8.526 L/min.

Table 2. Information of pumping test wells performed in the Area41.

Well	No.	NG ¹⁾ (m)	D ²⁾ (m)	WD ³⁾ (m)	Note
PW	B07-187	5.36	14.88	-	
MW1	B03-472	11.21	14.50		start time
MW2	B03-470	11.17	13.15		16:31
MW3	B09-181	11.24	14.40		Stop time
MW4	B03-471	5.35	11.40		01:02

1) natural groundwater level (bgl), 2) well depth, 3) well distance

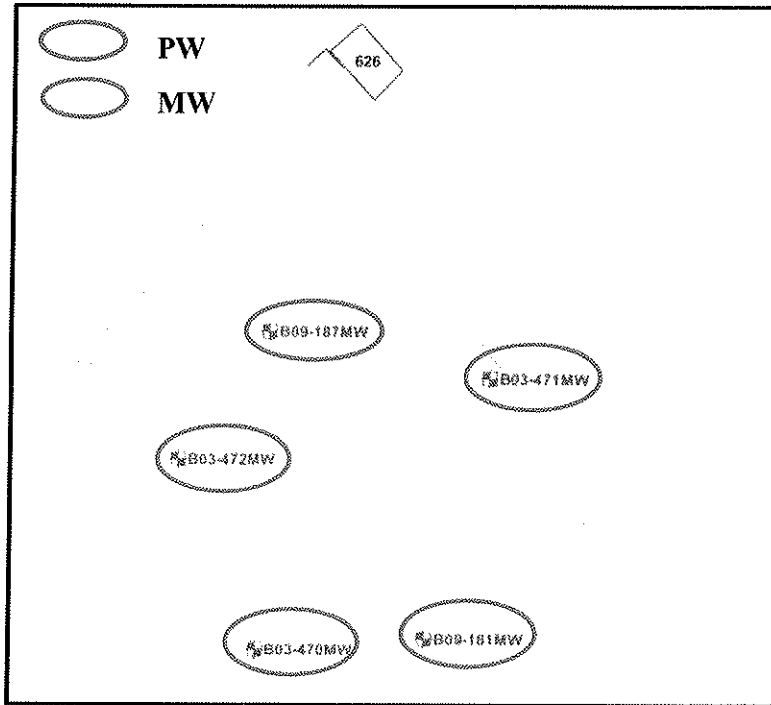
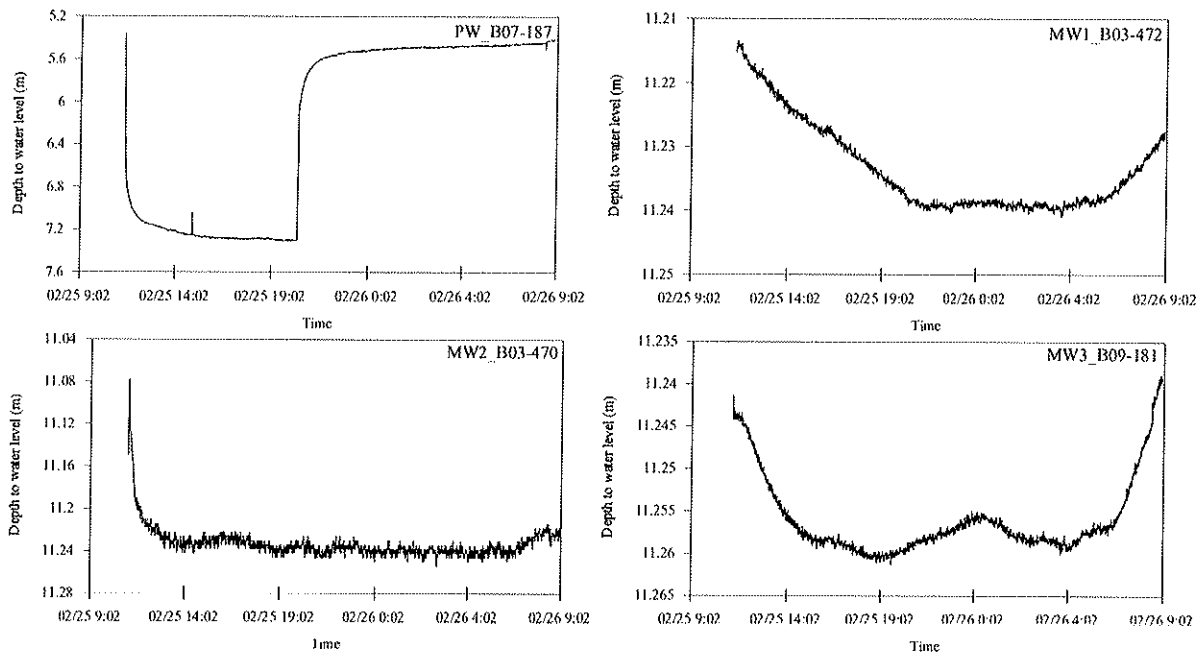


Figure 3 Location of Test wells conducted the Pumping test in the Landfarm.



3937

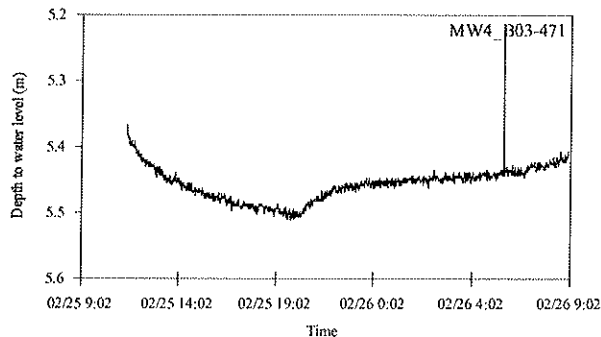
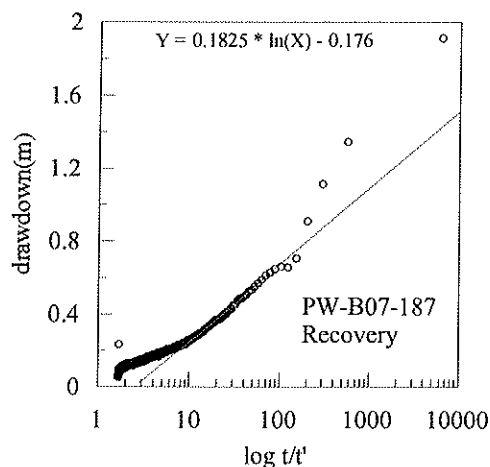
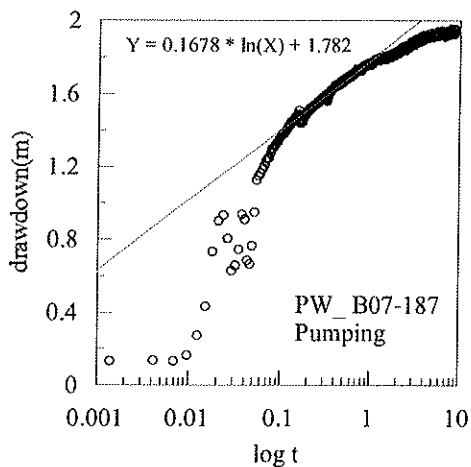


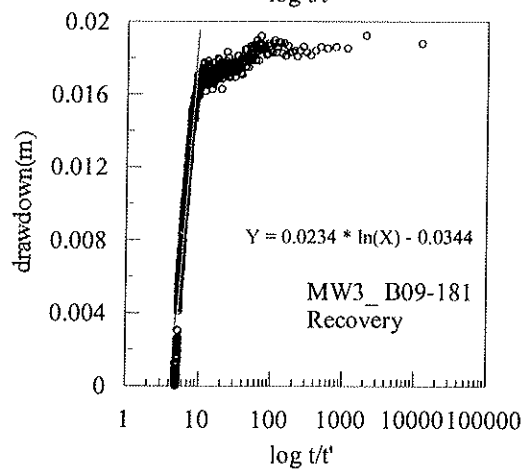
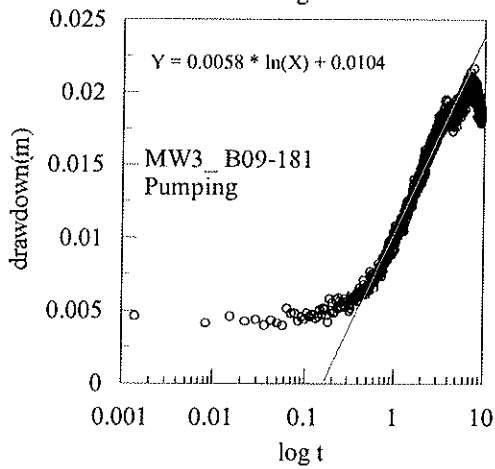
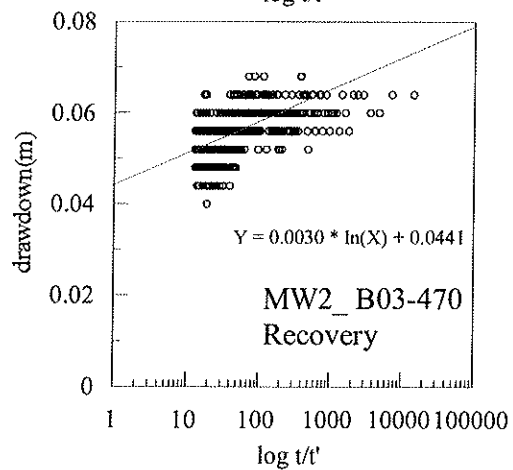
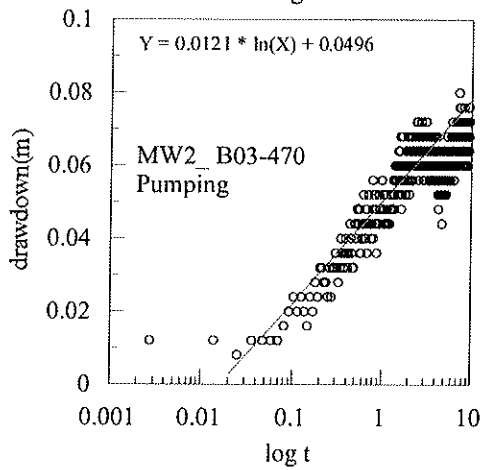
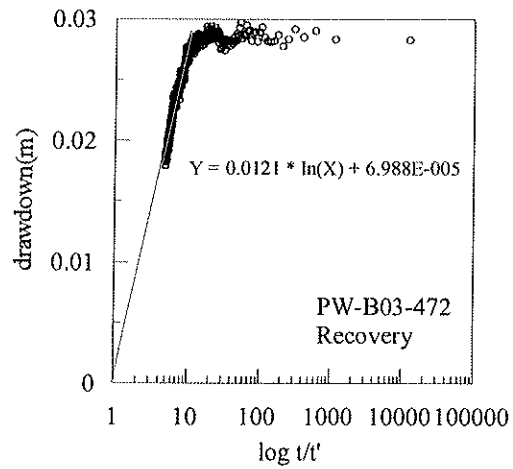
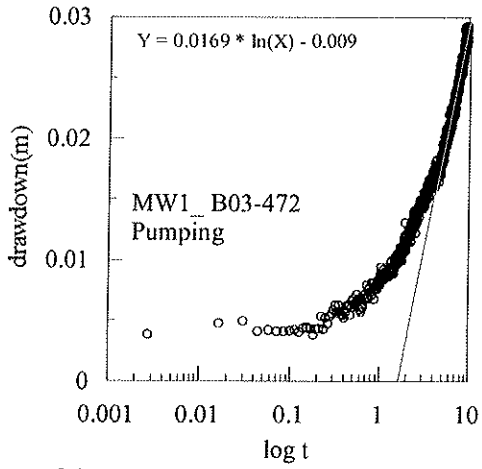
Figure 4 Diagram of elapsed time-depth to water level(blg) during pumping test in the Landfarm

Hydrogeological trend of groundwater level at each wells during pumping test. Groundwater level of B07-187 pumping well showed a fluctuation by pumping and recovery. Groundwater level drawdown of pumping well successfully cleared the general trend of the pumping well. MW1, MW3, MW is showed the response but not clear for start and stop by pumping.

Analysis of pumping test is calculated using Cooper-Jacob's method. The plots are the drawdown against the elapsed log-time. The slop (Δs) to be analyze is obtained with the fitting line on plots. The fitting line for pumping test has to consider the boundary effect in drawdown .



3938



3939

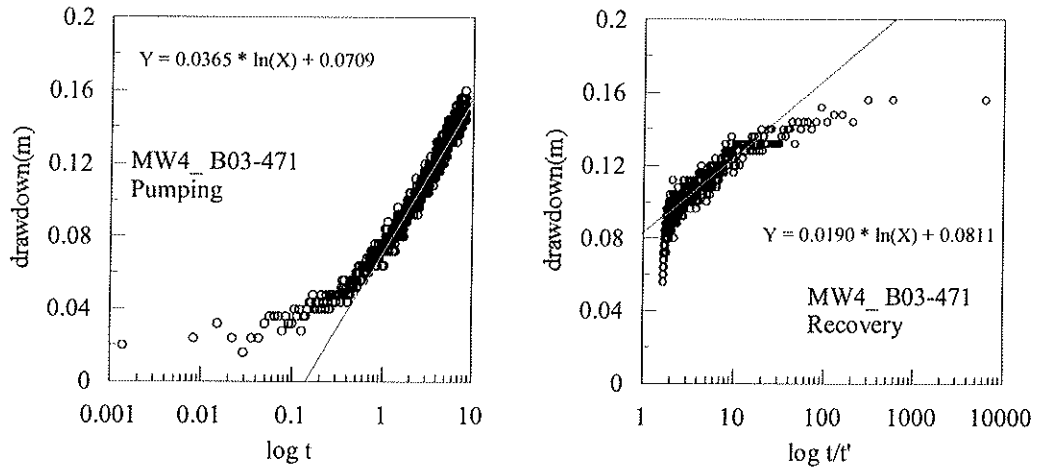
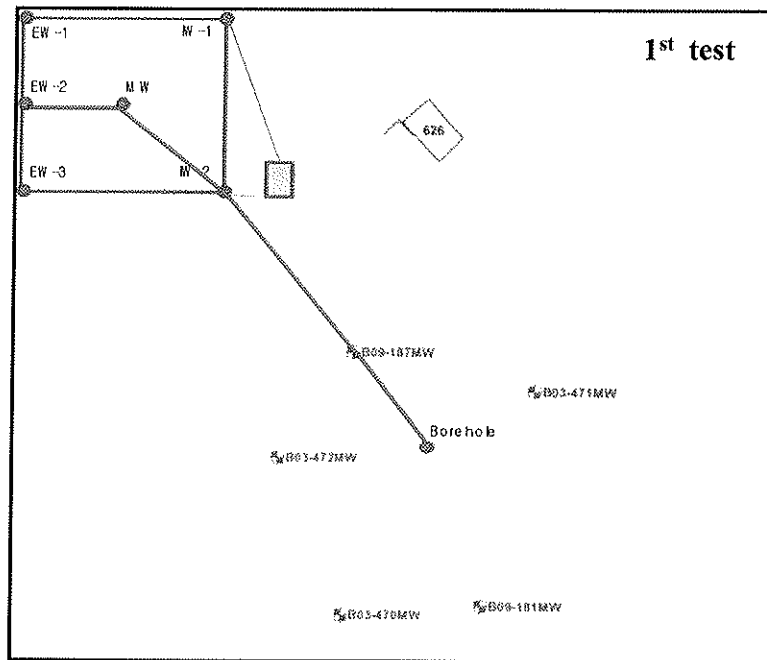


Figure 5 Curve-fitting results against elapsed log-time at constant pumping test in the Area41.

3.4 Description for the Air permeability Test at Sites

3.4.1 Area41



3940

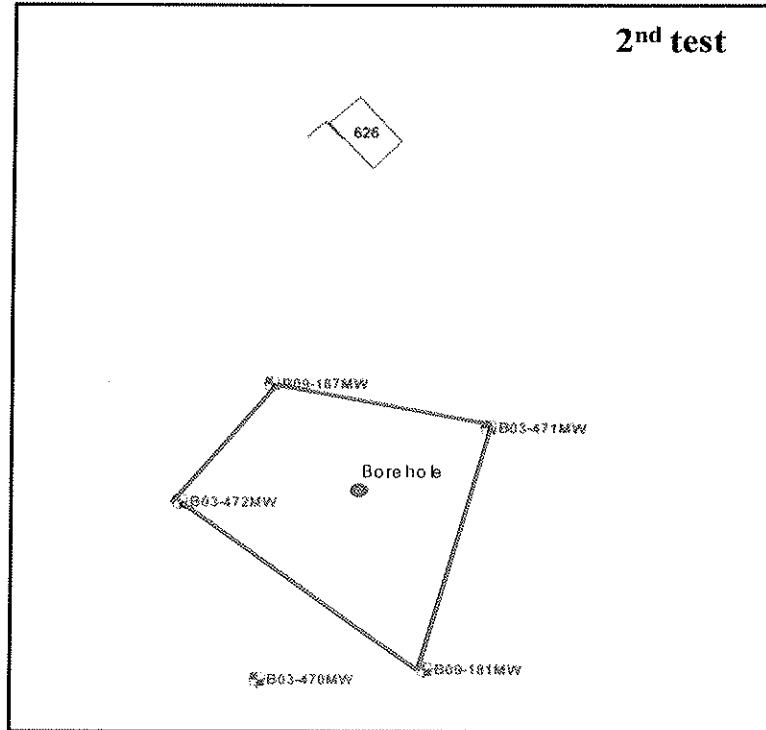


Figure 6 Location of Test wells conducted the 1st air permeability test in the Area41.

A series of air permeability test were conducted on 19 March 2010, to evaluate subsurface air flow patterns and radius of influence in adjacent to Area41 in the Camp Carroll. The layouts of the permeability test were determined based on the location of existing groundwater monitoring wells and the pre-installed air permeability test well. Figure 15 presents the well layout of 1st and 2nd air permeability tests at the project site at Area41.

Air permeability tests were conducted at five wells (as a set) consisting of one air extraction well and four observation wells. The extraction well was attached to a vacuum pump to control the air extraction rate. The extraction valves and measurement devices were securely attached and sealed at the top of each well pipe to prevent introducing any ambient air.

Upon starting the vacuum pump for subsurface air extraction, field measurement data was collected from both extraction and observation wells. During the entire air permeability test, the extraction vacuum was maintained at a constant rate and the monitoring wells' down pressure was monitored indications in change of pressure.

The 1st test was two times performed for total about 50 minutes, with air flow rate of each 20 / 30 cubic meters per hour. The extraction vacuum used during the test was about 10 ~ 30 kPa. Table 5 shows air permeability test well information in Area41. Figure 20~23 presents the observation results versus elapsed time.

The 2nd test was two times performed for total about 90 minutes, with an air flow rate of 30 cubic meters per hour. The extraction vacuum used during the test was about 30 kPa. Table 6 shows air permeability test well information in Area41. Figure 24~25 presents the observation results versus elapsed time.

Table 3. Information of 1st air permeability test wells performed in the Area41.

Classify	Well ID	Well Depth(m)	Water level (m)	Water column(m)	Distance (m)
Extraction well	MW	4.69	-	4.69	(standard)
Monitoring well 1	EW-2	4.77	-	4.77	2.60
Monitoring well 2	IW-2	4.05	-	4.05	3.47
Monitoring well 3	B09-187	15.52	5.04	10.48	16.30
Monitoring well 4	Bore hole	6.06	-	6.06	28.80

Table 4. Information of 2nd air permeability test wells performed in the Area41.

Classify	Well ID	Well Depth(m)	Water level (m)	Water column(m)	Distance (m)
Extraction well	Bore hole	6.06	-	6.06	(standard)
Monitoring well 1	B09-181	15.00	11.16	3.84	16.12
Monitoring well 2	B03-471	12.10	5.01	6.09	13.90
Monitoring well 3	B09-187	15.52	5.04	10.48	12.58
Monitoring well 4	B03-472	15.14	11.09	4.05	14.40

3942

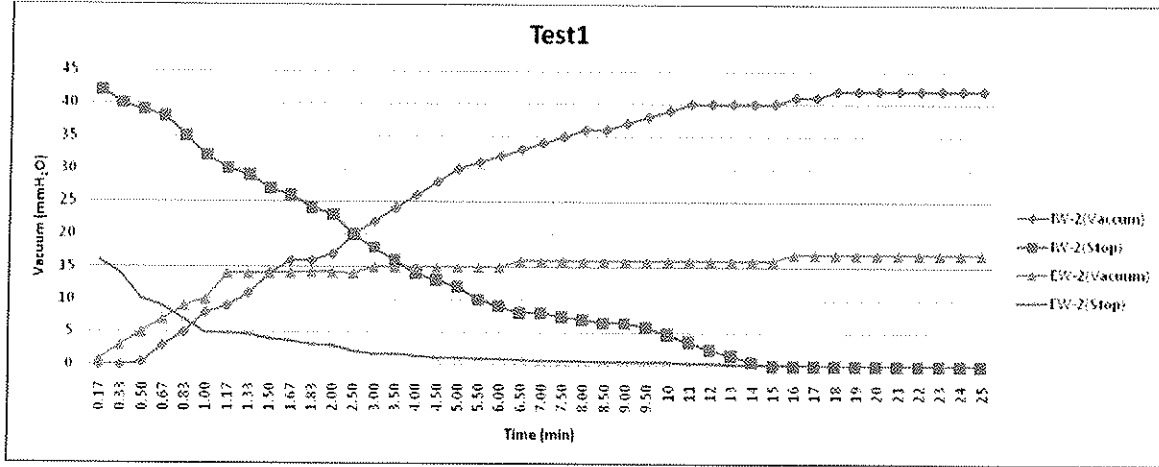


Figure 7 Observation results versus elapsed time at extraction flow rate 20 m³/hr

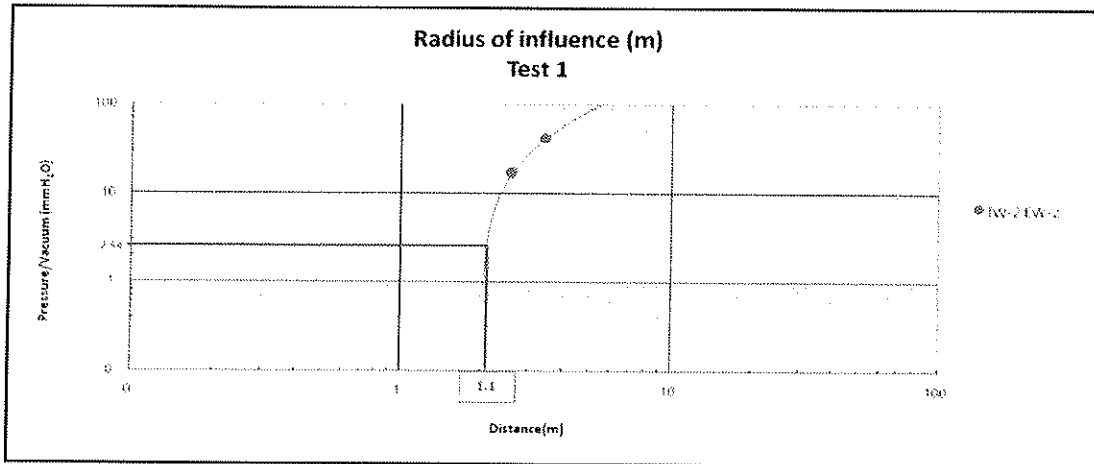


Figure 8 Radius of influence (ROI) at extraction flow rate 20 m³/hr

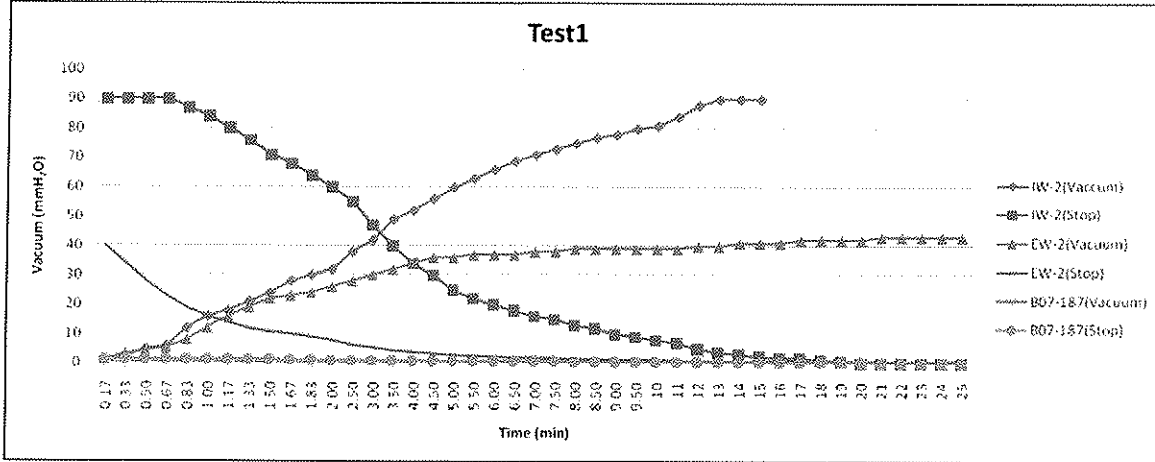


Figure 9 Observation results versus elapsed time at extraction flow rate 30 m³/hr

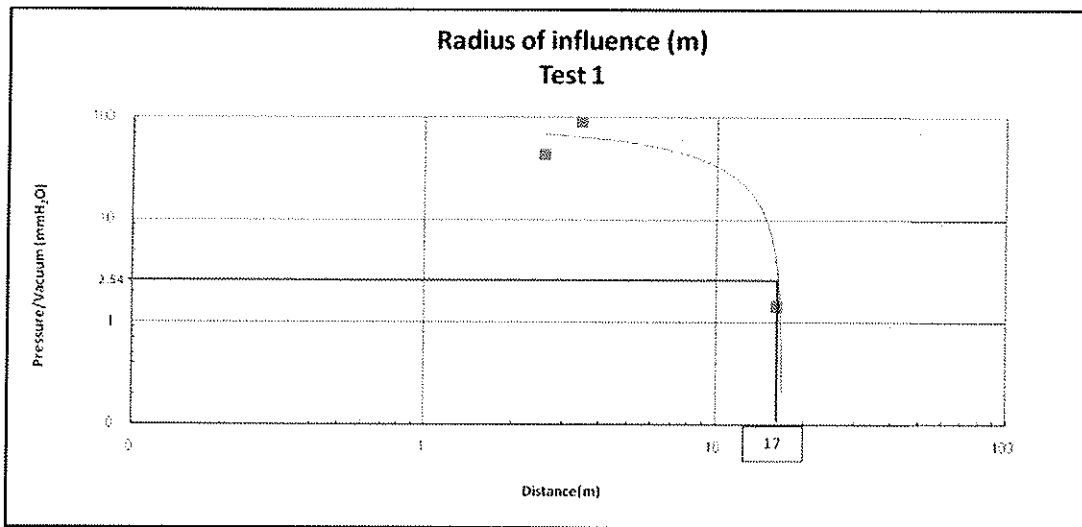


Figure 10 Radius of influence (ROI) at extraction flow rate 30 m³/hr

3944

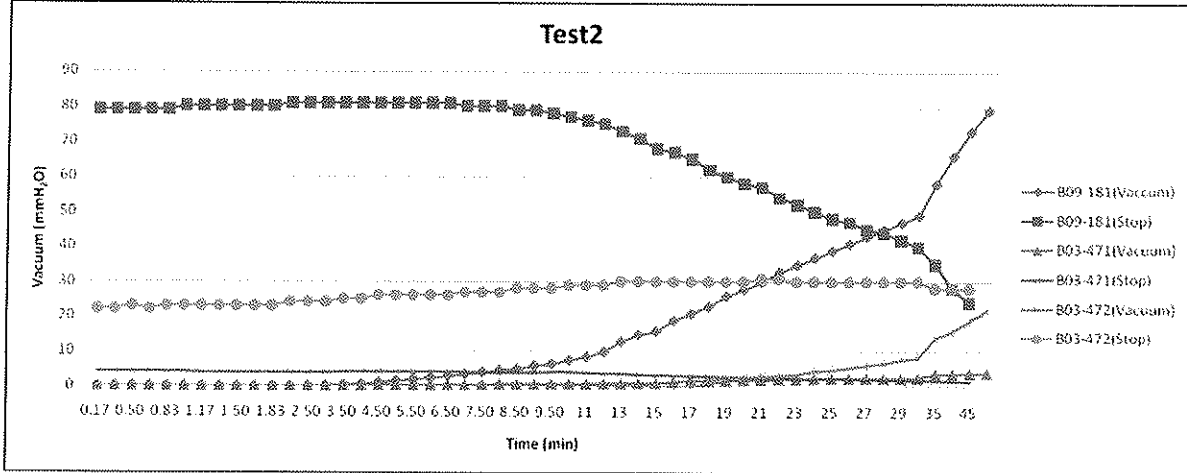


Figure 11 Observation results versus elapsed time at extraction flow rate 30 m³/hr

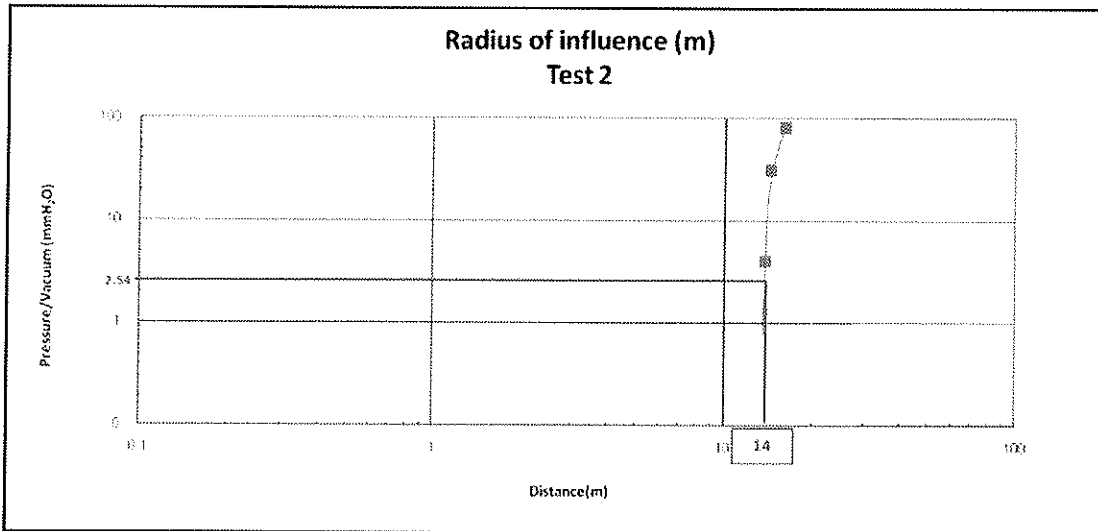


Figure 12 Radius of influence (ROI) at extraction flow rate 30 m³/hr

3945

3.5 Result

3.5.1 Slug test

The hydraulic conductivity(K) is calculated by the Hvorslev and the Bouwer & Rice methods ranges from 9.39E-06 cm/sec to 1.98E-03 cm/sec and from 8.42E-06 cm/sec to 1.76E-03 cm/sec. Average hydraulic conductivity(K) for slug tests were calculated using the Hvorslev/Bouwer&Rice methods to be;

- 1.02E-03 / 9.08E-04 cm/sec in the Area 41

Calculated results of the injection are greater than the withdrawal. In theory, hydraulic conductivity(K) have to be calculated the same value irrespective of injection and withdrawal of the slug. This is estimated a condition of the test apparatus or to be the skin effect around test wells(Lee et al., 1999, Ham et al.,2001). Also, calculated results using Horvslev method is a little differences with the Bouwer&Rice method. A correlation coefficient is 0.99 calculated results using between Horvslev method and the Bouwer&Rice method and it is nearly consistent.

Table 5 Hydraulic conductivity (K) estimated from the slug tests using the Horvslev and Bouwer & Rice method

Site	Well	Dummy	K(m/sec) (Hvorslev)	K(m/sec) (B& R)	K(m/day) (Hvorslev)	K(m/day) (B&R)	Average K (cm/sec) Hvorslev	Average K (cm/sec) B&R
	M03-471	injection	4.0E-06	3.4E-06	0.34739	0.29577	3.91E-04	3.33E-04
		withdrawal	3.8E-06	3.2E-06	0.32802	0.27927		
	M03-474	injection	9.3E-06	7.8E-06	0.80213	0.67675	1.03E-03	8.72E-04
		withdrawal	1.1E-05	9.6E-06	0.98479	0.83086		
Area 41	M03-475	injection	1.7E-05	1.6E-05	1.47763	1.38126	1.62E-03	1.52E-03
		withdrawal	1.5E-05	1.4E-05	1.32906	1.24238		
		withdrawal	1.3E-06	1.2E-06	0.11189	0.10548		
	B09-225	injection	4.2E-06	4.2E-06	0.36696	0.36308	4.19E-04	4.15E-04
		withdrawal	4.1E-06	4.1E-06	0.35765	0.35387		

3.5.2 Pumping test

The hydraulic conductivity(K) is calculated by the Cooper&Jacob's methods ranges from 1.56E-03 cm/sec to 2.73E-01 cm/sec in the Area41. Average hydraulic conductivity(K) for pumping tests were calculated using the Cooper&Jacob's methods to be;

- 8.73E-02 cm/sec in the Area41

3946

Calculated results of the pumping test were greater than general hydraulic conductivity(ex: case of silty sand is about $10^{-5} \sim 10^{-3}$). Except pumping well in each study areas, drawdown for most of monitoring well at pumping was within 10cm. It cannot be free from the effect with water level change by the atmospheric pressure.

Table 6 Hydraulic result estimated from the pumping tests using the Cooper&Jacob's method in Area 41

NO.	well	Maximum drawdown of WL(m)	Q (m ³ /day)	Slop (Δs)	T (cm ² /sec)	K (cm/sec)	Average K (cm/sec)	Storativity
Pumping well	B07-187 (pumping)	1.956	12.278	0.168	1.55	1.63E-03	1.56E-03	
	B07-187 (recovery)		12.278	0.183	1.43	1.50E-03		
Monitoring well 1	B03-472 (pumping)	0.031	12.278	0.017	15.4	4.68E-02	5.61E-02	3.78E-05
	B03-472 (recovery)		12.278	0.012	21.51	6.54E-02		
Monitoring well 2	B03-470 (pumping)	0.096	12.278	0.012	21.51	1.09E-01	2.73E-01	1.15E-07
	B03-470 (recovery)		12.278	0.003	86.74	4.38E-01		
Monitoring well 3	B09-181 (pumping)	0.022	12.278	0.006	44.87	1.42E-01	8.86E-02	2.04E-06
	B09-181 (recovery)		12.278	0.023	11.12	3.52E-02		
Monitoring well 4	B03-471 (pumping)	0.164	12.278	0.037	7.13	1.18E-02	1.72E-02	7.22E-07
	B03-471 (recovery)		12.278	0.019	13.7	2.26E-02		

3.5.3 Air permeability test

Table 11 shows the results of the air permeability test was calculated with the Hyperventilate program in Area41. An arbitrary point was selected on a coincident segment, W(u), u, gauge vacuum, and t were determined. With those values, k_a was thus determined.

$$a. \quad k_a = \{Q_v \mu\} / \{4\pi b (P - P_{atm})\}$$

Figure 10 shows the radius of influence (ROI) results of vacuum/pressure(mmH₂O) vs elapsed time. ROI is generally 1.5 m (clay) ~ 30 m (sand). The ROI for test1 was about 1.1 / 17m depending on gas flow rate which was approximately 20 / 30 cubic meters per hour. The ROI for test2 was about 14m depending on gas flow rate which was approximately 30 cubic meters per hour.

3947

Table 7 The results of the air permeability test was calculated with the Hyperventilate program

Test	Well ID	Pressure	K(darcy[A])	ROI(m)
Test1(20m ³ /hr) EW : MW	IW-2	vacuum	18.79028	1.1
		stop	-19.677898	
	EW-2	vacuum	65.849558	
		stop	-66.202391	
Test1(30m ³ /hr) EW : MW	IW-2	vacuum	12.247302	17
		stop	-12.213995	
	EW-2	vacuum	27.093349	
		stop	-38.411305	
	B09-187	vacuum	785.821223	
		stop	-355.308108	
Test1(30m ³ /hr) EW : Bore hole	B09-181	vacuum	26.490415	14
		stop	-36.785834	
	B03-471	vacuum	240.330929	
		stop	-375.123444	
	B03-472	vacuum	142.77886	
		stop	154.415329	

3948

Appendix IV: Project Data Quality Discussion

DATA QUALITY DISCUSSION.

1. Laboratory Quality Control (QC).

Laboratory QC consists of those procedures that a laboratory utilizes to verify that the entire analytical system is producing data of known quality. The contact laboratory utilized internal quality control procedures that are specified in the individual EPA test method. Neither laboratory reported difficulty with the sample analysis. The laboratory monitored internal quality through the use of matrix spikes (sample fortification with contaminants) and replicate analysis of selected extracts or digests. Laboratory reports were also reviewed by FED chemist (Dr. [REDACTED]) prior to develop the report.

2. Field QC Samples.

Field QC samples submitted to the laboratory in this project consists of trip blank and field duplicate samples for monitoring the quality of chemical data during the ESI/RE project sampling and shipments at Camp Carroll. Temperature blanks were also collected and placed into each ice cooler as same as for sample.

2.1. *Trip Blank (TB).*

Analysis of TB could be able to provide whether a sample bottle was contaminated during shipment from the manufacturer, while in bottle storage, in shipment to the laboratory, or during/after sample collection, or during analysis at lab. A total of eleven blank samples were provided by the contract lab to FED before sampling, and resubmitted to the lab together with soil and groundwater samples for VOCs analysis after sampling. A total of 6 VOC components, 2-Butanone, carbon disulfide, chloroform, chloromethane, toluene and methylene chloride were reported above the sample reporting limits. The reasons of detections in the trip blanks are not certain. Since the blanks have not been opened up in the field, the involvement of such chemicals could come from during blank sample preparation or from blank sample analysis together with samples. However, the level of contamination in the blanks are not significant compared to the sample test result and do not appear to be significant in the data quality and interpretation. Table I shows the analytical results for VOCs of TB.

2.2. *Duplicate samples.*

A total of three field duplicate samples were prepared and submitted to the laboratory to check the reproducibility of sampling and analytical results. The data for the duplicate samples should agree each other within certain permissible range. The duplicate samples reflect an indication of the laboratory precision (precise reproducibility) if the samples were well-mixed and homogenized before sampling. Agreement does not necessarily mean that the reported value is accurate, since the lab might have a systemic error. Data quality check was performed by a comparison of the chemical results from the sample duplicates. The data comparison is expressed as a Relative Percent Difference (RPD) using to compare how close the result is to the true value. When used with duplicate samples, the RPD measures precision: the lower the value is the more precise the results. It can also measure accuracy, when one of your results is the true value, such as the quality control lab results for a split sample, or the actual concentration of a known

or unknown sample. Table 2 shows the criteria established by the Corps of Engineers in determining the agreement between samples.

All duplicate chemical data were compared according to the RPD criteria, with an assumption of all the estimated values as actual detections. Table 3~4 presents the data comparison between the duplicate samples. Most of the data comparison fall into "AGREEMENT" category according to Table 2 or are not compared due to very low detection below the quantitation limit.

TABLE 1. CHEMICAL TEST RESULT FOR TRIP BLANK SAMPLES OBTAINED DURING REMEDIAL INVESTIGATION/FEASIBILITY STUDY AT CAMP CARROLL.

Component	Unit	Area 41							
		TB1	TB2	TB3	TB4	TB5	TB6	TB7	TB8
2-Butanone (MEK)	ug/L	-*	-	1.2J**	1.1J	-	-	0.42J	0.42J
Carbon disulfide	ug/L	-	-	-	0.44J	-	-	-	-
Chloroform	ug/L	1.9	1.9	0.66J	0.54J	0.66J	1.9	-	-
Chloromethane	ug/L	0.42J	0.34J	1	-	-	0.42J	-	-
Methylene chloride	ug/L	1.1	1.1	12	10	14	1.6	1.8	2.4
Toluene	ug/L	12	7.2	2.1	1.5	14	18	11	7
*- non detected. ** the value is an estimation and the result is below the reporting limit.									

TABLE 2. CRITERIA FOR COMPARING FIELD, QC, AND QA SAMPLE DATA.

Matrix	Parameter	Disagreement	Major Disagreement
All	All	>5x difference when one result is < DL	>10x difference when one result is < DL
All	All	>3x difference when one result is < LRL	>5x difference when one result is < LRL
Water	All except TPH	>2x difference	> 3x difference
Soil	All except metals, VOCs, BTEX, and TPH	>4x difference	>5x difference
Soil	Metals	>2x difference	>3x difference
Water and Soil	TPH	Arbitrary (suggest >3x difference)	Arbitrary (suggest >5x difference)
Soil	VOCs and BTEX	Arbitrary (suggest >5x difference)	Arbitrary (suggest >10x difference)

DL: Laboratory Detection Limit

QL: Quantitation Limit, the lowest level of the analyte that can accurately be determined.

2X difference is equivalent to an RPD of 67%; 3X 100%; 5X 133%; 10X 167%

Reference: CRREL Special Report No. 96-9, "Comparison Criteria for Environmental Chemical Analyses of Split Samples Sent to Different Laboratories - Corps of Engineers Archived Data", Grant, C.G., Jenkins, T.F., and Mudambi, A.R., USACE Cold Regions & Environmental Research Laboratory, Hanover NH, May 1996.

The above criteria shall be applied when comparing field and QC sample pair data, as well as when comparing project and QA sample pair data. With the exceptions of volatile organic compounds (VOCs) in soil; and benzene, toluene, ethylbenzene, and xylenes (BTEX) in soil; and of total petroleum hydrocarbons (TPH) in either water or soil, the above criteria will be used for all data comparisons. There is no definitive data for establishing comparison criteria for TPH (in water or soils) because of the wide variety of method modifications used by laboratories in the SW-846 8015M method ("M" is for "Modified"). The same is true for VOC and BTEX in soils because of the large potential for introducing error during the conventional sample handling process. Result pairs are considered to disagree whether they are in the "Disagreement" or "Major Disagreement" category.

From: Chemical Quality Assurance for HTRW Projects, Engineer Manual EM 200-1-6

3952

TABLE 3. FIELD SOIL DUPLICATE SAMPLE COMPARISON RESULT FOR VOCS. ACCORDING TO THE TABLE 2 GUIDANCE. THE DISAGREEMENT IN VOCS IS LIKELY DUE TO SAMPLING PROCEDURE.

Component (ug/kg)	B09-184		B09-186		B09-184	B09-186
	S1		S3		RPD***	RPD
Acetone	1300B*	1100B	-**	-	NA****	NA
n-Butylbenzene	-	-	110	120	NA	9%
sec-Butylbenzene	-	-	83	96	NA	15%
Chloro form	-	-	-	-	NA	NA
Chloromethane	-	-	-	9.9J	NA	NA
cis-1,2-Dichloroethene	29J*****	25J	24J	29J	NA	NA
Ethylbenzene	-	-	70	55J	NA	NA
Isopropylbenzene	-	-	32J	27J	NA	NA
p-Isopropyltoluene	-	-	44J	44J	NA	NA
Methylene chloride	120	98	-	-	20%	NA
Naphthalene	-	-	35J	31J	NA	NA
n-Propylbenzene	-	-	74	64	NA	14%
1,1,2,2-Tetrachloroethane	-	-	-	-	NA	NA
Tetrachloroethene	300	240	1100	1100	22%	0%
Toluene	-	-	43J	13J	NA	NA
1,2,3-Trichlorobenzene	-	-	-	-	NA	NA
Trichloroethene	27J	18J	34J	28J	NA	NA
1,2,4-Trimethylbenzene	-	-	640	680	NA	6%
1,3,5-Trimethylbenzene	-	-	150	160	NA	6%
m-Xylene & p-Xylene	-	-	220	180	NA	20%
o-Xylene	-	-	160	130	NA	21%
*-.The analyte found in a blank associated with the sample. **- not detected						
*** Relative percent difference, **** RPD calculation was NOT APPLICABLE, *****- Estimated result. Result is less than reporting limit.						

3953

TABLE 4. FIELD SOIL DUPLICATE SAMPLE COMPARISON RESULT FOR OC-PESTICIDE. RPD IS ACCORDING TO THE TABLE 2 GUIDANCE.

Component (ug/kg)	B09-184		
	S1		RPD*
alpha-BHC	-	-	NA**
gamma-BHC (Lindane)	-	-	NA
Heptachlor	-	-	NA
Aldrin	-	-	NA
beta-BHC	-	-	NA
delta-BHC	-	-	NA
Heptachlor epoxide	-	-	NA
Endosulfan I	-	-	NA
gamma-Chlordane	-	-	NA
alpha-Chlordane	-	-	NA
4,4'-DDE	1.7	1.8 J	NA
Dieldrin	-	-	NA
Endrin	- J	-	NA
4,4'-DDD	0.43	0.64 J	NA
Endosulfan II	-	-	NA
4,4'-DDT	0.55J	0.89 J	NA
Endrin aldehyde	-	-	NA
Methoxychlor	- J	-	NA
Endosulfan sulfate	-	-	NA
Toxaphene	-	-	NA
Chlordane (technical)	-	-	NA
J- Estimated result. Result is less than reporting limit.			
* Relative percent difference, ** RPD calculation was NOT APPLICABLE.			

3954