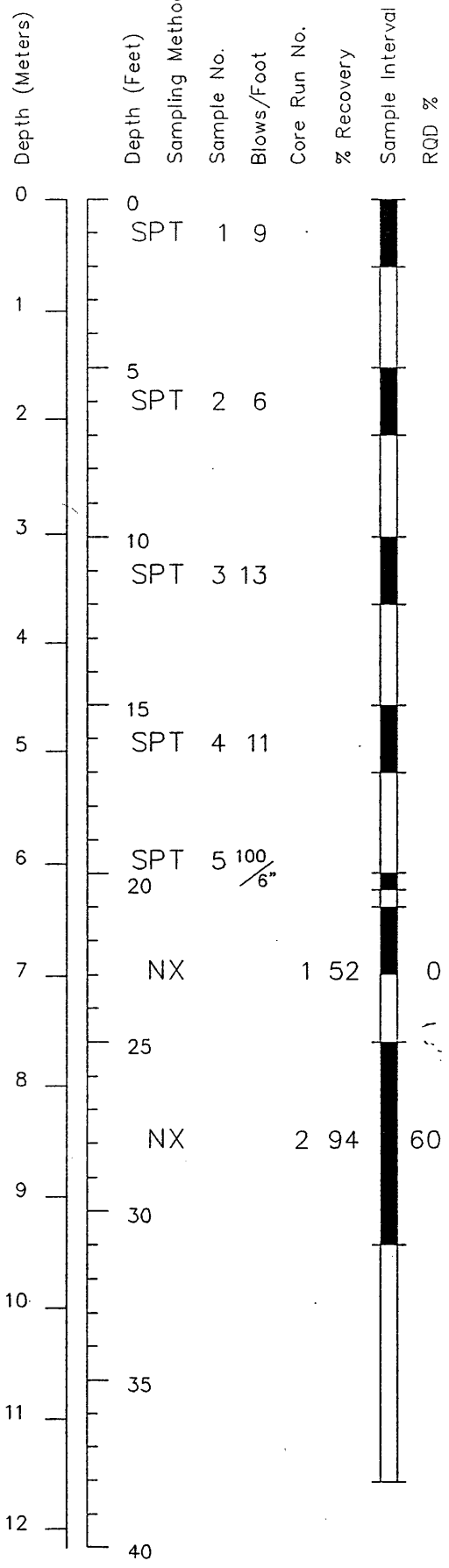
BORING 13MW2

Location: Radford AAP, Virginia
Surface Elevation: 1701.2 Feet, MSL
Start: 07:44 on 8-26-91
Finish: 12:00 on 8-26-91



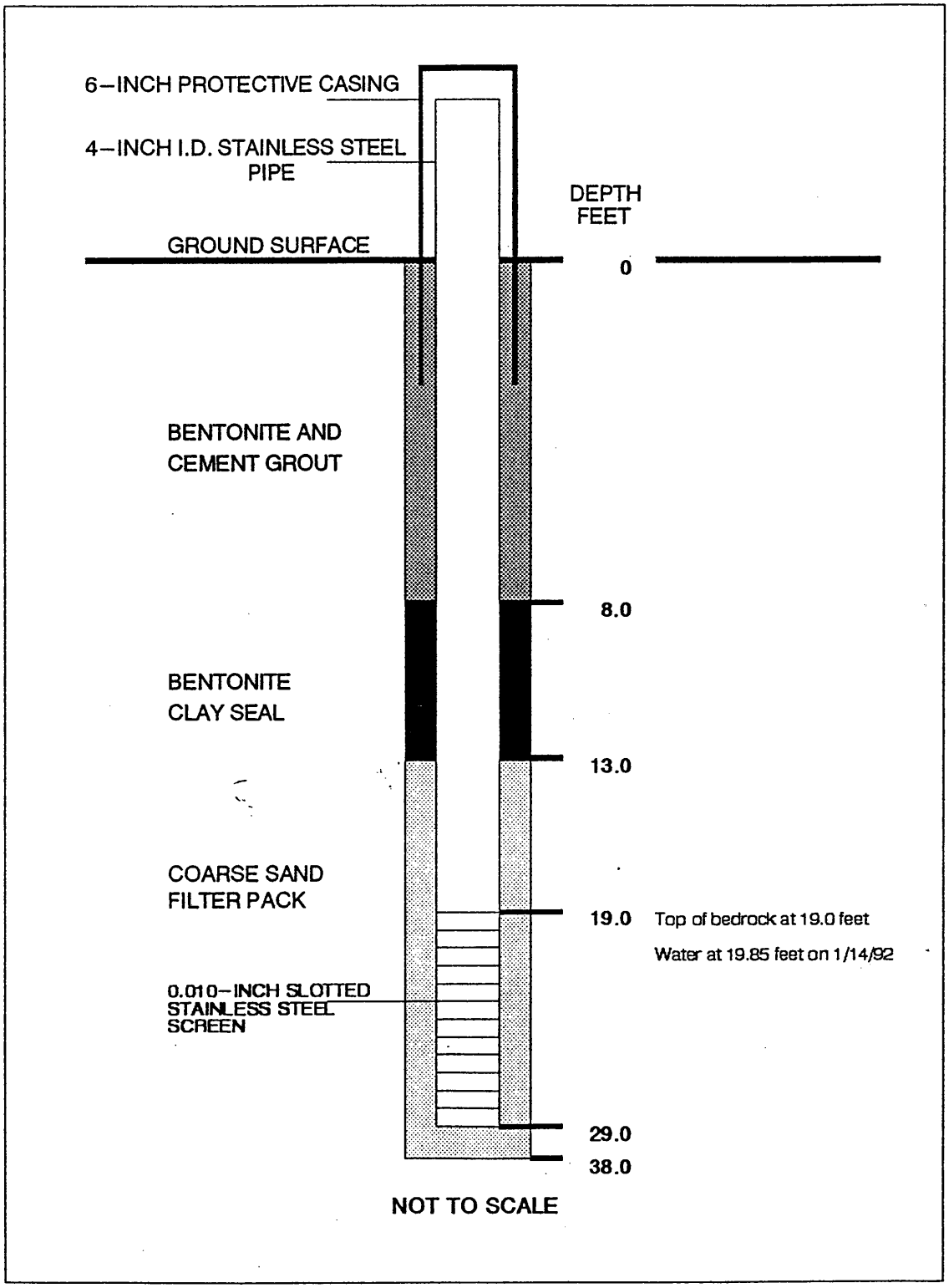
Symbols	Description
ML	DUSKY RED (2.5YR 3/2) SILT, MICACEOUS, MOIST
	GRADED CONTACT
SC/CL	DARK BROWN (7.5YR 4/4) SANDY CLAY WITH CLAY SEAMS
	GRADES TO DARK REDDISH BROWN (5YR 3/3) SILTY CLAY, MICACEOUS
	GRADED CONTACT
ML	REDDISH BROWN (5YR 4/3) CLAYEY SILT WITH FINE SAND, MICACEOUS, MOIST
	GRADED CONTACT
SM	DARK YELLOWISH BROWN (10YR 4/4) SILTY FINE SAND, MICACEOUS
	THIN LIMESTONE SEAM AT 16.8 FEET
	WEATHERED BEDROCK CONTACT AT 19.0 FEET
LS	DARK GRAY LIMESTONE WITH HORIZONTAL FRACTURES
	VERY FRACTURED SEAM
	NO RECOVERY 23.0 TO 25.6 FEET, MAYBE CLAY SEAM. LOST CORING WATER, POSSIBLE WATER TABLE
	DARK GRAY THINLY BEDDED LIMESTONE WITH ORANGE OXIDIZED SEAMS
	BECOMING RECEMENTED BRECIATED LIMESTONE
	WITH THIN CLAY SEAM
	OXIDIZED SEAMS LESS FREQUENT
	AIR ROTARY DRILL WITHOUT CORING BELOW 31.0 FEET
	BOREHOLE TERMINATED AT A DEPTH OF 38.0 FEET

LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR RCRA FACILITY INVESTIGATION
RADFORD AAP, VIRGINIA

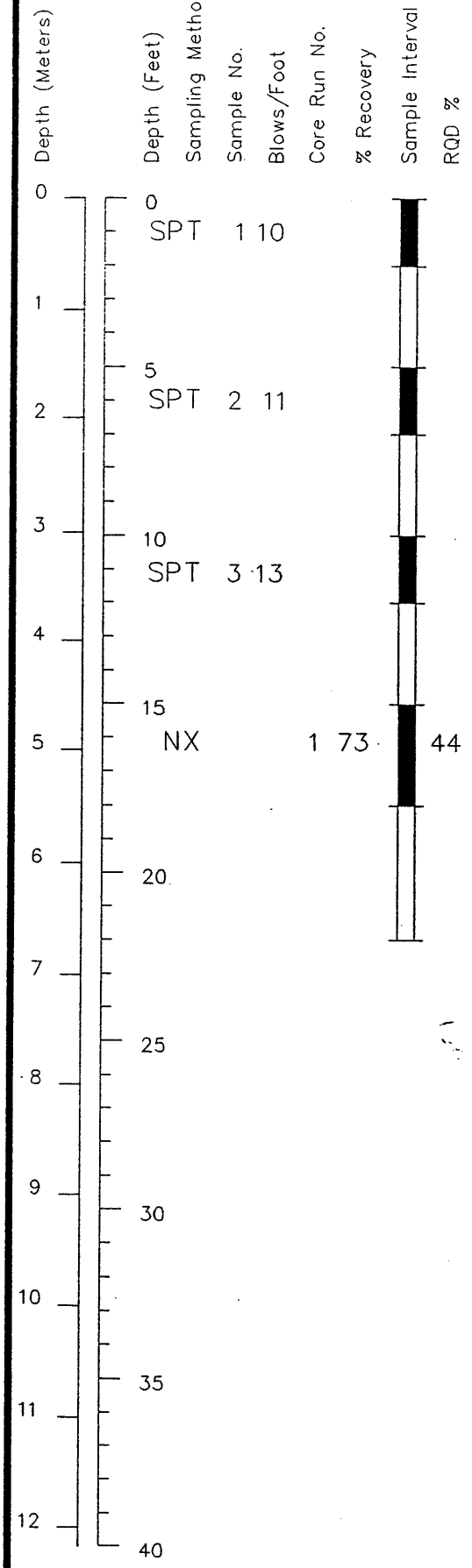
Location: 13MW2
Installation Date: 8/29/91
Surface Elevation: 1701.2 Feet
Top of SS Elevation: 1702.62 Feet



Dames & Moore

BORING 13MW3

Location: Radford AAP, Virginia
Surface Elevation: 1693.4 Feet, MSL
Start: 07:58 on 8-27-91
Finish: 11:27 on 8-27-91



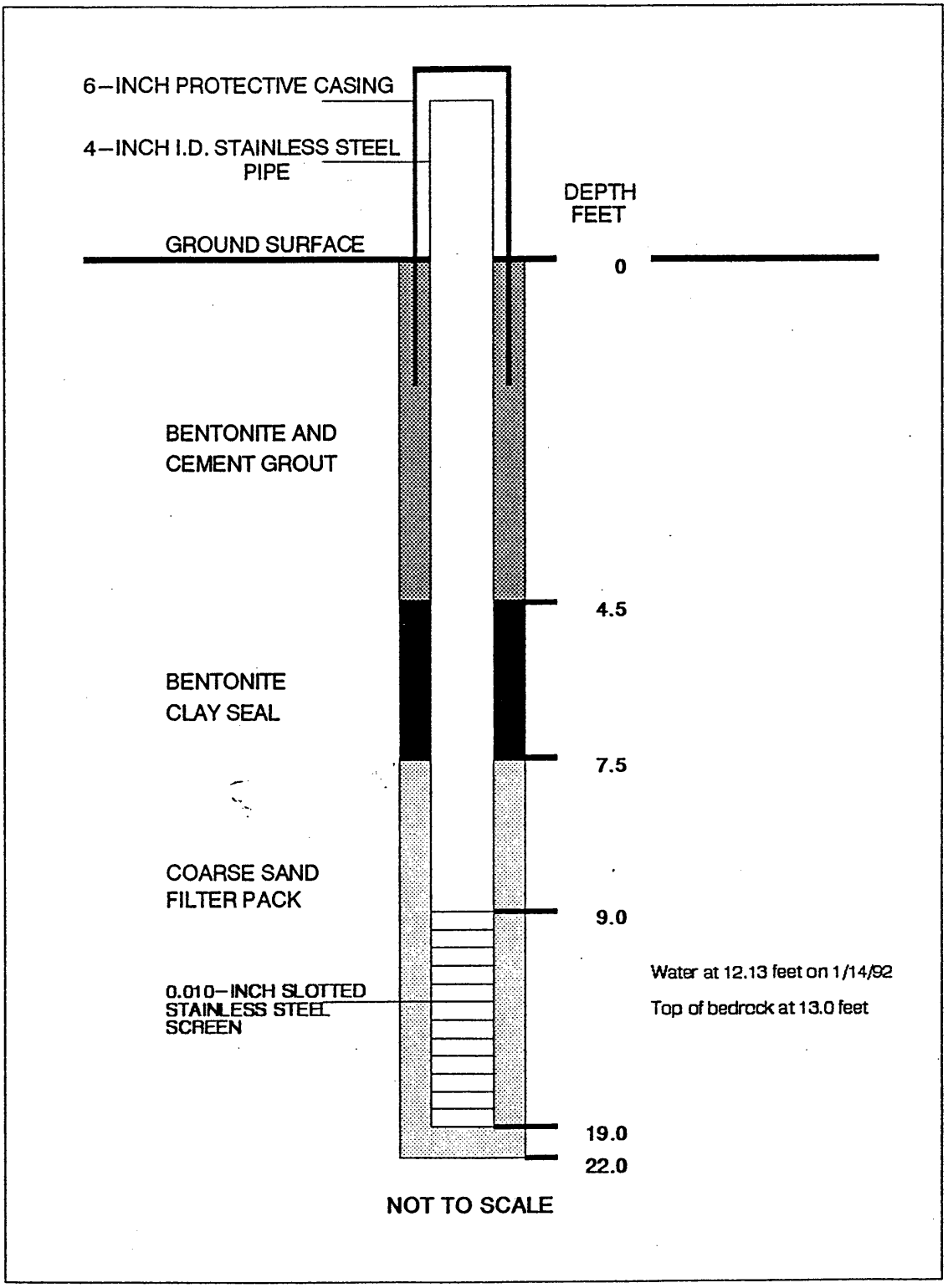
Symbols	Description
ML	DARK GRAYISH BROWN (10YR 3/2) SILT
SM	DARK GRAYISH BROWN (10YR 3/2) SILTY FINE SAND WITH SAND SEAMS, MOIST
	GRADES TO DARK BROWN (7.5YR 3/4) FINE SAND
SP	DARK BROWN (7.5YR 3/4) MEDIUM TO COARSE SAND WITH SOME GRAVEL AND TRACE SILT, MOIST
GP	GRAVELS AND COBBLES, MOIST TO WET
	WEATHERED BEDROCK AT 13.0 FEET, WET
LS	LIGHT GRAY AND GRAY SHALY LIMESTONE WITH BRECIATED SEAMS, WITH CALCITE VEINS
	GRADES TO HARD LIMESTONE WITH CALCITE
	AIR ROTARY DRILL WITHOUT CORING BELOW 18.0 FEET
	BOREHOLE TERMINATED AT A DEPTH OF 22.0 FEET

LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR RCRA FACILITY INVESTIGATION
RADFORD AAP, VIRGINIA

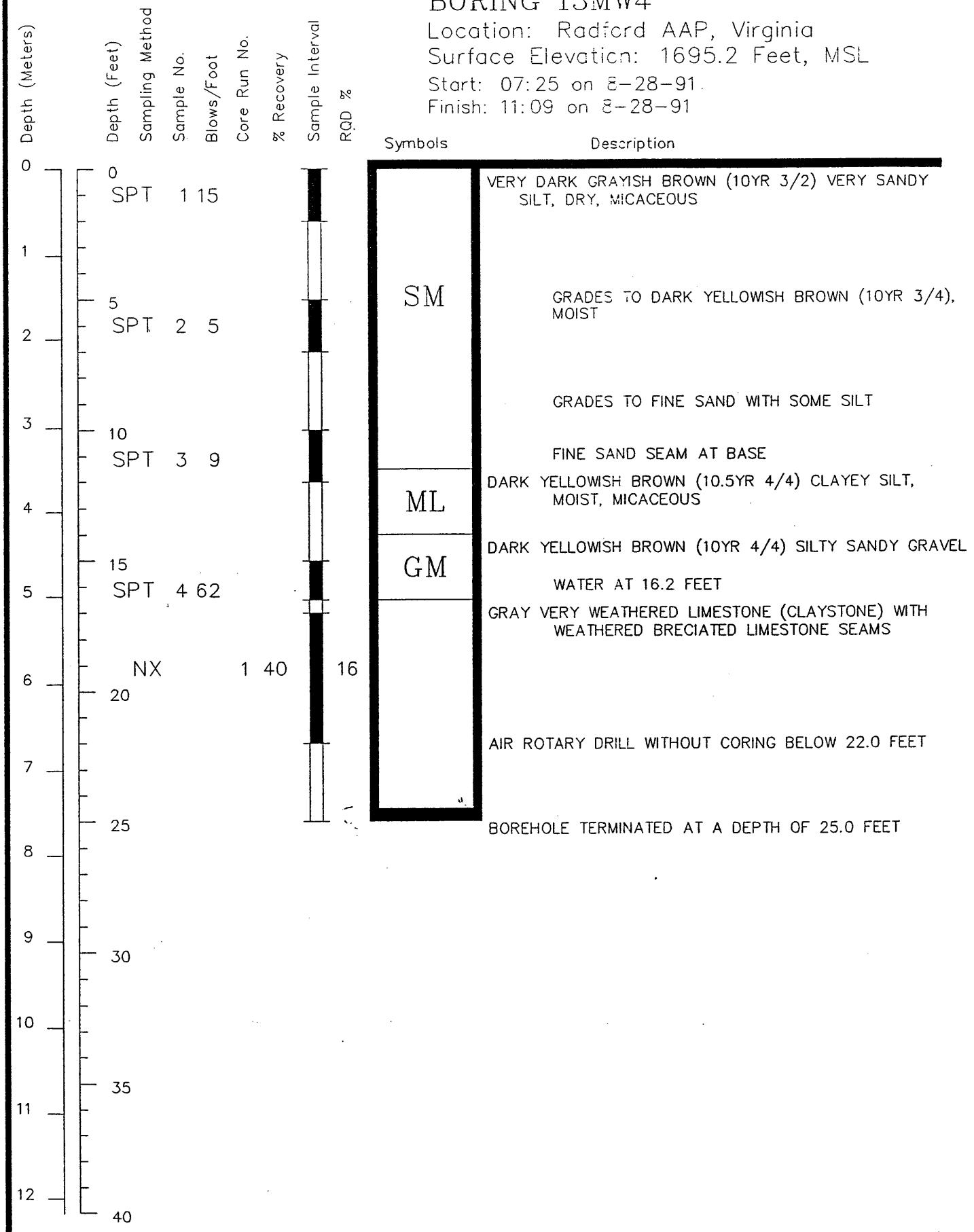
Location: 13MW3
Installation Date: 8/27/91
Surface Elevation: 1693.4 Feet
Top of SS Elevation: 1694.47 Feet



Dames & Moore

BORING 13MW4

Location: Radford AAP, Virginia
Surface Elevation: 1695.2 Feet, MSL
Start: 07:25 on 8-28-91
Finish: 11:09 on 8-28-91

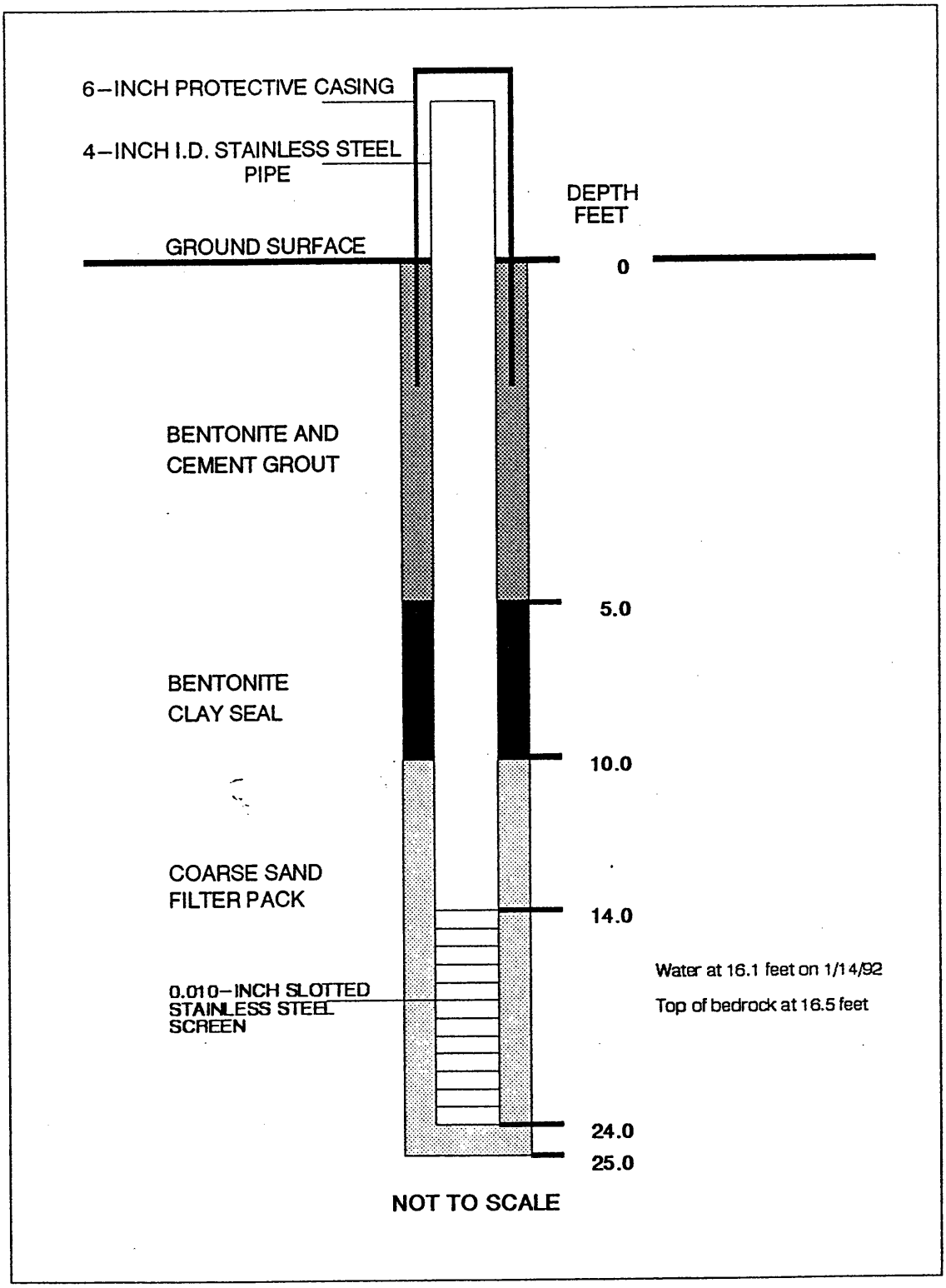


LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR RCRA FACILITY INVESTIGATION
RADFORD AAP, VIRGINIA

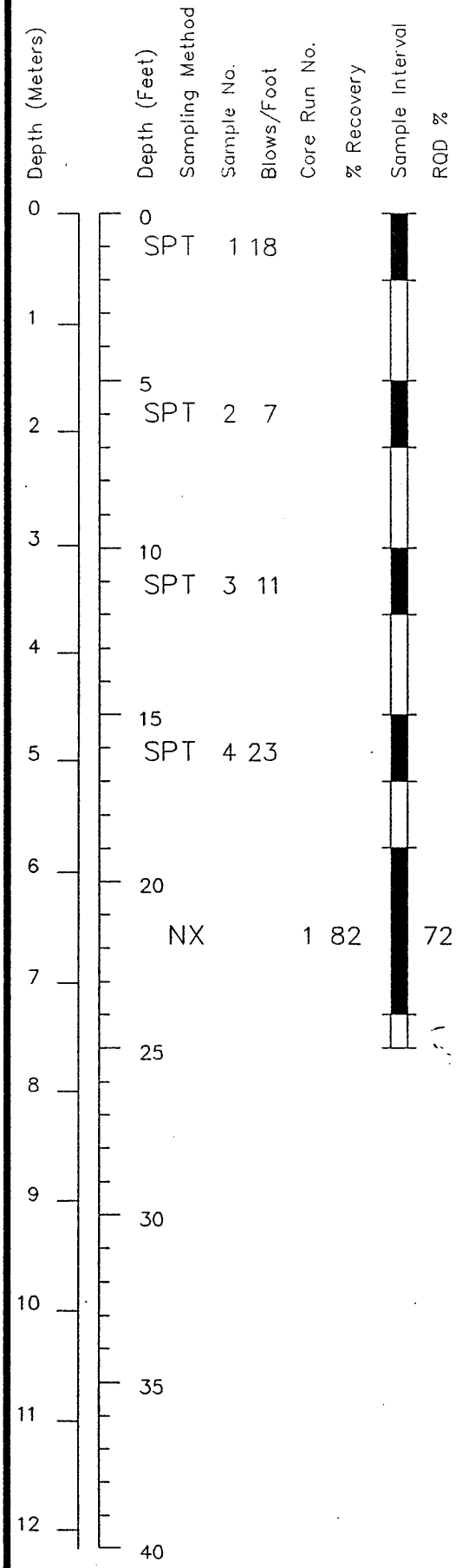
Location: 13MW4
Installation Date: 8/28/91
Surface Elevation: 1695.2 Feet
Top of SS Elevation: 1696.40 Feet



Dames & Moore

BORING 13MW5

Location: Radford AAP, Virginia
Surface Elevation: 1695.3 Feet, MSL
Start: 07:44 on 8-23-91
Finish: 10:53 on 8-23-91



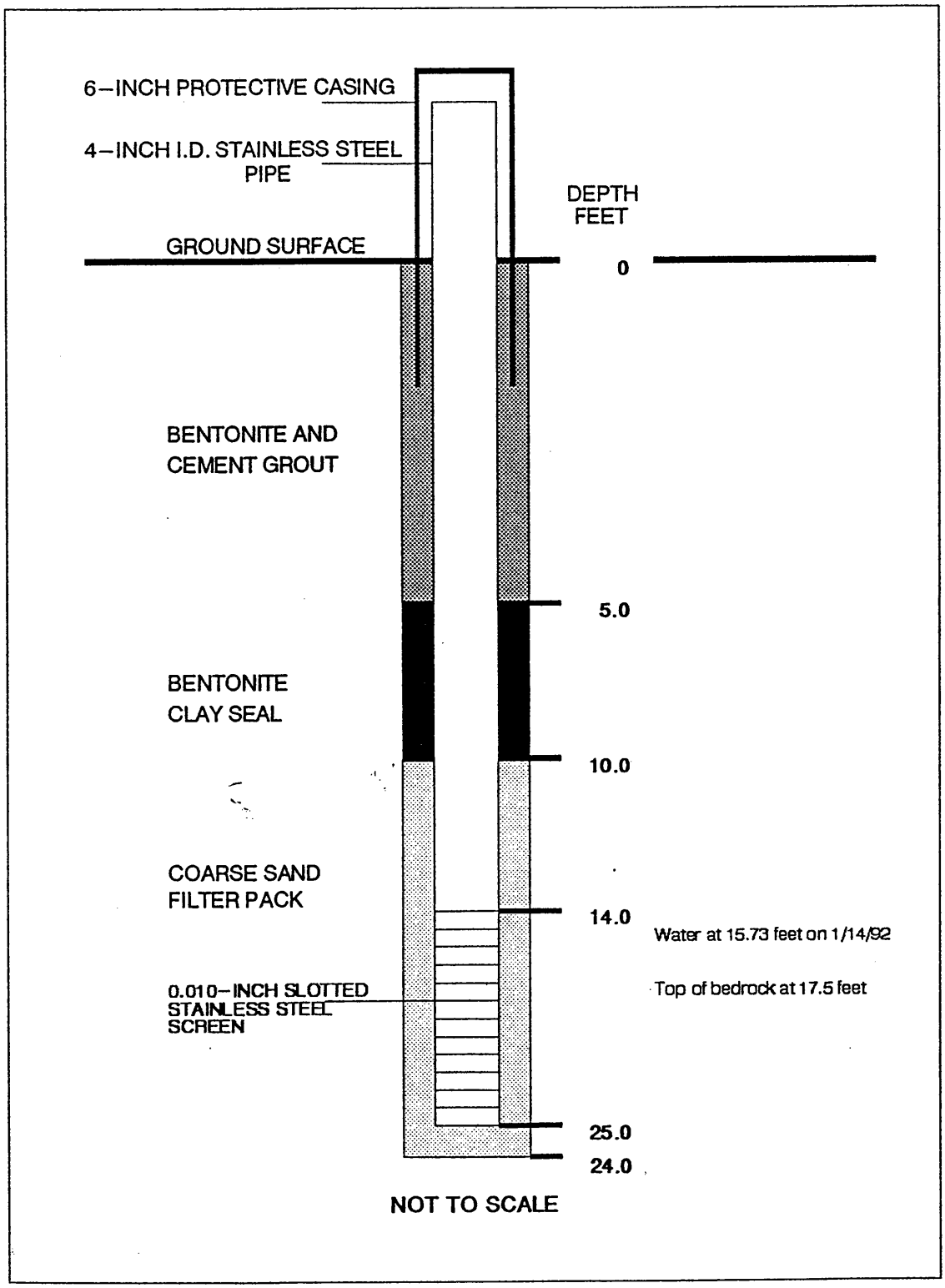
Symbols	Description
ML	DARK REDDISH BROWN (5YR 2.5/2) FINE SANDY SILT
	GRADES TO DARK BROWN SILT WITH SOME SAND
SM	DARK BROWN (7.5YR 4/4) SILTY FINE SAND, LOOSE, MICACEOUS
	GRADES CLAYEY SAND
SP	BROWN (10YR 5/3) SAND WITH GRAVEL
LS	DARK GRAYISH BROWN VERY WEATHERED LIMESTONE WITH CALCITE VEINS
	AIR ROTARY DRILL WITHOUT CORING BELOW 24.0 FEET
	BOREHOLE TERMINATED AT A DEPTH OF 25.0 FEET

LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR RCRA FACILITY INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 13MW5
Installation Date: 8/23/91
Surface Elevation: 1695.3 Feet
Top of SS Elevation: 1696.40 Feet



Dames & Moore

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 122 FT (FROM SURFACE)

DATE/TIME: 12/19/94 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW1

LOCATION: SWMU 48
NW OF LOWER DISPOSAL AREA

WEATHER: DAMP, 45° F

DATE/TIME START: 12/17/94 1545

DATE/TIME FINISH: 12/19/94 1255

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
6	1	100	11,9 7,14	3.4	SS	SS 5'-7'	ML	SILT, SOME CLAY, SOME SAND, ORANGE-BROWN
11	2	100	3,3 4,6	3.5	HS	SS 10'-12'	GM/SM	SILT AND SAND, GRAVEL, ORANGE-BROWN, SLIGHT ODOR
								SILT AND CLAY, ORANGE-BROWN TO YELLOW-BROWN
								SILT BECOMING MORE COMPETENT, MORE RED, WEATHERED, LAYERED
21	3*	95	11,8 7,10	4.0	HS	SS 20'-22'	ML	
26	4	95	8,7 8,10	1.1	HS	SS 25'-27'		
31	5	80	13,9 10,11	0.0	HS	SS 30'-32'		
36	6	75	9,12 9,9	4.0	HS	SS 35'-37'		
41	7	95	7,9 10,9	0.0	HS	SS 40'-42'		

LITHOLOGIC COLUMN

WELL COMPLETION

TOC
1819.95'
2.2'
STICK UP

GROUT
TO
SURFACE

DEPTH (FT)

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 122 FT (FROM SURFACE)

DATE/TIME: 12/19/94 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW1

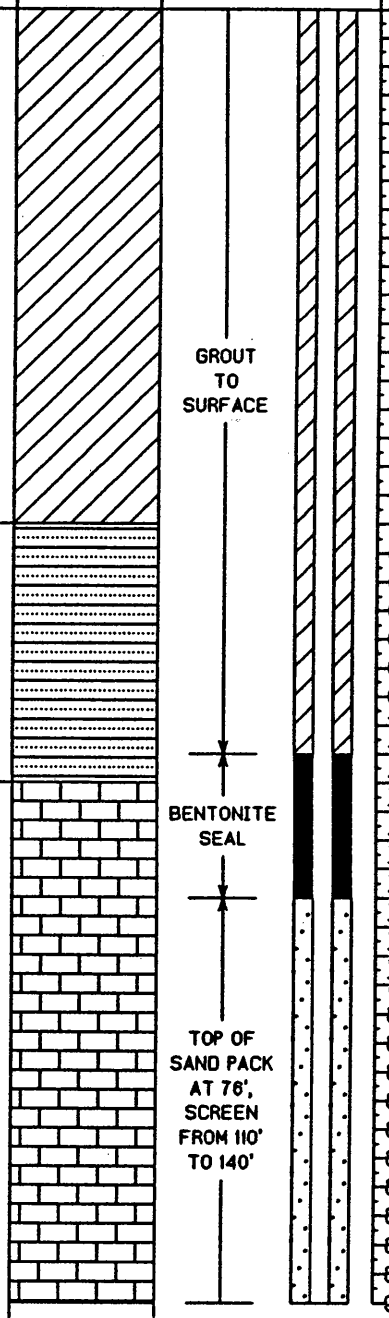
LOCATION: SWMU 48

WEATHER: DAMP, 45° F

DATE/TIME START: 12/17/94 1545

DATE/TIME FINISH: 12/19/94 1255

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
46-47	8	100	9,70 17,16	2.8	HS	SS 45'-47		CLAY AND SILT, TRACE SAND, BROWN, SLIGHTLY DAMP AT 52 FEET, WEATHERED
51-52	9	75	9,9 9,9	6.0	HS	SS 50'-52'	CL	
53-54	10*	75	16,8 9,8	6.0	HS	SS 52'-54		
61-62	11	60	10,10 10,10	4.5	HS	SS 60'-62		SWITCHED TO AIR ROTARY DRILLING AT 60 FEET
66-67	12	100	12,28 31,75	3.9	HS	SS 65'-67	SLSN	SILTSTONE, GREEN-BROWN, WEATHERED, VERY DAMP AT 66 FEET
								DISTINCT CHANGE AT 72 FEET
							LMSN	LIMESTONE, DARK BROWN CUTTINGS, ARGILLACEOUS



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CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 122 FT (FROM SURFACE)

DATE/TIME: 12/19/94 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW1

LOCATION: SWMU 48

WEATHER: DAMP, 45° F

DATE/TIME START: 12/17/94 1545

DATE/TIME FINISH: 12/19/94 1255

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
91-135							LMSN	LIMESTONE, DARK BROWN CUTTINGS, ARGILLACEOUS STOPPED OVERNIGHT AT 94 FEET, NO WATER IN HOLE 12-19-94 DRILLING RATE IS APPROXIMATELY 1 FOOT/1.5 MINUTES
100-135							DLMT	DOLOMITE, GRAY, WEATHERED, SOFT DRILLING RATE IS APPROXIMATELY 1 FOOT/2.5 MINUTES

LITHOLOGIC COLUMN

WELL COMPLETION

TOP OF SAND PACK AT 76', SCREEN FROM 110' TO 140'

DEPTH (FT)

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 122 FT (FROM SURFACE)

DATE/TIME: 12/19/94 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW1

LOCATION: SWMU 48

WEATHER: DAMP, 45° F

DATE/TIME START: 12/17/94 1545

DATE/TIME FINISH: 12/19/94 1255

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
136-180							DLMT	DOLOMITE, GRAY, WEATHERED, SOFT BECOMES HARDER AT 148 FEET, NO WATER TO END OF BORING, THEN WATER TO 122 FEET AFTER 1.5 HOURS END OF BORING AT 154 FEET

LITHOLOGIC COLUMN

WELL COMPLETION: TOP OF SAND PACK AT 76', SCREEN FROM 110' TO 140'

DEPTH (FT) 136-180

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 126 FT (FROM SURFACE)

DATE/TIME: 1/07/95 0830

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW2

LOCATION: SWMU 48
SW OF LOWER DISPOSAL AREA

WEATHER: CLEAR, 25° F

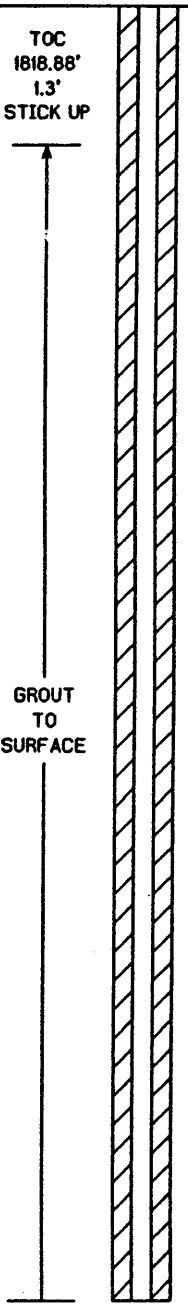
DATE/TIME START: 12/19/94 1630

DATE/TIME FINISH: 1/07/95 1200

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
6	1	60	8,12 15,16	0.0	HS	SS 5'-7'	ML	SILT, SOME SAND AND CLAY, RED-BROWN
11	2	75	7,5 5,4	0.0	HS	SS 10'-12'	SM	SILT AND SAND, BROWN VERY HARD DRILLING AT 17 FEET (GRAVEL)
21	3	5	100/ 2.5	0.0	HS	SS 20'-22'	GM/ML	SILT AND CLAY, SOME SAND, LIGHT BROWN, GRAVEL
31	4	30	10,8 5,4	0.0	HS	SS 30'-32'		
41	5*	90	18,25 25,28			SS 40'-42'	DLMT	DOLOMITE, WEATHERED, LIGHT GRAY, ARGILLACEOUS, INTERBEDDED SILTSTONE
45	6*	5	100/1			SS 44'-46'		SWITCHED TO AIR HAMMER AT 44 FT

LITHOLOGIC COLUMN

WELL COMPLETION



DEPTH (FT)

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USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE
HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
2 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 126 FT (FROM SURFACE)

DATE/TIME: 1/07/95 0830

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW2

LOCATION: SWMU 48

WEATHER: CLEAR, 25° F

DATE/TIME START: 12/19/94 1630

DATE/TIME FINISH: 1/07/95 1200

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
47-92								DOLOMITE, WEATHERED, LIGHT GRAY
							SLSN	SILTSTONE, LIGHT BROWN, WEATHERED, INTERBEDDED GRAY DOLOMITE DRILLING RATE (1 FOOT/3 MINUTES)
							DLMT	DOLOMITE, WEATHERED, LIGHT GRAY, ARGILLACEOUS DRILLING RATE (1 FOOT/2.3 MINUTES) NOTE: SOFT FORMATION NOT RETURNING CUTTINGS UP HOLE. MUST SET TEMPORARY CASING. HOLE IS STOPPED AT 80 FEET OVER HOLIDAY, RESUME DRILLING ON 1-5-95.
							LMSN	LIMESTONE, WEATHERED, GRAY-BROWN

LITHOLOGIC COLUMN

WELL COMPLETION: GROUT TO SURFACE

DEPTH (FT) 47-92

HSA = HOLLOW STEM AUGER
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SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
2 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 126 FT (FROM SURFACE)

DATE/TIME: 1/07/95 0830

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW2

LOCATION: SWMU 48

WEATHER: CLEAR, 25° F

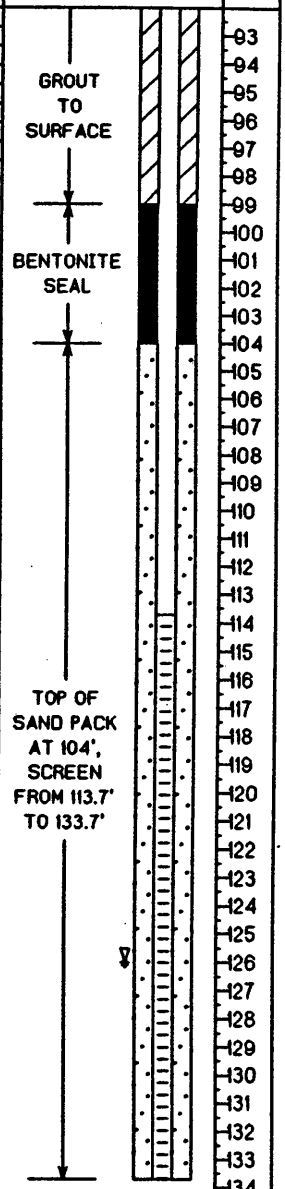
DATE/TIME START: 12/19/94 1630

DATE/TIME FINISH: 1/07/95 1200

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
93–110							LMSN	LIMESTONE, WEATHERED, GRAY-BROWN DRILLING RATE (1 FOOT/1.7 MINUTES)
110–134							DLMT	DOLOMITE, LIGHT GRAY, WEATHERED, ALTERNATING HARD AND SOFT, GRAY AND BROWN, LAYERS DRILLING RATE (1 FOOT/3.3 MINUTES)
134–138								END OF BORING AT 133.7 FEET

LITHOLOGIC COLUMN

WELL COMPLETION



DEPTH (FT) 93–138

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SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE

▽ = WATER LEVEL

COMMENTS:
2 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 119 FT (FROM SURFACE)

DATE/TIME: 1/08/95 1430

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW3

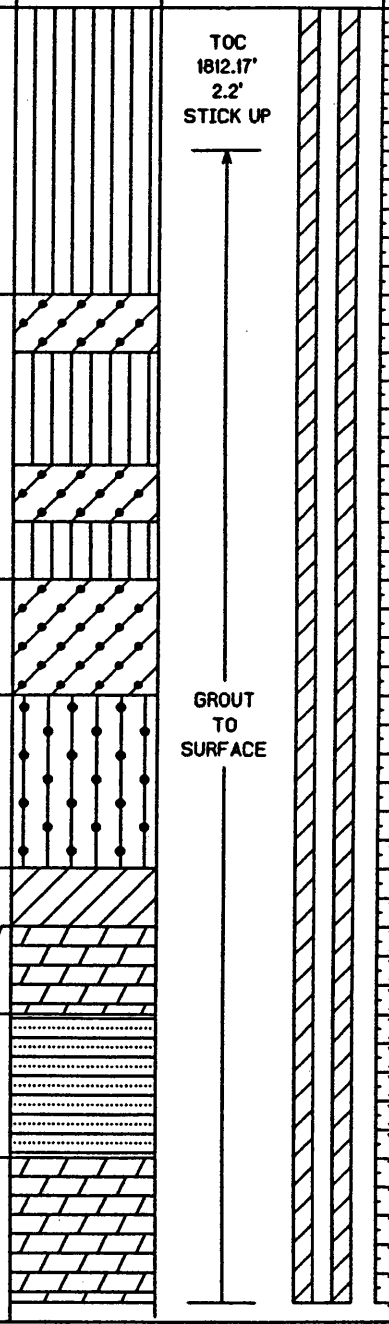
LOCATION: SWMU 48
SE OF LOWER DISPOSAL AREA

WEATHER: WET, COLD, 40° F

DATE/TIME START: 1/07/95 1237

DATE/TIME FINISH: 1/08/95 1430

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
1-10							ML	SILT AND CLAY, LITTLE SAND, ORANGE-BROWN
11-20	1	95	2,5 8,6	2.0	HS	SS	ML/SM	SILT, LITTLE SAND AND CLAY, ORANGE-BROWN
21-24	2*	95	2,6 6,5	3.5	SS	SS	SM	SILT AND SAND, LITTLE CLAY, ORANGE
25-30							GM	GRAVEL, SILTY
31-32	3*	90	8,26 50/2"	1.1	HS	SS	CL	CLAY AND SILT, YELLOW-BROWN, SWITCHED TO AIR HAMMER AT 32 FEET
32-35							DLMT	DOLOMITE, WEATHERED, LIGHT GRAY
35-40							SLSN	SILTSTONE, BROWN, INTERBEDDED WITH GRAY DOLOSTONE
40-45							DLMT	DOLOMITE, WEATHERED, GRAY, ARGILLACEOUS



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CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 119 FT (FROM SURFACE)

DATE/TIME: 1/08/95 1430

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW3

LOCATION: SWMU 48

WEATHER: WET, COLD, 40° F

DATE/TIME START: 1/07/95 1237

DATE/TIME FINISH: 1/08/95 1430

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
46-90							DLMT	DOLOMITE, WEATHERED, GRAY, ARGILLACEOUS DRILLING RATE FROM 40-60 FEET (1 FOOT/1.8 MINUTES) LESS CLAY, LESS WEATHERING DRILLING RATE FROM 60-90 FEET (1 FOOT/6.3 MINUTES) DOLOMITE, LIGHT GRAY

LITHOLOGIC COLUMN

WELL COMPLETION: GROUT TO SURFACE; BENTONITE SEAL

HSA = HOLLOW STEM AUGER
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SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 119 FT (FROM SURFACE)

DATE/TIME: 1/08/95 1430

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW3

LOCATION: SWMU 48

WEATHER: WET, COLD, 40° F

DATE/TIME START: 1/07/95 1237

DATE/TIME FINISH: 1/08/95 1430

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
91-135							LMSN	LIMESTONE, LIGHT GRAY, DRILLING RATE (1 FOOT/4 MINUTES)
105-122							DLMT	DOLOMITE, LIGHT GRAY, POSSIBLE WET ZONE AT 112 FEET. DRILLING RATE (1 FOOT/3.5 MINUTES)
122								END OF BORING AT 122 FEET

LITHOLOGIC COLUMN

WELL COMPLETION: TOP OF SAND PACK AT 90', SCREEN FROM 100' TO 120'

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 78.19 FT

DATE/TIME: 7/22/95 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW4

LOCATION: SWMU 48
CENTER OF UPPER DISPOSAL AREA

WEATHER: RAIN, 85° F

DATE/TIME START: 7/18/95 1100

DATE/TIME FINISH: 7/20/95 1830

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
1-4				0.1	BH		CL	CLAY AND SILT, LITTLE SAND, RED-BROWN
8-12				0.0	BH		GM	SILT AND GRAVEL, LITTLE SAND, ORANGE-BROWN
13-18				0.0	BH		CL	CLAY AND SILT, LITTLE SAND, RED-BROWN, MOIST
26-33				0.0	BH		ML	SILT AND CLAY, ORANGE-BROWN, MOIST ZONE AT 40-41 FEET
41-45				0.0	BH		GM	SAND AND GRAVEL, SOME SILT, BROWN, MOIST, GRAVEL LAYER AT 49 FEET

LITHOLOGIC COLUMN

WELL COMPLETION

TOC
1832.6
2.06'
STICK UP

GROUT
TO
SURFACE

DEPTH (FT)

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 78.19 FT

DATE/TIME: 7/22/95 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW4

LOCATION: SWMU 48

WEATHER: RAIN, 85° F

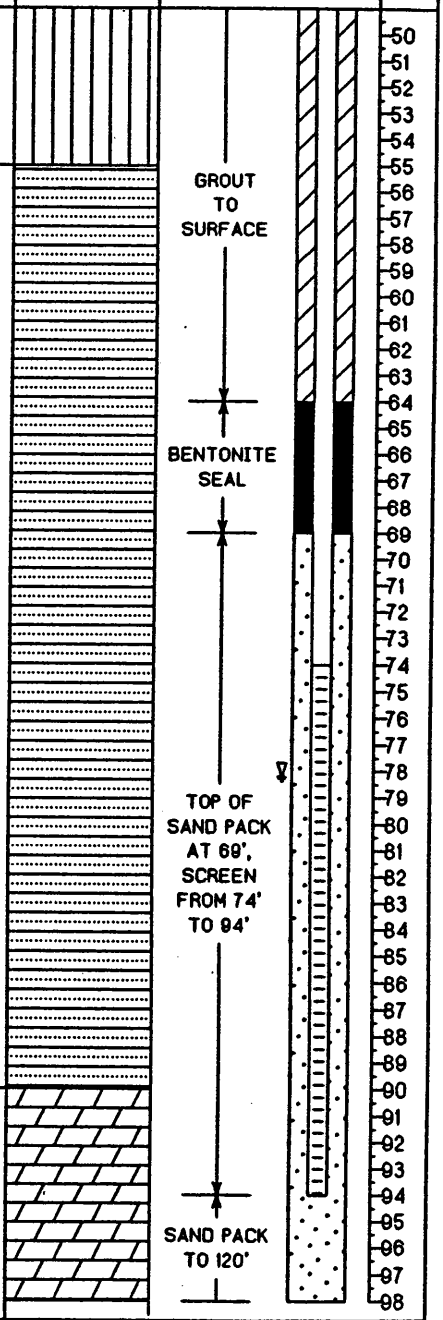
DATE/TIME START: 7/18/95 1100

DATE/TIME FINISH: 7/20/95 1830

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS
50-55				0.0	BH		ML	SILT, BROWN, BECOMING MORE COMPETENT, SWITCHED TO AIR ROTARY DRILLING AT 55 FEET
55-90				0.0	BH		SLSN	SILTSTONE, WEATHERED, ALTERNATING RED AND GREEN LAYERS, INTERBEDDED DOLOMITE (SLIGHT HCL FIZZ)
90-98				0.0	BH		DLMT	DOLOMITE, GREEN-GRAY, AND INTERBEDDED DARK GRAY SILTSTONE, SOFT ZONE AT 100-108 FEET (WATER?)

LITHOLOGIC COLUMN

WELL COMPLETION



DEPTH (FT)

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

CONTRACTOR: CT & E

GEOLOGIST: BACHOVCHIN/GLENNIE

DRILLING METHOD: HSA/AIR ROTARY

DTW FROM TOC: 78.19 FT

DATE/TIME: 7/22/95 1200

PARSONS ENGINEERING-SCIENCE, INC. DRILLING RECORD

PROJECT NAME: RAAP

CLIENT: US AEC

PROJECT NO.: 722843

BORING NO: 48MW4

LOCATION: SWMU 48

WEATHER: RAIN, 85° F

DATE/TIME START: 7/18/95 1100

DATE/TIME FINISH: 7/20/95 1830

DEPTH (FT)	SAMPLE ID	RECOVERY %	BLOW COUNT	PID (ppm)	READING AT	SAMPLE TYPE	USCS	LITHOLOGY/REMARKS	LITHOLOGIC COLUMN	WELL COMPLETION	DEPTH (FT)
99–120				0.0	BH		DLMT	DOLOMITE, GREEN-GRAY, AND INTERBEDDED DARK GRAY SILTSTONE, SOFT ZONE AT 100-108 FEET (WATER?)		SAND PACK TO 120'	99–120
120								END OF BORING AT 120 FEET			120
121–147											121–147

HSA = HOLLOW STEM AUGER
CAL = CALIBRATION
USCS = UNIFIED SOIL CLASS. SYS.

SS = SPLIT SPOON
A = AUGER CUTTINGS
* = LAB SAMPLE

BH = BORE HOLE
GS = GRAB SAMPLE

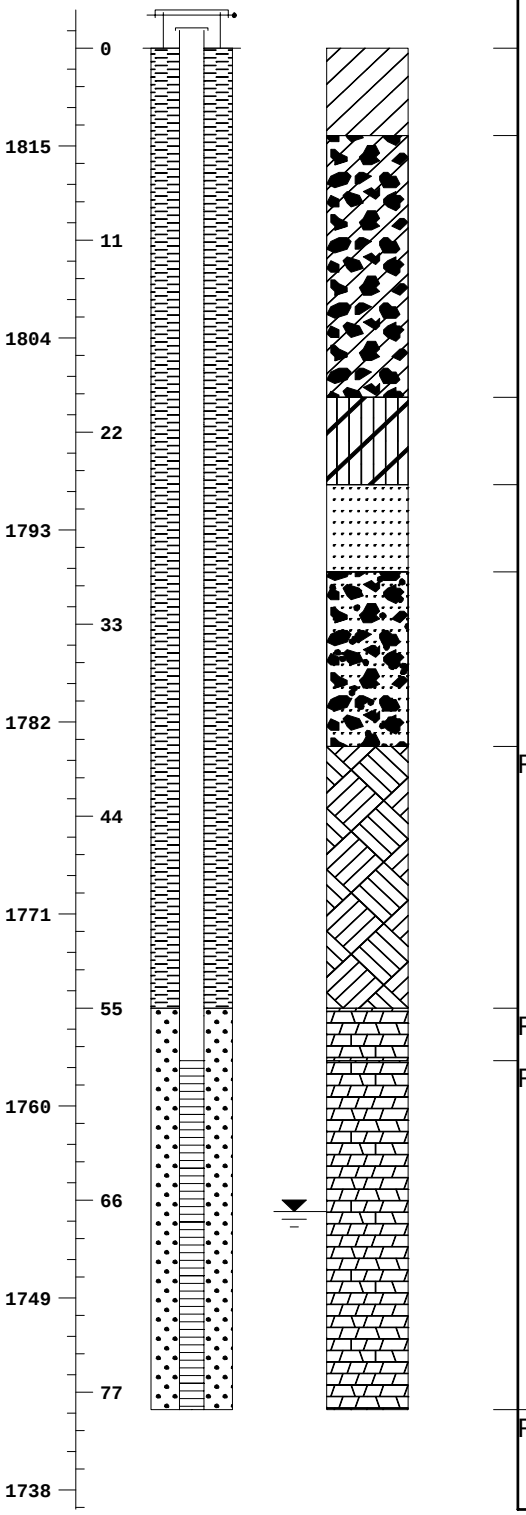
HS = HEADSPACE
▽ = WATER LEVEL

COMMENTS:
4 INCH ID PVC, SCH 40
0.01 INCH SLOT SCREEN

DRILL HOLE LOG
DRILL HOLE NO.: 48MW06

PROJECT: WPA 019 Groundwater Investigation
CLIENT/OWNER: RFAAP
HOLE LOCATION: RFAAP Radford, VA
DRILLER: Bedford Well Drilling
DRILL RIG: T3 Air Rotary
DEPTH TO WATER: 66.65
HOLE DIAMETER: 6 Inch

PROJECT NO.: 123461
DATE: 8/08/07
TOC ELEV.: 1822.8
GS ELEV.: 1820.6
LOGGED BY: J. Choynowski
HOLE NO.: 48MW06



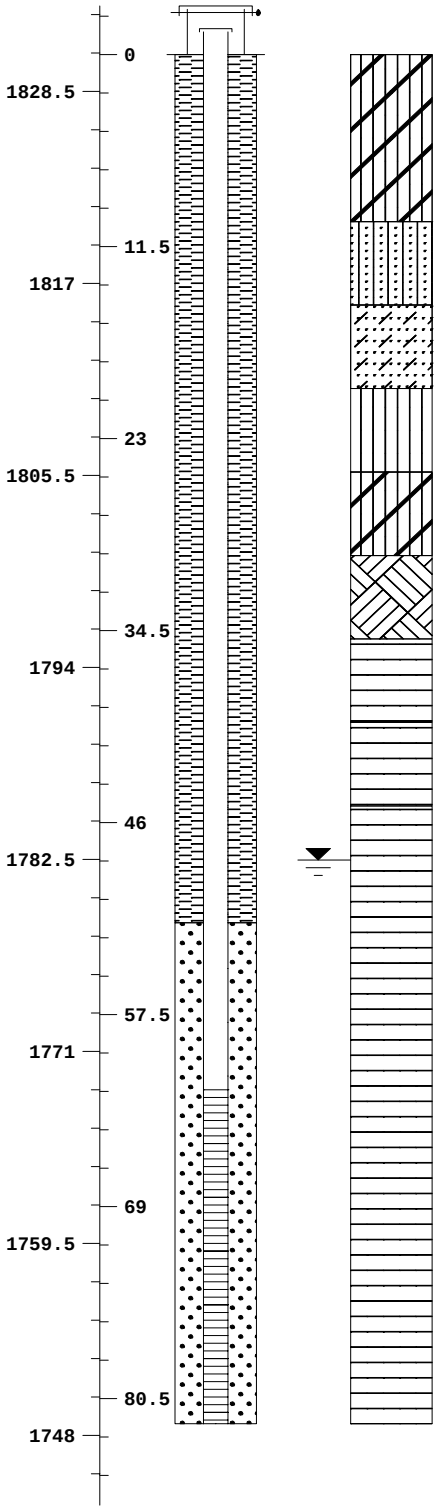
ELEVATION / DEPTH	WELL DETAILS	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	DESCRIPTION	Sample Number	Recovery	Water Content
				4" Protective case.			
0			CL	Red brown clay, low plasticity, little silt.			
				2" PVC well pipe.			
5			GC	Same as above with some coarse gravel.			
20			CL-ML	Yellowish brown clay & silt, some coarse sand and gravel.			
25			SW	Strong brown fine to medium sand, little gravel.			
30			GW-SW	Yellowish brown gravel & sand w/ some silt and some olive saprolite.			
40			ROCK	Olive & yellow brown saprolite, very weathered.			
55			ROCK	2.5yr 6/6 olive yellow dolomite.			
58			ROCK	Top of sand filter layer. Top of well screen, 0.010" slot.			
78			ROCK	Bottom of screen and well.			

FIGURE NO.

DRILL HOLE LOG
DRILL HOLE NO.: 48MW07

PROJECT: WPA 019 Groundwater Investigation
CLIENT/OWNER: RFAAP
HOLE LOCATION: RFAAP Radford, VA
DRILLER: Bedford Well Drilling
DRILL RIG: T3 Air Rotary
DEPTH TO WATER: 48.24
HOLE DIAMETER: 6 Inch

PROJECT NO.: 123461
DATE: 8/07/07
TOC ELEV.: 1833.7
GS ELEV.: 1830.7
LOGGED BY: J. Choynowski
HOLE NO.: 48MW07



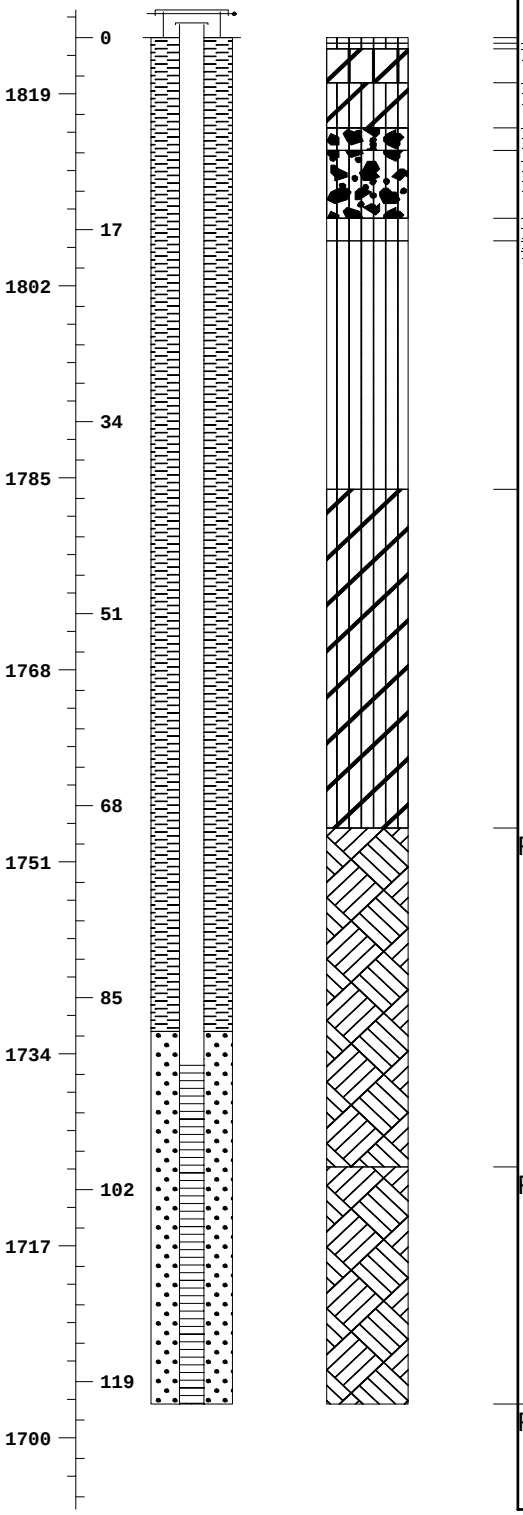
ELEVATION / DEPTH	WELL DETAILS	SOIL SYMBOLS, SAMPLER SYMBOLS AND FIELD TEST DATA	USCS	DESCRIPTION	Sample Number	Recovery	Water Content
				4" Protective case.			
				0			
			CL-ML	Yellowish red clay & silt. 2" PVC well pipe.			
				10			
			SM	Red brown silt & fine sand.			
				15			
			SW-SC	Yellow brown fine sand, little silt, little coarse gravel.			
				20			
			ML	Strong brown silt, little weathered saprolite.			
				25			
			CL-ML	Pale olive clay & silt.			
				30			
			ROCK	Competent saprolite, olive.			
				35			
			ROCK	Redish brown shale.			
				40			
			ROCK	Green shale.			
				45			
			ROCK	Yellowish brown shale. Pale brown. Top of sand filter layer. Olive. Red brown. Top of well screen, 0.010" slot. Olive brown, dust stopped. Pale olive. Dark olive.			
				82			
				Bottom of screen and well.			

FIGURE NO.

DRILL HOLE LOG
DRILL HOLE NO.: 49MW01

PROJECT: WPA 019 Groundwater Investigation
CLIENT/OWNER: RFAAP
HOLE LOCATION: RFAAP Radford, VA
DRILLER: Bedford Well Drilling
DRILL RIG: T3 Air Rotary
DEPTH TO WATER:
HOLE DIAMETER: 6 Inch

PROJECT NO.: 123461
DATE: 8/09/07
TOC ELEV.: 1826.4
GS ELEV.: 1823.98
LOGGED BY: J. Choynowski
HOLE NO.: 49MW01



ELEVATION / DEPTH	USCS	DESCRIPTION	Sample Number	Recovery	Water Content
		4" Protective case.			
	ML	10yr 5/4 yellow-brown silt with roots.			
	ML	2" PVC well pipe.	A		
	CH-MH	10yr 5/6 yellow-brown silt, little rock.			
	CL-ML	2.5yr 5/8 red clay & silt, trace(+)fine sand. No splitspoon.	B		
	ML	2.5yr 5/8 red clay & silt, little(-) very fine sand.			
	GW-GM	2.5yr 7/6 Reddish yellow gravel, some sand & silt w/ little 2-3" diameter cobbles.	C		
	GW-GM	Same as above No splitspoon.			
	ML	2.5yr 6/7 Olive yellow silt, soft, little(-) clay.			
	ML	2.5yr 6/8 olive yellow silt with some clay, little(-) cobble, some very fine sand.			
	CL-ML	Yellowish brown silt & clay.			
	ROCK	Competent rock, bedrock, pale brown to olive brown.			
		Top of sand filter layer. Top of well screen, 0.010" slot.			
	ROCK	Olive yellow, damp.			
	ROCK	Bottom of screen and well.			

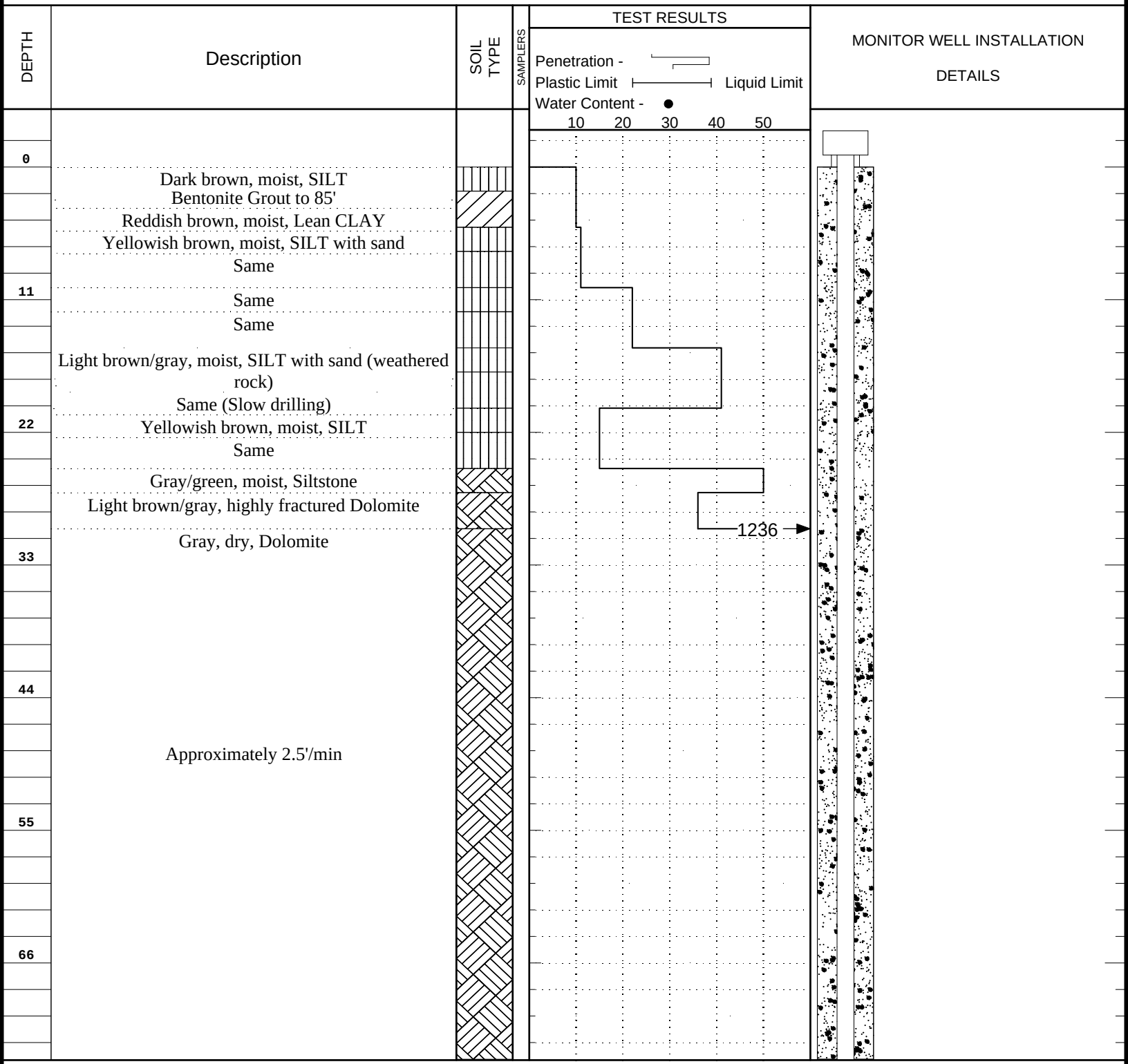
0
0.5
1
4
8
10
16
18
40
70
100
121

FIGURE NO.

DRILL HOLE LOG
BORING NO.: 49MW02

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Track Mounted Rig
DEPTH TO WATER> **INITIAL:** 99 **AT COMPLETION:** 89

PROJECT NO.: 123461
DATE: 4/16-4/17/13
ELEVATION:
LOGGED BY: J. Hillebrand



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW02

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Track Mounted Rig
DEPTH TO WATER> **INITIAL:** 99 **AT COMPLETION:** 89

PROJECT NO.: 123461
DATE: 4/16-4/17/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
				Penetration - Plastic Limit — Liquid Limit; Water Content - ●; 10 20 30 40 50	
77	Approximately 2'/min				
	Bentonite seal from 85-89'				
88	Approximately 1.5'/min Sand packed pvc from 89-103				
99	Low volume water bearing fracture encountered @ 99' Gray, dry, Dolomite Screen from 103-133'				
110					
121	Water bearing fracture @ 121'				
132	Water bearing fracture @ 129'				
	Bottom of well @ 133' Boring Terminated @ 133'				
143					

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW03

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Track Mounted Rig
DEPTH TO WATER> **INITIAL:** 100 **AT COMPLETION:** 96

PROJECT NO.: 123461
DATE: 4/12-4/15/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
0	Brown, moist, SILT			Penetration - Plastic Limit — Liquid Limit; Water Content - ● (10 20 30 40 50)	
	Bentonite grout to 48'				
	Same				
	Reddish brown, moist, Lean CLAY with sand				
	Reddish brown, moist, SILT with sand				
11	Reddish brown, moist, Sandy SILT				
	Same				
	Reddish brown, moist, Silty SAND				
	Same				
22	Same				
	Same, auger chattering @ 23'				
	Light brown/gray, moist, Silty SAND (Sapprolite)				
	Same				
	Same				
33	Same				
	Same				
	Same				
	Same; Switched to air rotary. Rotary to 60'. Air				
44	rotary stopped working. Ran augers back down to rock surface.				
	Bentonite plug from 48-50'				
	Sand pack from 50-77'				
55					
	Light brown/green, moist, Silty SAND (Sapprolite)				
	Same				
66	Same				
	Same				
	Same; Water seam encountered				
	Same; wet cuttings				

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW03

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Track Mounted Rig
DEPTH TO WATER> **INITIAL:** 100 **AT COMPLETION:** 96

PROJECT NO.: 123461
DATE: 4/12-4/15/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
77	Same; wet			Penetration - Plastic Limit — Liquid Limit Water Content - ● 10 20 30 40 50	
	Same; wet cuttings Screened from 77-117'				
	Same, wet				
	Same, Rock surface encountered at 85.5'. Switch to air rotary.				
88	Light brown/gray, moist, Dolomite				
99					
	Green/gray, dry, heavily fractured, Dolomite. No drilling returns.				
110	Green/gray, dry, heavily fractured, Dolomite. No drilling returns.				
	Green/gray, wet, heavily fractured, Dolomite				
121	Boring terminated at 117' due to the lack of drilling returns and high degree of fracturing. Well set @ 117'				
132					
143					

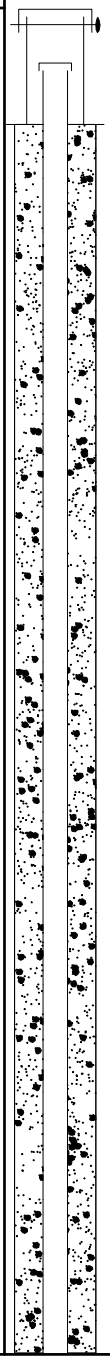
This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW04

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Truck Mounted Rig
DEPTH TO WATER> **INITIAL:** 57 **AT COMPLETION:** 18.6

PROJECT NO.: 123461
DATE: 4/8-4/9/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
0	Brown, moist, SILT Bentonite grout to 45'			Penetration - Plastic Limit — Liquid Limit Water Content - ● 10 20 30 40 50	
	Same				
5	Brown, moist, SILT with sand				
	Brown, moist, Sandy SILT				
10	Same				
	Same; trace mica				
15	Same				
	Same; difficult augering from 18-18.5'				
	Auger refusal. 50/1". No water encountered after 14 hours. Switch to air rotary. Gray, dry, fractured, Limestone				
20	Same				
25					
30					



This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW04

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Truck Mounted Rig
DEPTH TO WATER> **INITIAL:** 57 **AT COMPLETION:** 18.6

PROJECT NO.: 123461
DATE: 4/8-4/9/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
	Same, competent (no fractures)			Penetration - Plastic Limit — Liquid Limit — Water Content - 10 20 30 40 50	
35					
40					
	Same, competent (no fractures)				
45	Bentonite seal from 45-48'				
	Sand pack around PVC riser from 48-50'				
50	Screened from 50-70'				
	Same, Low volume water bearing fracture at 52.5'. No significant water accumulation after 1 hour.				
55					
60					
	Gray, dry, competent (no fractures) Limestone. Water bearing fracture encountered @ 60'				
65					

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW04

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Truck Mounted Rig
DEPTH TO WATER> **INITIAL:** 57 **AT COMPLETION:** 18.6

PROJECT NO.: 123461
DATE: 4/8-4/9/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
70	Well set @ 70' Borehole backfilled from 70-72' with sand.			Penetration - Plastic Limit — Liquid Limit Water Content - ● 10 20 30 40 50	
	Boring terminated at 72'.				
75					
80					
85					
90					
95					
100					

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW05

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Truck Mounted Rig
DEPTH TO WATER> **INITIAL:** 30.2 **AT COMPLETION:** 20.7

PROJECT NO.: 123461
DATE: 4/10/13
ELEVATION:
LOGGED BY: J. Hillebrand

DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
0	Bentonite grout to 12'			Penetration - Plastic Limit — Liquid Limit; Water Content - ● 10 20 30 40 50	
	Dark brown, moist, SILT				
	Same				
5	Same				
	Same				
10	Brown, moist, Sandy SILT				
	Same Bentonite seal from 12-14.5'				
15	Sand packed PVC from 14.5-16.8'				
	Brown, moist, Silty SAND (Limestone fragments)				
	Screened from 16.8 to 36.8'				
	Auger refusal @ 17.1. Switched to air rotary. Gray, dry, slightly fractured, Limestone. Low volume water bearing fracture @ 26'				
20	▼				
25	Gray, dry, slightly fractured, limestone. Water bearing fractures at 28'.				
30	▽				

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
BORING NO.: 49MW05

PROJECT: SWMU 48/49 MNA
CLIENT:
LOCATION: SWMU 48/49 MNA
DRILLER: Arnold Chapel
DRILLING METHOD: Truck Mounted Rig
DEPTH TO WATER> **INITIAL:** 30.2

PROJECT NO.: 123461
DATE: 4/10/13
ELEVATION:
LOGGED BY: J. Hillebrand
AT COMPLETION: 20.7

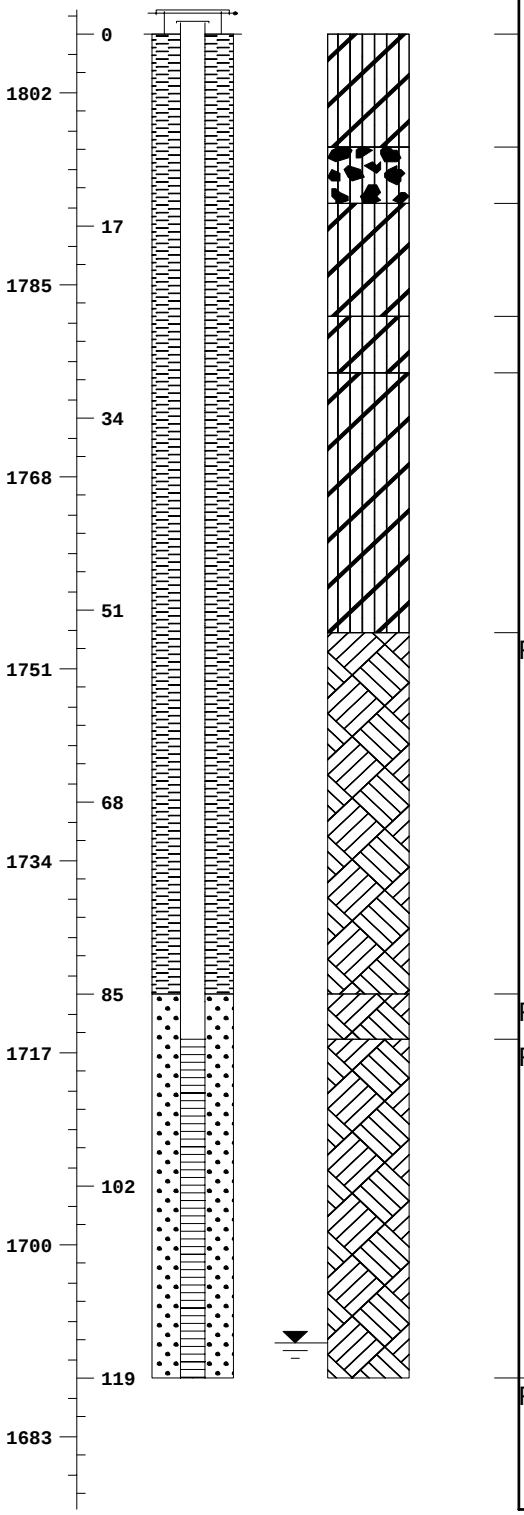
DEPTH	Description	SOIL TYPE	SAMPLERS	TEST RESULTS	MONITOR WELL INSTALLATION DETAILS
35				Penetration - Plastic Limit — Liquid Limit — Water Content - ● 10 20 30 40 50	
	Boring terminated @ 37'. Well set @ 36. 8'				
40					
45					
50					
55					
60					
65					

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

DRILL HOLE LOG
DRILL HOLE NO.: 50MW02

PROJECT: WPA 019 Groundwater Investigation
CLIENT/OWNER: RFAAP
HOLE LOCATION: RFAAP Radford, VA
DRILLER: Bedford Well Drilling
DRILL RIG: T3 Air Rotary
DEPTH TO WATER: 115.9
HOLE DIAMETER: 6 Inch

PROJECT NO.: 123461
DATE: 8/09/07
TOC ELEV.: 1809.6
GS ELEV.: 1807.2
LOGGED BY: J. Choynowski
HOLE NO.: 50MW02



ELEVATION / DEPTH	USCS	DESCRIPTION	Sample Number	Recovery	Water Content
		4" Protective case.			
0	CL-ML	Red brown silt & clay.			
		2" PVC well pipe.			
10	ML	Red brown silt, trace coarse gravel.			
15	CL-ML	Red brown silt, little (-) clay.			
25	CL-ML	Brown silt, some (-) clay, low plasticity.			
30	CL-ML	Yellow brown silt & clay, low plasticity.			
53	ROCK	Pale brown to olive brown. Competent rock.			
85	ROCK	Top of sand filter layer.			
89	ROCK	Top of well screen, 0.010" slot.			
119	ROCK	Bottom of screen and well.			

FIGURE NO.

KEY TO SYMBOLS

Symbol	Description
Strata symbols	
	Silt
	Inorganic silts and clays
	Silty low plasticity clay
	Well graded gravel with silt
	Generic rock
	Low plasticity organic silts
	Well graded gravel and sand
	Variable gravel and silty sand mix
	Clayey sand
	Silty gravel
	Low plasticity clay
	Silty sand
	Clayey gravel
	Well graded sand
	Dolomite

Symbol	Description
	Well graded sand with clay
	Shale
	Clayey sand and gravel
	Shale and dolostone.
	Limestone
	Limestone and dolostone.
Misc. Symbols	
	Boring continues
	Water table at boring completion
Monitor Well Details	
	Capped riser with locking cover
	Bentonite pellets
	Silica sand, blank PVC
	Slotted pipe w/ sand

Notes:

1. Borings were drilled on 8/10/07 using a 6-inch diameter air rotary T3 drill rig.

2. These logs are subject to the limitations, conclusions, and recommendations in this report.

1/26/15
D. Cseny
O. Hillebrand

Arrive onsite @ 6:30 for Badging. Safety meeting was conducted at the background @ 7:30. Had u/ BAE + RIMAP Safety prior to beginning work. Calibrated Horiba & PID according to spec. Both fell w/in Tolerance. Sampled background wells.

#	levels
BMW2	22.01
BMW3	15.51
BMW4	17.04
BMW5	15.54
48MW1	105.62
48MW2	125.42
48MW3	98.06
48MW06	66'
48MW07	47.86
49MW01	115.57
49MW02	95.41
49MW03	105.94
49MW04	21.05
49MW05	20.16
50MW02	115.72

To finish in the allotted time, 2 pumps were utilized. Well parameters from second pump are found in Seperate Field Book.

Setup on 49mw04 start @ 8:55
well set @ 55'. 100 ml/m P.D = 0

Time	Temp	cond	DO	pH	Turb	orp	ft
9:00	12.00	.684	5.36	7.39	29	-42	21.09
9:05	12.40	.689	5.25	7.42	24.8	-42	21.13
9:10	12.20	.690	4.02	7.46	3.8	-43	21.14
9:15	12.39	.690	3.83	7.48	0.4	-44	21.15
9:20	12.39	.689	3.71	7.46	0.1	-44	21.15
9:25	12.40	.689	3.65	7.46	0.0	-44	21.15
9:30	12.40	.689	3.64	7.46	0.0	-44	21.16
9:35	12.40	.689	3.63	7.46	0.0	-44	21.15

well stable @ 9:35
Collected sample 935. Fe = <.2
Decomed pump. MOB to 13mw2.

Set up on 13mw2. Start pump @ 10:20. Pump set @ 25'. 100 ml/m.

P.D = 0

13MW2

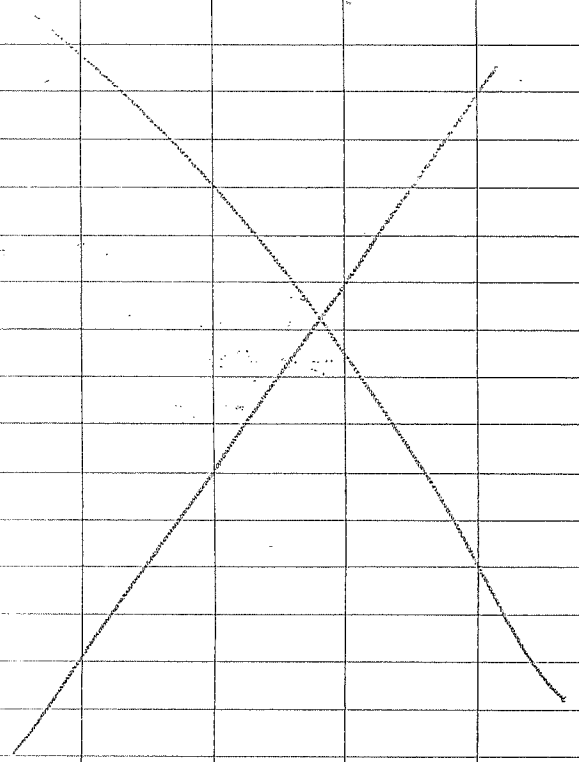
Time	Temp	Cond	DO	pH	Turb	orp	ft
10:25	13.05	.818	6.52	6.89	11	-12	22.03
10:30	12.84	.812	4.63	6.90	5.9	-13	22.05
1035	12.86	.812	4.60	6.90	6.2	-13	22.05
1040	12.75	.811	4.50	6.91	4.6	-12	22.05
1045	12.71	.809	4.48	6.90	4.5	-12	"
1055	12.69	.811	4.48	6.90	4.5	-12	" "
1100	12.66	.813	4.44	6.90	5.3	-12	" "
1105	12.66	.813	4.44	6.90	5.1	-12	" "
1110	12.65	.813	4.44	6.90	4.1	-12	" "

well stable @ 1110. Collected samples @ 1110. Fe = <.2.
Decomed pump & MOB to 49MW05.
well purged @ 32'. Pump started @ 12:15.
100 ml/min

Time	Temp	cond	DO	pH	Turb	orp	ft
12:20	12.23	.754	5.61	7.05	800+	226	20.21
12:25	13.48	.741	2.46	6.98	91.1	254	20.22
1230	13.33	.717	2.47	7.00	39.7	247	20.22
1235	13.25	.699	2.18	7.05	21.3	235	20.23
1240	13.23	.698	2.18	7.04	26.4	235	" "
245	13.21	.697	2.15	7.04	17.6	230	" "
1250	13.21	.697	2.16	7.04	15.2	229	" "
1255	13.20	.696	2.16	7.04	16.8	227	" "

well stable @ 1255. Fe = .3
Decon pump + demob.

Drove to down storage area to deposit ~ 18 gallons purge water. Demob to drop samples + gather supplies.



1/27/15
J. Hillebrand
B. Csernak

Held JSA + tailgate meeting @ 6:30. Mob to Radford. Passed security @ 7:30. Set up on 49MW02. Calibrated horiba + PID. Both pieces of equipment passed tolerances provided by manufacturer.

49MW02

Set @ 125' pump set @ 100 ml/m.
PID = ø Started @ 8:45.
Silty well. Rapid water level drop

Time	Temp	ph	cond	orp	turb	DO	T
8:50	10.85	7.57	.580	141	757	1.32	99'
8:55	9.93	7.51	.580	90	327	ø	99.90
9:00	10.15	7.43	.574	90	317	ø	99.94
9:10	9.49	7.48	.575	104	237	ø	100.52
9:20	8.55	7.48	.568	107	210	ø	101.2
9:30	8.51	7.48	.562	99	180	ø	101.23
9:40	8.50	7.49	.560	100	145	ø	101.28
9:50	8.56	7.44	.564	90	129	ø	101.4
10:00	8.57	7.53	.570	80	101	ø	101.6
10:10	8.57	7.54	.568	78	86.9	ø	101.67
10:15	8.57	7.54	.568	79	82.3	ø	101.67
10:20	8.57	7.54	.568	78	68.1	ø	101.67

Time	Temp	pH	cond	orp	turb	DO	∅
10:25	8.57	7.53	.568	78	45.2	∅	101.68
10:30	8.57	7.53	.567	78	45.1	∅	101.68
10:35	8.59	7.52	.567	77	45.0	∅	101.69
10:40	8.59	7.52	.567	77	45.1	∅	101.69
10:45	8.60	7.52	.567	77	45.2	∅	101.69
10:50	8.59	7.52	.567	77	45.2	∅	101.69

After 2hr, well stabilized w/turb at 45.2ntu. Collected samples. Decpump. Fe = ∅

Mob to 50MW02

Pump set @ 118' 100ml/min

PID = ∅

Pump on @ 1135 Highly turbid

Time	Temp	pH	cond	orp	turb	DO	∅
1140	5.66	7.07	.768	252	761	3.37	116.10
1145	5.02	7.05	.765	257	503	3.23	116.10
1150	14.85	7.05	.759	261	387	3.25	116.12
1155	15.22	7.04	.754	261	261	3.21	116.12
1200	15.47	7.04	.751	255	208	3.15	116.11
1205	15.70	7.04	.741	250	251	3.12	116.11
1210	15.64	7.03	.742	~~250~~ 249	135	3.13	116.12
1220	15.64	7.03	.738	243	107	3.09	116.13
1225	15.65	7.00	.737	239	98.9	3.07	116.15

Time	Temp	pH	cond	orp	turb	DO	∅
1230	15.65	7.05	.738	238	75.4	3.07	116.15
1235	15.67	7.06	.737	239	32.9	3.07	116.17
1240	15.68	7.05	.737	238	21.3	3.07	116.18
1245	15.68	7.05	.737	238	20.1	3.06	116.18
1250	15.68	7.05	.737	238	19.2	3.06	116.18
1255	15.67	7.05	.737	238	19.4	3.06	116.18

well stable @ 1255. collected sample @ 1255. Collected 49TM01.

Fe = ∅

Decon pump & mob to 49MW3.

Set pump @ 115' @ 100ml/min

PID = ∅ Pump on @ 1340.

49MW3

Time	Temp	pH	cond	orp	turb	DO	∅
1345	11.56	7.32	.750	286	40.7	6.05	98.06
1350	11.78	7.28	.750	287	33.5	5.05	98.06
1355	11.63	7.25	.752	285	23.1	4.49	98.06
1400	11.63	7.24	.752	285	22.4	4.46	98.06
1405	11.63	7.24	.752	284	20.1	4.35	98.06
1410	11.60	7.23	.754	282	16.0	4.25	98.07
1415	11.57	7.24	.754	280	15.2	4.19	98.07
1420	11.54	7.24	.753	281	13.4	3.79	98.07
1425	11.54	7.23	.752	280	11.3	3.78	98.07
1430	11.54	7.23	.752	280	11.0	3.78	98.08
1435	11.54	7.23	.752	280	11.6	3.78	98.08

well stabilized @ 1435. GW samples collected. Collected MS/MSD @ ~~49MW02~~ 49TMW02. Fe = ∅.

After samples were collected, Rinseblank RB01272014 was collected @ 1510

1/28/14
B. Cesmat
J. Nildbrand

~~Arrived~~ Held JSA & Tailgate meeting @ 6:30 while standardizing equipment. Equipment calibrated accordingly to spec.

MOB to 49MW03

Pump set @ 115'. pump @ 100ml/min.

PID = ∅

Highly turbid @ start

Started @ 8:00

Time	Temp	pH	Cond	orp	turb	DO	T
8:05	10.86	7.63	.379	261	7800	9.81	106.21
8:10	12.26	7.67	.379	278	642	9.80	106.25
8:15	13.52	7.75	.385	279	245	9.80	106.25
8:20	12.46	7.73	.385	293	84.1	9.79	106.25
8:25	12.31	7.73	.385	295	72.3	9.81	106.25
8:30	12.48	7.69	.386	299	51.8	9.82	106.26
8:35	12.49	7.67	.385	300	35.1	9.81	106.26
8:40	12.49	7.65	.386	301	18.1	9.81	106.26
8:45	12.49	7.65	.386	301	19.8	9.81	106.26
8:50	12.49	7.66	.386	302	17.3	9.80	106.26

well stabilized @ 850. Collected sample Fe = ∅. Geo pump & Mob to 48MW2

48MW2

Setup on well @ 9:30

Pump set @ 131'

PID = ∅

Pump started @ 9:35

Time	Temp	pH	cond	orp	turb	DO	F
9:40	9.78	7.58	.527	286	770	8.14	1262
9:45	10.61	7.57	.525	286	740	8.01	126.24
9:50	12.78	7.53	.515	286	763	7.32	126.22
9:55	12.79	7.52	.513	286	777	7.20	126.22
10:00	13.25	7.54	.514	285	746	7.28	126.22
10:10	13.22	7.53	.519	285	995	7.24	126.22
10:20	13.52	7.52	.519	284	7900	7.42	126.22
10:30	13.38	7.47	.553	281	7900	7.43	126.22
10:40	13.64	7.57	.553	279	7900	7.92	126.22
10:50	13.58	7.50	.527	279	600	7.92	126.22
11:00	12.64	7.25	.571	227	691	7.32	126.22
11:10	13.91	7.23	.575	219	562	7.29	126.22
11:20	13.92	7.24	.574	221	272	7.28	126.23
11:30	13.91	7.24	.574	222	152	7.28	126.23
11:40	13.91	7.25	.575	222	42.3	7.28	126.23
11:50	1	7.25	.575	222	46.8	7.28	126.23
12:00		7.25	.575	222	43.6	7.28	126.23

well declared stable after 2+ hr

Fe = ∅ turb. still high. Sample collected

@ 1200. Decomed pump & MoB To 49MW01.

49MW01

Set up on well @ 1235.

Pump set @ 120'. 100ml/min

PID = ∅

Pump started @ 1240

Time	Temp	pH	cond	orp	turb	DO	F
1245	13.63	7.28	0.542	215	343	4.72	115.62
1250	13.76	7.33	0.541	212	162	4.63	115.63
1255	13.93	7.33	0.543	211	74.4	4.53	115.65
1300	13.75	7.35	0.547	211	63.0	3.92	115.69
1305	13.75	7.35	0.537	212	56.4	4.22	115.69
1310	13.75	7.35	0.537	210	20.4	4.21	115.69
1315	13.75	7.35	0.537	210	19.2	4.21	115.69
1320	13.75	7.35	0537	210	18.4	4.21	115.69

Well stable @ 1320. Sampled @ 1320.

Fe = ∅

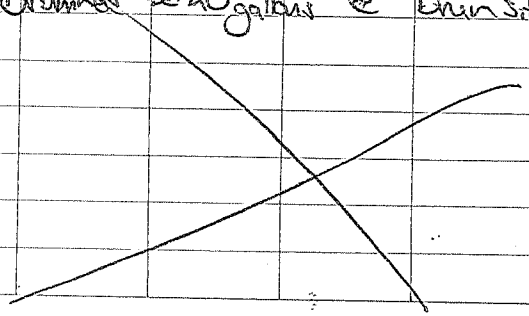
Decomed pump, MoB to 48MW1.

Setup on 48MW1 @ 1345
Pump @ 116'
PID = ∅
Started @ 1350

Time	Temp	pH	cond	orp	Turb	DO	%
1350	10.02	7.39	.582	220	72.0	2.72	105.70
1355	11.90	7.41	.586	209	56.3	2.62	105.74
1400	11.92	7.43	.586	206	34.2	2.60	105.76
1405	11.95	7.47	.581	199	20.1	2.61	105.77
1410	11.95	7.48	.581	195	17.68	2.70	105.77
1415	11.96	7.49	.580	194	17.8	2.71	105.79
1420	11.96	7.49	.580	192	17.4	2.71	105.79
1425	11.96	7.49	.580	191	17.6	2.71	105.79
1430	11.97	7.50	.580	191	16.2	2.71	105.80

well stable @ 1430. Samples collected @ 1430. Fe = ∅

Decon pump & mob from site.
Drummed ≈20 gallons @ Drum site



1/29/14
B. Cseman
J. Hillebrand

Held JSA + Safety meetings @ 6:30.
MOB to site. Calibrated PID + Horiba.
Both pieces of equipment standardized according to specs
Setup on 48MW07 @ 8:00.
Pump set @ 180', 100 ml/min
Started @ 8:05 PID ≠ 0
Highly turbid initially

Time	Temp	pH	cond	orp	Turb	DO	%
8:05	11.29	8.37	.221	244	7800	11.92	47.92
8:15	11.91	8.27	.217	250	7800	11.65	47.95
8:25	11.72	8.28	.216	249	7860	11.64	47.95
8:35	12.20	8.26	.216	251	7800	11.38	47.98
8:45	12.86	8.17	.213	264	344	10.62	4802
8:50	13.09	8.13	.212	271	90.4	10.37	48.05
8:55	13.17	8.06	.212	278	62.2	10.34	48.06
9:00	13.10	8.02	.212	279	54.0	10.34	48.06
9:05	13.10	8.02	.211	277	37.0	10.28	48.07
9:10	13.11	8.02	.211	278	28.1	10.19	48.07
9:15	13.13	8.02	.211	278	14.5	10.19	48.09
9:20	13.13	8.02	.211	280	14.7	10.18	48.09
9:25	13.13	8.02	.211	281	18.9	10.18	48.09

well stable @ 9:25. Collected sample. Fe = ∅
Decon pump & MOB to 48MW06.

Setup on MW06 @ 955
PID = ∅
Pump set @ 75' 100mL/m
Started @ 10:00

Time	temp	pH	cond	orp	turb	DO	∅
1005	13.19	7.52	.621	275	401	1.45	66.31
1010	13.52	7.42	.747	267	396	1.57	66.34
1020	13.87	7.35	.849	326	324	1.79	66.36
1030	14.05	7.32	.956	251	187	1.72	66.37
1040	14.01	7.26	1.04	246	127	1.72	66.36
1050	14.03	7.27	1.11	240	81.7	1.67	66.38
1100	14.03	7.30	1.12	234	68.8	1.56	66.39
1110	14.03	7.29	1.15	231	51.3	1.48	66.39
1120	14.04	7.29	1.15	226	24.2	1.44	66.41
1125	14.05	7.29	1.16	224	19.8	1.36	66.41
1130	14.05	7.30	1.16	222	19.7	1.36	66.41
1135	14.06	7.29	1.16	221	17.4	1.36	66.43

well stable @ 1135. Samples collected.
Pet ∅
Move to Drum storage to dispose purge
& Decon meter. 2-Drums total.
~~Homogenized~~ Drums sampled
ADW01

1/26/15 BCsemack JMillebrand

Pump set @ 17 ft

13MW3 100 ml/min PID Ø Iron Ø

Time	Temp	Cond	DO	PH	ORP	TURB	Δ
855	11.67	0.667	5.50	7.2	244	0.2	
900	11.71	0.665	5.44	7.11	259	0.2	
905	11.77	0.666	5.31	7.11	263	0	
910	11.79	0.669	5.11	7.09	267	0	
915	11.43	0.668	5.07	7.11	271	0	
920	11.57	0.670	4.93	7.10	270	0	

Samples taken @ 925

Pump set @ 20 ft

13MW4 100 ml/min PID Ø Iron 0.50

Time	Temp	Cond	DO	PH	ORP	TURB	Δ
1045	12.59	1.08	1.66	7.31	270	23.8	
1050	12.34	1.09	0.62	7.32	262	23.2	
1055	12.30	1.09	0.34	7.30	256	20.6	
1100	12.43	1.09	0.17	7.29	252	21.1	
1105	12.52	1.09	0.04	7.29	248	19.0	
1110	12.46	1.09	0	7.29	248	16.2	
1115	12.58	1.09	0.03	7.29	234	14.3	

Samples taken @ 1120

Pump set @ 20 ft

13MW5 100 ml/min PID Ø Iron Ø

Time	Temp	Cond	DO	PH	ORP	TURB	Δ
1245	13.49	0.613	3.50	7.28	276	5.0	
1250	13.23	0.60	~~3.6~~ BC 1.59	7.27	270	3.5	
1255	13.30	0.589	1.85	7.21	269	4.9	
1300	13.24	0.580	2.29	7.17	270	5.8	
1305	13.31	0.569	2.72	7.12	274	7.6	

Sampled @ 1310

1501102

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

25439

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 877-345-1113 ♦ (fax) 866-417-0548

11

Send Results to:	Send Invoice to:
Name Eric Malouf	Name
Company CBI Fed Sers.	Company
Address 4696 Millennium Dr	Address
City Belcamp	City
State, Zip MD 21014	State, Zip
Phone	Phone
Fax	Fax
E-mail Eric.Malouf@CBIfederalservices.com	E-mail
Project No./Name:	Sampler's (Signature):

Analysis Requirements: VOC (HCl) | RSK (HCl) | Anion (Nitric) | TOC (H2SO4)

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #

CAR #

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	VOC	RSK	Anion	TOC	Comments	No of Bottles	Lab Use Only Containers/Pres
01	1/26 925	13MW3	GW	3	2	1	1		7	
02	1/26/15 935	49MW04	GW	3	2	1	1		7	
03	1/26/15 935	Trip Blank # 14-0841	GW	2					2	
04	1/26/15 1110	13MW2 ~~1110~~	GW	3	2	1	1		7	
05	1/26/15 1120	13 MW ~~1120~~	GW	3	2	1	1		7	
06	1/26/15 1255	49MW05	GW	3					3	
07	1/26/15 1310	13MW5	GW	3					3	

Relinquished by (Signature)	Date/Time	Received By (Signature)
	1/26/15	
Relinquished by (Signature)	Date/Time	Received By (Signature)
Received for Laboratory by (Signature)	Date/Time	Temperature
	1/27/15 0845	3.7

REMARKS

Details

Page 1 of 1

Cooler No 1 of 1

Date Shipped 1/26/14

Shipped By JN

Turnaround Standard

Distribution: Original and yellow copies accompany sample shipment to laboratory. Pink retained by samplers

1501102 Summ Package

1501116

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

25440

11

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 877-345-1113 ♦ (fax) 866-417-0548

Send Results to:
Name Eric Malanos
Company CBI Fed Serv.
Address 4696 Millennium Dr
City Belcamp
State, Zip MD 21017
Phone
Fax
E-mail
Project No./Name.

Send Invoice to:
Name
Company
Address
City
State, Zip
Phone
Fax
E-mail
Sampler's (Signature)

Analysis Requirements:
(HCl) (HCl) (H2SO4)
VOC RSK Anions TOC

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #
CAR #

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	VOC	RSK	Anions	TOC	Comments	No of Bottles	Lab Use Only Containers/Pres
01	1/27 8:00	Trip Blank 14-0842	GW	2					2	
02	1/27 1035	49MW02	GW	3	2	1	1		7	
03	1/27 1255	50MW02	GW	3	2	1	1		7	
04	1/27 1255	49TM01	GW	3	2	1	1		7	
05	1/27 1435	48MW3	GW	9	6	3	3	MS/MSD	21	
06	1/27 1515	RB012714	GW	3	2	1	1			
07	1/27 1435	49TM02	GW	3	2	1	1			

	Date/Time		
Relinquished by (Signature)		Received By (Signature)	
	1/27 4:00		
Relinquished by (Signature)	Date/Time	Received By (Signature)	
Received for Laboratory by (Signature)	Date/Time 1/28/15 840	Temperature 0.4	

REMARKS:

Details
Page 1 of 1
Cooler No 1 of 1
Date Shipped 1/27
Shipped By JH
Turnaround Standard

Distribution Original and yellow copies accompany sample shipment to laboratory, Pink retained by samplers

1501116 Summ Package

1501124

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

25453

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 877-345-1113 ♦ (fax) 866-417-0548

11

Send Results to:	Send Invoice to:
Name Eric Malaves	Name
Company CBI Fed Serv.	Company
Address 4696 millennium Dr	Address
City Belcamp	City
State, Zip MD 21034	State, Zip
Phone	Phone
Fax	Fax
E-mail	E-mail
Project No./Name: Summ 48/49	**Sampler's (Signature):**

Analysis Requirements: VOC (HCl) · RSK (HCl) · Anions · TOC (HCl)

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	VOC (HCl)	RSK (HCl)	Anions	TOC (HCl)	Comments	No. of Bottles	Lab Use Only Containers/Pres.
01	1/28 835	49MW03	GW	3					3	
02	1/28 800	Trip Blank 140840	GW	2					2	
03	1/28 1200	48MW2	GW	3	2	1	1		7	
04	1/28 1320	49MW01	GW	3	2	1	1		7	
05	1/28 1430	48MW1	GW	3	2	1	1		7	

Relinquished by: (Signature)	Date/Time: 1/28 4:00	Received By: (Signature)	
Relinquished by: (Signature)	Date/Time:	Received By: (Signature)	
Received for Laboratory by: (Signature)	Date/Time: 0945 1/29/15	*Temperature:* 4.1	

REMARKS:

Details:

Page 1 of 1

Cooler No. 1 of 1

Date Shipped 1/28/15

Shipped By JN

Turnaround Standard

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

1501124 Summ Package

1501134
1501134 TH 1/30/15

EMPIRICAL LABORATORIES, LLC - CHAIN OF CUSTODY RECORD

23326

SHIP TO: 621 Mainstream Drive, Suite 270 ♦ Nashville, TN 37228 ♦ 877-345-1113 ♦ (fax) 866-417-0548

Send Results to:	Send Invoice to:
Name Eric Malavet	Name
Company CBI Fed. Serv.	Company
Address 4696 Millennium Dr	Address
City Belcamp	City
State, Zip MD 21017	State, Zip
Phone	Phone
Fax	Fax
E-mail	E-mail

Project No./Name: Summ 45/49 MNA

Sampler's (Signature):

Analysis Requirements: VOC (HCl) · RSK (HCl) · Anions · TOC (Alkaline) · TAL Metals · COD · pH

Lab Use Only:

VOA Headspace	Y	N	NA
Field Filtered	Y	N	NA
Correct Containers	Y	N	NA
Discrepancies	Y	N	NA
Cust. Seals Intact	Y	N	NA
Containers Intact	Y	N	NA

Airbill #:

CAR #:

Lab Use Only Lab #	Date/Time Sampled	Sample Description	Sample Matrix	VOC (HCl)	RSK (HCl)	Anions	TOC (Alkaline)	TAL Metals	COD	pH	Comments	No. of Bottles	Lab Use Only Containers/Pres.
01	1/29 800	Rinseblank	GW	2								2	
02	1/29 925	48MW07	GW	3								3	
03	1/29 1135	48MW06	GW	3	2	1	1					7	
04	1/29 1245	ADW01	GW	3				1	1	1		6	
													1

	Date/Time:	Received By: (Signature)
Relinquished by: (Signature)	1/29 1500	
Relinquished by: (Signature)		
Received for Laboratory by: (Signature)	Date/Time: 1/30/15 835	*Temperature:* 1.9

REMARKS:

Details:

Page 1 of 1

Cooler No. 1 of 1

Date Shipped 1/29

Shipped By JH

Turnaround Standard

Distribution: Original and yellow copies accompany sample shipment to laboratory; Pink retained by samplers.

1501134 Summ Package

CB&I Federal Services, LLC
4696 Millennium Drive, Suite 320
Belcamp, Maryland 21017
Tel: +1 (410) 273-7100
Fax: +1 (225) 952-3016
Eric.malarek@CBIfederalservices.com

MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Chloride, Nitrate, and Sulfate
Empirical Laboratories, LLC; SDG 1501102

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 26, 2015. Samples were analyzed for the chloride, nitrate, and sulfate using USEPA SW-846 9056A. A total of four aqueous samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
13MW3	1501102-01	13MW2	1501102-04
49MW04	1501102-02	13MW4	1501102-05

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Laboratory Duplicate Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate Sample
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
ANIONS REVIEW
SDG 1501102

I-Holding Times and Preservation

The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C and 28 days for sulfate and chloride and Cool to 4°C±2°C with H_2SO_4 to pH<2 and 2 days for nitrate. The dates and times were compared between the sample collection and laboratory analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/26/15, the cooler was received by the laboratory (Empirical) on 01/27/15 at 3.7°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: Samples were collected on 01/26/15. The samples were prepped and analyzed on 01/27/15 for sulfate and nitrate analysis and on 01/27/15 and 02/03/15 for chloride analysis. Sample collection dates may be found on the attached form 1s. All holding time criteria were met. No qualifiers were applied.

II-Initial and Continuing Calibration

Requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

Anions: 1 – blank
5 – standards ($r \geq 0.995$ or $r^2 \geq 0.99$)
ICV/CCV (90-110%)
Method Reporting Limit (MRL) (50-150%)

- Chloride, sulfate, and nitrate analysis was calibrated on 12/16/14 using linear equation techniques. All correlation coefficients were ≥0.995 for chloride, sulfate, and nitrate. All ICV/CCV/MRL criteria were met for all anions and runs. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to these initial and continuing calibrations.

III-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <2MDL for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (for this SDG)
01/27/15	Chloride	ICB/CCBs	<LOD	NA	None
01/27/15	Sulfate	ICB/CCBs	<LOD	NA	None
01/27/15	Nitrate	ICB/CCBs	<LOD	NA	None
02/03/15	Chloride	ICB/CCBs	<LOD	NA	None
01/27/15	Chloride	5A27016-BLK1	0.384	1.92	None
01/27/15	Sulfate	5A27016-BLK1	<½MRL	NA	None
01/27/15	Nitrate	5A27016-BLK1	<½MRL	NA	None
02/03/15	Chloride	5B03415-BLK1	<½MRL	NA	None
01/28/15	Chloride	RB012715	<½MRL	NA	None
01/28/15	Sulfate	RB012715	<½MRL	NA	None
01/28/15	Nitrate	RB012715	<½MRL	NA	None

J = Estimated Value >MDL and <MRL
LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample

The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Per DoD QSM, all LCS results must fall within the specified control limits: 80-120%

- Sample 5A27016-BS1 was used as the aqueous LCS for chloride, sulfate, and nitrate analysis on 01/27/15. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) [excluding chloride for sample 13MW2 (1501102-04)] apply to this LCS.

- Sample 5B03415-BS1 was used as the aqueous LCS for chloride analysis on 02/03/15. All criteria were met. No qualifiers were applied. Sample 13MW2 (1501102-04) applies to this LCS.

V-Duplicate Sample Analysis

Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. Per DoD QSM, RPDs must be within established control limits (≤25%RPD).

- No site lab duplicate was performed with this SDG; therefore, was not evaluated.

VI-Matrix Spike and Matrix Spike Duplicate
Matrix spikes (MSs) and MSDs are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples or preparatory batch of similar matrix. Per DoD QSM, MS/MSD recoveries and RPDs should be within the specified limits:

Anions: 80-120%; RPD≤20%

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for chloride, sulfate, and nitrate analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 13MW3 (1501102-01), sulfate

$Y = mX + b$

Y = Sample Area
m = slope of curve
X = Concentration (mg/L)
b = Y-intercept
DF = Dilution Factor

Given:
m = 0.202746
b = 0.0
Y = Area = 25.5384561
DF = 1

X = 126 mg/L * DF = 126 mg/L * 1 = 126 mg/L

Reported concentration = 126 mg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Total Organic Carbon
Empirical Laboratories, LLC; SDG 1501102

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 26, 2015. Samples were analyzed for Total Organic Carbon (TOC) using USEPA SW-846 9060A. A total of four aqueous samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
13MW3	1501102-01	13MW2	1501102-04
49MW04	1501102-02	13MW4	1501102-05

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Laboratory Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
TOC REVIEW
SDG 1501102

I-Holding Times and Preservation
The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C, HCl pH<2, 28 days for TOC (USEPA criteria). The dates and times were compared between the sample collection and laboratory analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/26/15, the cooler was received by the laboratory (Empirical) on 01/27/15 at 3.7°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: The samples were collected on 01/26/15. The TOC analysis was run on 01/27/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifier was applied.

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial and continuing calibration (90-110%) must be within limits.

TOC: 1 - blank
5 - standards ($r \geq 0.995$)
ICV/CCV (80-120%)

- The TOC analysis was run on 01/27/15. The initial calibration for TOC was analyzed on 01/19/15 with a coefficient of determination of 0.9996. The ICV and CCVs were evaluated for where they bracketed reported samples. All ICV/CCVs that bracketed reported samples were within criteria. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to these initial and continuing calibrations.

III-Blank Analysis
The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <LOD (i.e. <2MDL) for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (For this SDG)
01/27/15	TOC	ICB/CCBs	<LOD	NA	None
01/27/15	TOC	5A27017-BLK1	<½MRL	NA	None
02/05/15	TOC	RB012714	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample
The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. All aqueous LCS results must fall within the control limits (80-120%).

- Sample 5A27017-BS1 was used as the aqueous LCS for TOC analysis on 01/27/15. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to this LCS.

V-Matrix Spike and Spike Duplicate
Matrix spikes (MSs) and matrix spike duplicates (MSDs) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples of similar matrix. The percent recoveries (%Rs or RPD) must be within the specified control limits (75-125%; RPD≤20%).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VI-Laboratory Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits (≤20%RPD).

- No aqueous laboratory duplicate was analyzed for TOC with this SDG; therefore, it was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for TOC analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 5A27017-BS1, TOC

TOC: Y = m*X (mg/L) + b
m = 11.56
b = 0.00
Y = 311.6
DF = 1

TOC (mg/L) = X = (26.96 mg/L) * 1 = 26.96 mg/L

Reported Value = 26.96 mg/L
% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

ANALYSIS DATA SHEET

13MW3

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/26/15 09:25

SDG: 1501102
Project: Radford AAP
Laboratory ID: 1501102-01
Received: 01/27/15 08:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**3.88**	**0.170**	0.330	0.500	1		SW9056A	5A27016	01/27/15 19:14
14797-55-8	Nitrate as N	**1.66**	**0.0330**	0.100	0.250	1		SW9056A	5A27016	01/27/15 19:14
14808-79-8	Sulfate as SO4	**126**	**0.330**	1.00	2.50	1		SW9056A	5A27016	01/27/15 19:14
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5A27017	01/27/15 17:41

ANALYSIS DATA SHEET

49MW04

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/26/15 09:35

SDG: 1501102
Project: Radford AAP
Laboratory ID: 1501102-02
Received: 01/27/15 08:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**5.16**	**0.170**	0.330	0.500	1		SW9056A	5A27016	01/27/15 19:32
14797-55-8	Nitrate as N	**0.249**	**0.0330**	0.100	0.250	1	J	J SW9056A	5A27016	01/27/15 19:32
14808-79-8	Sulfate as SO4	**53.6**	**0.330**	1.00	2.50	1		SW9056A	5A27016	01/27/15 19:32
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5A27017	01/27/15 18:03

ANALYSIS DATA SHEET

13MW2

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/26/15 11:10

SDG: 1501102
Project: Radford AAP
Laboratory ID: 1501102-04
Received: 01/27/15 08:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**2.75**	**0.170**	0.330	0.500	1		SW9056A	5B03415	02/03/15 15:42
14797-55-8	Nitrate as N	**0.0715**	**0.0330**	0.100	0.250	1	J	SW9056A	5A27016	01/27/15 19:50
14808-79-8	Sulfate as SO4	**45.9**	**0.330**	1.00	2.50	1		SW9056A	5A27016	01/27/15 19:50
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5A27017	01/27/15 18:26

ANALYSIS DATA SHEET

13MW4

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/26/15 11:20

SDG: 1501102
Project: Radford AAP
Laboratory ID: 1501102-05
Received: 01/27/15 08:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**11.5**	**0.170**	0.330	0.500	1		SW9056A	5A27016	01/27/15 20:07
14797-55-8	Nitrate as N		0.0330	0.100	0.250	1	U	SW9056A	5A27016	01/27/15 20:07
14808-79-8	Sulfate as SO4	**23.8**	**0.330**	1.00	2.50	1		SW9056A	5A27016	01/27/15 20:07
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5A27017	01/27/15 18:49

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation – Methane, Ethane, and Ethene
Empirical Laboratories, LLC; SDG 1501102

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 26, 2015. The samples were analyzed for methane, ethane, and ethene using laboratory method RSK-175. A total of four aqueous samples were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
13MW3	1501102-01	13MW2	1501102-04
49MW04	1501102-02	13MW4	1501102-05

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial Calibration
	X	Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
DISSOLVED GASES REVIEW
SDG 1501102

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For methane, ethane, and ethene, aqueous samples are cooled @ 4°C ± 2°C; the maximum holding time is 7 days un-preserved and 14 days preserved to pH<2 with HCl from sample collection to analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/26/15, the cooler was received by the laboratory (Empirical) on 01/27/15 at 3.7°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: The aqueous samples were collected on 01/26/15. They were prepped and analyzed for the dissolved gases on 02/04/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the calibration factors on which the quantitations are based. If linear regression is used for quantification, the correlation coefficient must be ≥0.995 for linearity fit (DoD QSM). If calibration factor method is used, the %RSD should be ≤20% (DoD QSM). All ICVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration performed on 11/30/14 on instrument GL-GCVOA, all target compounds were within criteria (%RSD≤20%%; RRF≥0.05) except for the following. Target compound methane (27.9%) was outside criteria. Methane (r^2=0.9991; quadratic) was quantified using second order regression with coefficient of determination r^2≥0.99; therefore, no qualifiers were applied based upon this outlier. All other target compounds were quantified using calibration factor method. All criteria were met. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to this initial calibration.

III-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. If calibration factor method is used, the percent difference (%D) should all fall within the control criteria of ≤20% (DoD QSM). All CCVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration verification for methane, ethane, and ethene performed on 12/01/14 @00:44 on instrument GL-GCVOA, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this initial calibration verification.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @11:47 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @15:11 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

IV-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks. The DoD QSM criterion specifies all concentrations should be less than one-half MRL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤5 times (5x) the maximum amount for explosive target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (For this SDG)
02/04/15	5B04002-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	All target <½MRL	NA	NA	None

MRL = Method Reporting Limit
NA = Not Applicable

V-Laboratory Control Sample

Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. DoD LCS aqueous recovery limits are specified in the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. Percent recoveries (%Rs) should be within the specified control limits.

- Sample 5B04002-BS1 was used as LCS for methane, ethane, and ethene analysis performed on 02/04/15. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), 13MW2 (1501102-04), and 13MW4 (1501102-05) apply to this LCS.

VI-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. DoD QSM MS and MSD recovery limits use the LCS criteria, which currently is the use of in-house specified limits (DoD, 2010).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis

Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established in the Groundwater Monitored Natural Attenuation (GWMNA) QAPP at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results was verified and data results reviewed. The following was determined:

- The percent difference (%D) between the calculated and the reported values should be within 10% through the calculation from the raw data provided. The calculation verification was confirmed within 10% difference.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 5B04002-BS1, ethane

Conc. µg/L = (((Vhs*(Ax/CF))/Vs*Density)+((Ax/CF)/HLC)*55.5/1.137*(MW*1000))*DF

Where:

Ax	= Area of characteristic ion for compound being measured.
CF	= Average relative calibration factor for compound being measured (from ICAL)
MW	= molecular weight of analyte = 30.0 ug/umol
DF	= dilution factor 1
Vhs	= Volume of headspace = 5.5 mL
Vs	= Volume of sample = 0.015 L
Density	= 0.64356M,1.1262Ee,or 1.2067Ea
HLC	= Henry's Law Constant = 44900M,12700Ee, or 34200Ea

Conc. µg/L =
(((5.5*(561935/550513.3))/0.015*1.2067)+((561935/550513.3)/34200)*55.5/1.137*(30*1000))*1
= 495.3 µg/L

Reported Value = 495.3 µg/L

% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

13MW3

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-01	File ID:	005F0501.D\Report.TXT
Sampled:	01/26/15 09:25	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 12:28
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

49MW04

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-02	File ID:	006F0601.D\Report.TXT
Sampled:	01/26/15 09:35	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 12:41
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

13MW2

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-04	File ID:	007F0701.D\Report.TXT
Sampled:	01/26/15 11:10	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 12:55
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

13MW4

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-05 File ID: 008F0801.D\Report.TXT

Sampled: 01/26/15 11:20 Prepared: 02/04/15 07:09 Analyzed: 02/04/15 13:09

Solids: Preparation: RSK175 Dilution: 1

Batch: 5B04002 Sequence: 5B03704 Calibration: 4335002 Instrument: GL-GCVOA

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation - Volatiles
Empirical Laboratories, LLC; SDG 1501102

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 26, 2015. The samples were analyzed for volatile organic compounds (VOCs) using USEPA SW846 method 5030B/8260B for aqueous matrices. A total of seven aqueous samples (includes one trip blank) were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
13MW3	1501102-01	13MW4	1501102-05
49MW04	1501102-02	49MW05	1501102-06
Trip Blank #14-0841	1501102-03	13MW5	1501102-07
13MW2	1501102-04		

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Instrument Performance Results
	X	Initial Calibration
	X	Continuing Calibration
X		Blank Analysis
	X	Laboratory Control Sample and Laboratory Control Sample Duplicate
	X	Matrix Spike / Spike Duplicate Sample
	X	System Monitoring Compounds
	X	Internal Standards
	X	Field Sample Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
VOLATILES REVIEW
SDG 1501102

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For aqueous samples, VOC compounds are shipped cooled (@4°C ± 2°C) and preserved pH≤2 HCl with a maximum holding time of 14 days (7 days if no HCl) from sample collection to determinative analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/26/15, the cooler was received by the laboratory (Empirical) on 01/27/15 at 3.7°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: For the samples collected on 01/26/15, the aqueous VOCs were prepped and analyzed on 02/03/15. Sample collection and analysis dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check
The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, bromofluorobenzene (BFB), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the relative response factors on which the quantitations are based. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent relative standard deviation (%RSD) must be ≤15% for each target compound and must be ≤30% for each calibration check compound. For compounds analyzed using linear regression or second order, correlation coefficients must be >0.995 and coefficients of determination >0.99.

- For initial calibration performed on 02/02/15 on instrument MS-VOA6, target compounds bromoform (19.7%), bromomethane (23.9%), 2-butanone (21.1%), and carbon tetrachloride (19.8%) were outside criteria. All other target compounds were within criteria (%RSD≤15% or ≤30%; RRF≥0.05). Bromoform, bromomethane, 2-butanone, and carbon tetrachloride were quantified using second order quadratic equation with coefficients of determination >0.99. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), Trip Blank #14-0841 (1501102-03), 13MW2 (1501102-04), 13MW4 (1501102-05), 49MW05 (1501102-06), and 13MW5 (1501102-07) were analyzed using this initial calibration.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within 20% for all target compounds. The initial calibration verification should be between 80-120% recoveries.

- For initial calibration verification for the VOC analysis performed on 02/02/15 @15:40 on instrument MS-VOA6, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No samples reported were analyzed using this initial calibration verification.

- For continuing calibration for the VOC analysis performed on 02/03/15 @09:48 on instrument MS-VOA6, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). Samples 13MW3 (1501102-01), 49MW04 (1501102-02), Trip Blank #14-0841 (1501102-03), 13MW2 (1501102-04), 13MW4 (1501102-05), 49MW05 (1501102-06), and 13MW5 (1501102-07) were analyzed using this continuing calibration.

V-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. A method blank analysis must be performed after the calibration standards and once every 12-hour time period beginning with the injection of BFB. No contaminants should be detected in any of the associated blanks > the MDL. The DoD QSM criteria specifies all concentrations should be less than one-half MRL (<MRL for common laboratory contaminants methylene chloride, acetone, and 2-butanone). Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, and 2-butanone (MEK), or 5 times (5X) the maximum amount for other volatile target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG. Trip blank sample Trip Blank #14-0841 (1501102-03) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (for this SDG)
02/03/15	5B03424-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	Acetone	9.32J	93.2	49MW05
02/03/15	Trip Blank #14-0841	All target <½MRL	NA	NA	None

J = Estimated value <MRL and >MDL.
NA = Not Applicable
MRL = Method Reporting Limit
MDL = Method Detection Limit
LOD = Level of Detection

VI-Laboratory Control Sample and Laboratory Control Sample Duplicate
Data for laboratory control samples (LCS) and LCSD are evaluated to determine long-term precision and accuracy of the analytical method on various matrices. Percent recoveries (%Rs) should be within the specified control limits. DoD LCS aqueous recovery limits are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. The LCS/LCSD RPD should be ≤30%.

- Samples 5B03424-BS1 and 5B03424-BSD1 were used as the aqueous LCS/LCSD for the VOC analysis on 02/03/15. All criteria were met. No qualifiers were applied. Samples 13MW3 (1501102-01), 49MW04 (1501102-02), Trip Blank #14-0841 (1501102-03), 13MW2 (1501102-04), 13MW4 (1501102-05), 49MW05 (1501102-06), and 13MW5 (1501102-07) apply to this LCS/LCSD.

VII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. The DoD MS/MSD aqueous recovery limits follow the LCS criteria and are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. The MS/MSD RPD should be ≤30%.

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VIII-System Monitoring Compounds (Surrogates)
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Recoveries for system monitoring compounds in volatile samples and blanks must be within the specified control limits. DoD surrogate recovery limits are specified in Table G-3 of the DoD QSM (DoD, 2010). If the surrogate is not listed, then the laboratory criteria shall be used.

Aqueous Criteria: 4-Bromofluorobenzene (75-120%; RT±1.000)
Dibromofluoromethane (85-115%; RT±1.000)
1,2-Dichloroethane-d4 (70-120%; RT±1.000)
Toluene-d8 (85-120%; RT±1.000)

- All criteria were met. No qualifiers were applied.

IX-Internal Standards (IS)
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Specific criteria include: area counts (-50% to +100%) of the associated calibration standard, and retention time (± 30 seconds) from that of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

X-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

XI-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 13MW3 (1501102-01), trichloroethene

Conc. (µg/L) = (Ax)*(Is)*(DF) / (Ais)*(RRF)

where: Ax is the compound area
Ais is the corresponding internal standard area
Is is the corresponding internal standard concentration (µg/L)
DF is the dilution factor
RRF is the relative response factor.

Conc. µg/L = (7820 * 30 µg/L * 1) / (812690 * 0.327063) = 0.883 µg/L

Reported Conc. = 0.883 µg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

13MW3

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-01 File ID: 0110201B.D

Sampled: 01/26/15 09:25 Prepared: 02/03/15 14:52 Analyzed: 02/03/15 14:52

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride	**4.62**	0.250	0.500	1.00	
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform	**0.470**	0.250	0.500	1.00	J
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene	**0.883**	0.250	0.500	1.00	J
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.44	98.1	75 - 120	
Dibromofluoromethane	30.00	29.79	99.3	85 - 115	
1,2-Dichloroethane-d4	30.00	29.09	97.0	70 - 120	

ANALYSIS DATA SHEET

13MW3

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-01	File ID:	0110201B.D
Sampled:	01/26/15 09:25	Prepared:	02/03/15 14:52	Analyzed:	02/03/15 14:52
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.20	97.3	85 - 120	

ANALYSIS DATA SHEET

49MW04

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-02 File ID: 0110202B.D

Sampled: 01/26/15 09:35 Prepared: 02/03/15 15:19 Analyzed: 02/03/15 15:19

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride	**0.662**	0.250	0.500	1.00	J
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform	**1.46**	0.250	0.500	1.00	
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.31	97.7	75 - 120	
Dibromofluoromethane	30.00	29.92	99.7	85 - 115	
1,2-Dichloroethane-d4	30.00	28.79	96.0	70 - 120	

ANALYSIS DATA SHEET

49MW04

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-02	File ID:	0110202B.D
Sampled:	01/26/15 09:35	Prepared:	02/03/15 15:19	Analyzed:	02/03/15 15:19
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.56	98.5	85 - 120	

ANALYSIS DATA SHEET

Trip Blank #14-0841

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-03 File ID: 0110203A.D

Sampled: 01/26/15 09:35 Prepared: 02/03/15 13:02 Analyzed: 02/03/15 13:02

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	U
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	30.27	101	75 - 120	
Dibromofluoromethane	30.00	28.98	96.6	85 - 115	
1,2-Dichloroethane-d4	30.00	28.75	95.8	70 - 120	

ANALYSIS DATA SHEET

Trip Blank #14-0841

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-03	File ID:	0110203A.D
Sampled:	01/26/15 09:35	Prepared:	02/03/15 13:02	Analyzed:	02/03/15 13:02
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.70	99.0	85 - 120	

ANALYSIS DATA SHEET

13MW2

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-04 File ID: 0110204B.D

Sampled: 01/26/15 11:10 Prepared: 02/03/15 15:47 Analyzed: 02/03/15 15:47

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	U
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.69	99.0	75 - 120	
Dibromofluoromethane	30.00	29.80	99.3	85 - 115	
1,2-Dichloroethane-d4	30.00	29.23	97.4	70 - 120	

ANALYSIS DATA SHEET

13MW2

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-04	File ID:	0110204B.D
Sampled:	01/26/15 11:10	Prepared:	02/03/15 15:47	Analyzed:	02/03/15 15:47
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.45	98.2	85 - 120	

ANALYSIS DATA SHEET

13MW4

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-05 File ID: 0110205B.D

Sampled: 01/26/15 11:20 Prepared: 02/03/15 16:14 Analyzed: 02/03/15 16:14

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride	**0.592**	0.250	0.500	1.00	J
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.26	97.5	75 - 120	
Dibromofluoromethane	30.00	29.88	99.6	85 - 115	
1,2-Dichloroethane-d4	30.00	29.95	99.8	70 - 120	

ANALYSIS DATA SHEET

13MW4

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-05	File ID:	0110205B.D
Sampled:	01/26/15 11:20	Prepared:	02/03/15 16:14	Analyzed:	02/03/15 16:14
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.45	98.2	85 - 120	

ANALYSIS DATA SHEET

49MW05

Laboratory: Empirical Laboratories, LLC | SDG: 1501102

Client: CB&I | Project: Radford AAP

Matrix: Water | Laboratory ID: 1501102-06 | File ID: 0110206B.D

Sampled: 01/26/15 12:55 | Prepared: 02/03/15 16:42 | Analyzed: 02/03/15 16:42

Solids: | Preparation: 5030B | Dilution: 2

Batch: 5B03424 | Sequence: 5B03707 | Calibration: 5035003 | Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone	**18.6**	5.00	10.0	20.0	JD
71-43-2	Benzene		0.500	1.00	2.00	U
75-27-4	Bromodichloromethane		0.500	1.00	2.00	U
75-25-2	Bromoform		0.500	1.00	2.00	U
74-83-9	Bromomethane		1.00	2.00	4.00	U
78-93-3	2-Butanone		5.00	10.0	20.0	U
75-15-0	Carbon disulfide		0.500	1.00	2.00	U
56-23-5	Carbon tetrachloride		0.500	1.00	2.00	U
108-90-7	Chlorobenzene		0.500	1.00	2.00	U
75-00-3	Chloroethane		1.00	2.00	4.00	U
67-66-3	Chloroform		0.500	1.00	2.00	U
74-87-3	Chloromethane		0.500	1.00	2.00	U
124-48-1	Dibromochloromethane		0.500	1.00	2.00	U
75-34-3	1,1-Dichloroethane		0.500	1.00	2.00	U
107-06-2	1,2-Dichloroethane		0.500	1.00	2.00	U
75-35-4	1,1-Dichloroethene		0.500	1.00	2.00	U
156-59-2	cis-1,2-Dichloroethene		0.500	1.00	2.00	U
156-60-5	trans-1,2-Dichloroethene		0.500	1.00	2.00	U
78-87-5	1,2-Dichloropropane		0.500	1.00	2.00	U
10061-01-5	cis-1,3-Dichloropropene		0.500	1.00	2.00	U
10061-02-6	trans-1,3-Dichloropropene		0.500	1.00	2.00	U
100-41-4	Ethylbenzene		0.500	1.00	2.00	U
591-78-6	2-Hexanone		2.50	5.00	10.0	U
75-09-2	Methylene chloride		1.00	2.00	4.00	U
108-10-1	4-Methyl-2-pentanone		2.50	5.00	10.0	U
100-42-5	Styrene		0.500	1.00	2.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.500	1.00	2.00	U
127-18-4	Tetrachloroethene		0.500	1.00	2.00	U
108-88-3	Toluene		0.500	1.00	2.00	U
79-00-5	1,1,2-Trichloroethane		0.500	1.00	2.00	U
71-55-6	1,1,1-Trichloroethane		0.500	1.00	2.00	U
79-01-6	Trichloroethene		0.500	1.00	2.00	U
75-01-4	Vinyl chloride		0.500	1.00	2.00	U
108-38-3/106-42-	m,p-Xylene		1.00	2.00	4.00	U
95-47-6	o-Xylene		0.500	1.00	2.00	U

B

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.24	97.5	75 - 120	
Dibromofluoromethane	30.00	30.49	102	85 - 115	
1,2-Dichloroethane-d4	30.00	28.40	94.7	70 - 120	

ANALYSIS DATA SHEET

49MW05

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-06	File ID:	0110206B.D
Sampled:	01/26/15 12:55	Prepared:	02/03/15 16:42	Analyzed:	02/03/15 16:42
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.01	96.7	85 - 120	

ANALYSIS DATA SHEET

13MW5

Laboratory: Empirical Laboratories, LLC SDG: 1501102

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501102-07 File ID: 0110207B.D

Sampled: 01/26/15 13:10 Prepared: 02/03/15 17:09 Analyzed: 02/03/15 17:09

Solids: Preparation: 5030B Dilution: 1

Batch: 5B03424 Sequence: 5B03707 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	U
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene	**1.42**	0.250	0.500	1.00	
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.74	99.1	75 - 120	
Dibromofluoromethane	30.00	29.99	100	85 - 115	
1,2-Dichloroethane-d4	30.00	29.78	99.3	70 - 120	

ANALYSIS DATA SHEET

13MW5

Laboratory:	Empirical Laboratories, LLC			SDG:	1501102
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501102-07	File ID:	0110207B.D
Sampled:	01/26/15 13:10	Prepared:	02/03/15 17:09	Analyzed:	02/03/15 17:09
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B03424	Sequence:	5B03707	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.50	98.3	85 - 120	

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Chloride, Nitrate, and Sulfate
Empirical Laboratories, LLC; SDG 1501116

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 27, 2015. Samples were analyzed for the chloride, nitrate, and sulfate using USEPA SW-846 9056A. A total of six aqueous samples (includes one rinse blank) were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
49MW02	1501116-02	48MW3	1501116-05
50MW02	1501116-03	RB012714	1501116-06
49TM01	1501116-04	49TM02	1501116-07

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Laboratory Duplicate Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate Sample
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
ANIONS REVIEW
SDG 1501116

I-Holding Times and Preservation

The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C and 28 days for sulfate and chloride and Cool to 4°C±2°C with H_2SO_4 to pH<2 and 2 days for nitrate. The dates and times were compared between the sample collection and laboratory analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/27/15, the cooler was received by the laboratory (Empirical) on 01/28/15 at 0.4°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: Samples were collected on 01/27/15. The samples were prepped and analyzed on 01/28/15 for sulfate, chloride, and nitrate analysis. Sample collection dates may be found on the attached form 1s. All holding time criteria were met. No qualifiers were applied.

II-Initial and Continuing Calibration

Requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

Anions: 1 – blank
5 – standards ($r \geq 0.995$ or $r^2 \geq 0.99$)
ICV/CCV (90-110%)
Method Reporting Limit (MRL) (50-150%)

- Chloride, sulfate, and nitrate analysis was calibrated on 12/16/14 using linear equation techniques. All correlation coefficients were ≥0.995 for chloride, sulfate, and nitrate. All ICV/CCV/MRL criteria were met for all anions and runs. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to these initial and continuing calibrations.

III-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <2MDL for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (for this SDG)
01/28/15	Chloride	ICB/CCBs	<LOD	NA	None
01/28/15	Sulfate	ICB/CCBs	<LOD	NA	None
01/28/15	Nitrate	ICB/CCBs	<LOD	NA	None
01/28/15	Chloride	5A28014-BLK1	<½MRL	NA	None
01/28/15	Sulfate	5A28014-BLK1	<½MRL	NA	None
01/28/15	Nitrate	5A28014-BLK1	<½MRL	NA	None
01/28/15	Chloride	RB012715	<½MRL	NA	None
01/28/15	Sulfate	RB012715	<½MRL	NA	None
01/28/15	Nitrate	RB012715	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample

The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Per DoD QSM, all LCS results must fall within the specified control limits: 80-120%

- Sample 5A28014-BS1 was used as the aqueous LCS for chloride, sulfate, and nitrate analysis on 01/28/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this LCS.

V-Duplicate Sample Analysis

Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. Per DoD QSM, RPDs must be within established control limits (≤25%RPD).

- Sample 48MW3 (1501116-05) was used as the aqueous lab duplicate for chloride, sulfate, and nitrate analysis on 01/28/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this lab duplicate.

VI-Matrix Spike and Matrix Spike Duplicate
Matrix spikes (MSs) and MSDs are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples or preparatory batch of similar matrix. Per DoD QSM, MS/MSD recoveries and RPDs should be within the specified limits:

Anions: 80-120%; RPD≤20%

- Sample 48MW3 (1501116-05) was used as the aqueous MS/MSD for chloride, sulfate, and nitrate analysis on 01/28/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this MS/MSD.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- Field groundwater sample duplicate pair 50MW02 (1501116-03) and 49TM01 (1501116-04) was analyzed for chloride, sulfate, and nitrate analysis in this SDG. All detected chloride, sulfate, and nitrate found in the sample and its duplicate pair and associated %RPD are noted in **Table 3**. All criteria were met. No qualifiers were applied.

Table 3 Field Precision Analysis Summary for Anions for Duplicate Pair 50MW02 (1501116-03) and 49TM01 (1501116-04)

Compound	Original Sample (mg/L)	Duplicate Pair (mg/L)	%RPD
Chloride	7.27	6.99	3.9
Nitrate	2.06	2.05	0.5
Sulfate	73.2	73.0	0.3

- Field groundwater sample duplicate pair 48MW3 (1501116-05) and 49TM02 (1501116-07) was analyzed for chloride, sulfate, and nitrate analysis in this SDG. All detected chloride, sulfate, and nitrate found in the sample and its duplicate pair and associated %RPD are noted in **Table 3**. All criteria were met. No qualifiers were applied.

Table 4 Field Precision Analysis Summary for Anions for Duplicate Pair 48MW3 (1501116-05) and 49TM02 (1501116-07)

Compound	Original Sample (mg/L)	Duplicate Pair (mg/L)	%RPD
Chloride	2.22	2.25	1.3
Nitrate	6.40	6.44	0.6
Sulfate	29.8	30.0	0.7

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 49MW02 (1501116-02), sulfate

$Y = mX + b$

Y = Sample Area
m = slope of curve
X = Concentration (mg/L)
b = Y-intercept
DF = Dilution Factor

Given:
m = 0.202746
b = 0.0
Y = Area = 5.3982647
DF = 1

X = 26.6 mg/L * DF = 26.6 mg/L * 1 = 26.6 mg/L

Reported concentration = 26.6 mg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Total Organic Carbon
Empirical Laboratories, LLC; SDG 1501116

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 27, 2015. Samples were analyzed for Total Organic Carbon (TOC) using USEPA SW-846 9060A. A total of six aqueous samples (includes one rinse blank) were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
49MW02	1501116-02	48MW3	1501116-05
50MW02	1501116-03	RB012714	1501116-06
49TM01	1501116-04	49TM02	1501116-07

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Laboratory Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
TOC REVIEW
SDG 1501116

I-Holding Times and Preservation
The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C, HCl pH<2, 28 days for TOC (USEPA criteria). The dates and times were compared between the sample collection and laboratory analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/27/15, the cooler was received by the laboratory (Empirical) on 01/28/15 at 0.4°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: The samples were collected on 01/27/15. The TOC analysis was run on 02/05/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifier was applied.

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial and continuing calibration (90-110%) must be within limits.

TOC:	1 - blank
	5 - standards ($r \geq 0.995$)
	ICV/CCV (80-120%)

- The TOC analysis was run on 02/05/15. The initial calibration for TOC was analyzed on 01/19/15 with a coefficient of determination of 0.9996. The ICV and CCVs were evaluated for where they bracketed reported samples. All ICV/CCVs that bracketed reported samples were within criteria. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to these initial and continuing calibrations.

III-Blank Analysis
The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <LOD (i.e. <2MDL) for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (For this SDG)
02/05/15	TOC	ICB/CCBs	<LOD	NA	None
02/05/15	TOC	5B05019-BLK1	<½MRL	NA	None
02/05/15	TOC	RB012714	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample
The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. All aqueous LCS results must fall within the control limits (80-120%).

- Sample 5B05019-BS1 was used as the aqueous LCS for TOC analysis on 02/05/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this LCS.

V-Matrix Spike and Spike Duplicate
Matrix spikes (MSs) and matrix spike duplicates (MSDs) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples of similar matrix. The percent recoveries (%Rs or RPD) must be within the specified control limits (75-125%; RPD≤20%).

- Sample 48MW3 (1501116-05) was used as the aqueous MS/MSD for TOC analysis on 02/05/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this MS/MSD.

VI-Laboratory Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits (≤20%RPD).

- Sample 48MW3 (1501116-05) was used as the aqueous lab duplicate for TOC analysis on 02/05/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this lab duplicate.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- Field groundwater sample duplicate pair 50MW02 (1501116-03) and 49TM01 (1501116-04) was analyzed for TOC analysis in this SDG. TOC was non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

- Field groundwater sample duplicate pair 48MW3 (1501116-05) and 49TM02 (1501116-07) was analyzed for TOC analysis in this SDG. TOC was non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 5B05019-BS1, TOC

TOC: Y = m*X (mg/L) + b
m = 11.56
b = 0.00
Y = 322.2
DF = 1

TOC (mg/L) = X = (27.87 mg/L) * 1 = 27.87 mg/L

Reported Value = 27.87 mg/L
% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

ANALYSIS DATA SHEET

49MW02

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 10:55

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-02
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**3.45**	**0.170**	0.330	0.500	1		SW9056A	5A28014	01/28/15 13:14
14797-55-8	Nitrate as N	**0.0476**	**0.0330**	0.100	0.250	1	J	J SW9056A	5A28014	01/28/15 13:14
14808-79-8	Sulfate as SO4	**26.6**	**0.330**	1.00	2.50	1		SW9056A	5A28014	01/28/15 13:14
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 17:48

ANALYSIS DATA SHEET

50MW02

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 12:55

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-03
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**7.27**	**0.170**	0.330	0.500	1		SW9056A	5A28014	01/28/15 13:32
14797-55-8	Nitrate as N	**2.06**	**0.0330**	0.100	0.250	1		SW9056A	5A28014	01/28/15 13:32
14808-79-8	Sulfate as SO4	**73.2**	**0.330**	1.00	2.50	1		SW9056A	5A28014	01/28/15 13:32
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 18:11

ANALYSIS DATA SHEET

49TM01

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 12:55

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-04
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**6.99**	**0.170**	0.330	0.500	1		SW9056A	5A28014	01/28/15 13:50
14797-55-8	Nitrate as N	**2.05**	**0.0330**	0.100	0.250	1		SW9056A	5A28014	01/28/15 13:50
14808-79-8	Sulfate as SO4	**73.0**	**0.330**	1.00	2.50	1		SW9056A	5A28014	01/28/15 13:50
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 18:33

ANALYSIS DATA SHEET

48MW3

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 14:35

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-05
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**2.22**	**0.170**	0.330	0.500	1		SW9056A	5A28014	01/28/15 14:08
14797-55-8	Nitrate as N	**6.40**	**0.0330**	0.100	0.250	1		SW9056A	5A28014	01/28/15 14:08
14808-79-8	Sulfate as SO4	**29.8**	**0.330**	1.00	2.50	1		SW9056A	5A28014	01/28/15 14:08
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 18:56

ANALYSIS DATA SHEET

RB012714

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 15:15

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-06
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride		0.170	0.330	0.500	1	U	SW9056A	5A28014	01/28/15 15:19
14797-55-8	Nitrate as N		0.0330	0.100	0.250	1	U	SW9056A	5A28014	01/28/15 15:19
14808-79-8	Sulfate as SO4		0.330	1.00	2.50	1	U	SW9056A	5A28014	01/28/15 15:19
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 20:19

ANALYSIS DATA SHEET

49TM02

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/27/15 14:35

SDG: 1501116
Project: Radford AAP
Laboratory ID: 1501116-07
Received: 01/28/15 08:40

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**2.25**	**0.170**	0.330	0.500	1		SW9056A	5A28014	01/28/15 15:37
14797-55-8	Nitrate as N	**6.44**	**0.0330**	0.100	0.250	1		SW9056A	5A28014	01/28/15 15:37
14808-79-8	Sulfate as SO4	**30.0**	**0.330**	1.00	2.50	1		SW9056A	5A28014	01/28/15 15:37
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 20:41

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation – Methane, Ethane, and Ethene
Empirical Laboratories, LLC; SDG 1501116

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 27, 2015. The samples were analyzed for methane, ethane, and ethene using laboratory method RSK-175. A total of six aqueous samples (includes one rinse blank) were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
49MW02	1501116-02	48MW3	1501116-05
50MW02	1501116-03	RB012714	1501116-06
49TM01	1501116-04	49TM02	1501116-07

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial Calibration
	X	Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/17/15

Date

RFAAP VALIDATION REPORT
DISSOLVED GASES REVIEW
SDG 1501116

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For methane, ethane, and ethene, aqueous samples are cooled @ 4°C ± 2°C; the maximum holding time is 7 days un-preserved and 14 days preserved to pH<2 with HCl from sample collection to analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/27/15, the cooler was received by the laboratory (Empirical) on 01/28/15 at 0.4°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: The aqueous samples were collected on 01/27/15. They were prepped and analyzed for the dissolved gases on 02/04/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the calibration factors on which the quantitations are based. If linear regression is used for quantification, the correlation coefficient must be ≥0.995 for linearity fit (DoD QSM). If calibration factor method is used, the %RSD should be ≤20% (DoD QSM). All ICVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration performed on 11/30/14 on instrument GL-GCVOA, all target compounds were within criteria (%RSD≤20%%; RRF≥0.05) except for the following. Target compound methane (27.9%) was outside criteria. Methane (r^2=0.9991; quadratic) was quantified using second order regression with coefficient of determination r^2≥0.99; therefore, no qualifiers were applied based upon this outlier. All other target compounds were quantified using calibration factor method. All criteria were met. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this initial calibration.

III-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. If calibration factor method is used, the percent difference (%D) should all fall within the control criteria of ≤20% (DoD QSM). All CCVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration verification for methane, ethane, and ethene performed on 12/01/14 @00:44 on instrument GL-GCVOA, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this initial calibration verification.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @11:47 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. Sample 49MW02 (1501116-02) applies to this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @15:11 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. Samples 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @17:54 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

IV-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks. The DoD QSM criterion specifies all concentrations should be less than one-half MRL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤5 times (5x) the maximum amount for explosive target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (For this SDG)
02/04/15	5B04002-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	All target <½MRL	NA	NA	None

MRL = Method Reporting Limit
NA = Not Applicable

V-Laboratory Control Sample

Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. DoD LCS aqueous recovery limits are specified in the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. Percent recoveries (%Rs) should be within the specified control limits.

- Sample 5B04002-BS1 was used as LCS for methane, ethane, and ethene analysis performed on 02/04/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this LCS.

VI-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. DoD QSM MS and MSD recovery limits use the LCS criteria, which currently is the use of in-house specified limits (DoD, 2010).

- Sample 48MW3 (1501116-05) was used as the aqueous MS/MSD for the methane, ethane, and ethene analysis on 02/04/15. All criteria were met. No qualifiers were applied. Samples 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this MS/MSD.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established in the Groundwater Monitored Natural Attenuation (GWMNA) QAPP at 50% RPD for the aqueous samples.

- Field groundwater sample duplicate pair 50MW02 (1501116-03) and 49TM01 (1501116-04) was analyzed for methane, ethane, and ethene analysis in this SDG. All dissolved gases were non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

- Field groundwater sample duplicate pair 48MW3 (1501116-05) and 49TM02 (1501116-07) was analyzed for methane, ethane, and ethene analysis in this SDG. All dissolved gases were non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results was verified and data results reviewed. The following was determined:

- The percent difference (%D) between the calculated and the reported values should be within 10% through the calculation from the raw data provided. The calculation verification was confirmed within 10% difference.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 5B04002-BS1, ethane

Conc. µg/L = (((Vhs*(Ax/CF))/Vs*Density)+((Ax/CF)/HLC)*55.5/1.137*(MW*1000))*DF

Where:

Ax	= Area of characteristic ion for compound being measured.
CF	= Average relative calibration factor for compound being measured (from ICAL)
MW	= molecular weight of analyte = 30.0 ug/umol
DF	= dilution factor 1
Vhs	= Volume of headspace = 5.5 mL
Vs	= Volume of sample = 0.015 L
Density	= 0.64356M,1.1262Ee,or 1.2067Ea
HLC	= Henry's Law Constant = 44900M,12700Ee, or 34200Ea

Conc. µg/L =
(((5.5*(561935/550513.3))/0.015*1.2067)+((561935/550513.3)/34200)*55.5/1.137*(30*1000))*1
= 495.3 µg/L

Reported Value = 495.3 µg/L

% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

49MW02

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-02	File ID:	016F1601.D\Report.TXT
Sampled:	01/27/15 10:55	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 14:57
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
74-82-8	Methane	**1.54**	1.00	2.00	4.00	J	J
74-84-0	Ethane		1.00	2.00	4.00	U	
74-85-1	Ethene	**1.40**	1.00	2.00	4.00	J	J

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

50MW02

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-03	File ID:	018F1801.D\Report.TXT
Sampled:	01/27/15 12:55	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 15:24
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

49TM01

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-04	File ID:	019F1901.D\Report.TXT
Sampled:	01/27/15 12:55	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 15:38
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

48MW3

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-05 File ID: 020F2001.D\Report.TXT

Sampled: 01/27/15 14:35 Prepared: 02/04/15 07:09 Analyzed: 02/04/15 15:51

Solids: Preparation: RSK175 Dilution: 1

Batch: 5B04002 Sequence: 5B03704 Calibration: 4335002 Instrument: GL-GCVOA

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

RB012714

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-06 File ID: 023F2301.D\Report.TXT

Sampled: 01/27/15 15:15 Prepared: 02/04/15 07:09 Analyzed: 02/04/15 16:32

Solids: Preparation: RSK175 Dilution: 1

Batch: 5B04002 Sequence: 5B03704 Calibration: 4335002 Instrument: GL-GCVOA

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

49TM02

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-07 File ID: 024F2401.D\Report.TXT

Sampled: 01/27/15 14:35 Prepared: 02/04/15 07:09 Analyzed: 02/04/15 16:46

Solids: Preparation: RSK175 Dilution: 1

Batch: 5B04002 Sequence: 5B03704 Calibration: 4335002 Instrument: GL-GCVOA

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation - Volatiles
Empirical Laboratories, LLC; SDG 1501116

DATE: February 17, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 27, 2015. The samples were analyzed for volatile organic compounds (VOCs) using USEPA SW846 method 5030B/8260B for aqueous matrices. A total of seven aqueous samples (includes one trip blank and one rinse blank) were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
Trip Blank #14-0842	1501116-01	48MW3	1501116-05
49MW02	1501116-02	RB012714	1501116-06
50MW02	1501116-03	49TM02	1501116-07
49TM01	1501116-04		

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Instrument Performance Results
	X	Initial Calibration
X		Continuing Calibration
X		Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike / Spike Duplicate Sample
	X	System Monitoring Compounds
	X	Internal Standards
	X	Field Sample Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/17/15
Date

RFAAP VALIDATION REPORT
VOLATILES REVIEW
SDG 1501116

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For aqueous samples, VOC compounds are shipped cooled (@4°C ± 2°C) and preserved pH≤2 HCl with a maximum holding time of 14 days (7 days if no HCl) from sample collection to determinative analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/27/15, the cooler was received by the laboratory (Empirical) on 01/28/15 at 0.4°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: For the samples collected on 01/27/15, the aqueous VOCs were prepped and analyzed on 02/04/15. Sample collection and analysis dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check
The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, bromofluorobenzene (BFB), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the relative response factors on which the quantitations are based. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent relative standard deviation (%RSD) must be ≤15% for each target compound and must be ≤30% for each calibration check compound. For compounds analyzed using linear regression or second order, correlation coefficients must be >0.995 and coefficients of determination >0.99.

- For initial calibration performed on 02/02/15 on instrument MS-VOA6, target compounds bromoform (19.7%), bromomethane (23.9%), 2-butanone (21.1%), and carbon tetrachloride (19.8%) were outside criteria. All other target compounds were within criteria (%RSD≤15% or ≤30%; RRF≥0.05). Bromoform, bromomethane, 2-butanone, and carbon tetrachloride were quantified using second order quadratic equation with coefficients of determination >0.99. All criteria were met. No qualifiers were applied. Samples Trip Blank #14-0842 (1501116-01), 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) were analyzed using this initial calibration.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within 20% for all target compounds. The initial calibration verification should be between 80-120% recoveries.

- For initial calibration verification for the VOC analysis performed on 02/02/15 @15:40 on instrument MS-VOA6, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No samples reported were analyzed using this initial calibration verification.

- For continuing calibration for the VOC analysis performed on 02/04/15 @09:48 on instrument MS-VOA6, acetone (29.3%Drift) and dibromochloromethane (21.4%D) were outside criteria (%D≤20%; %Drift≤20%; RRF≥0.05). All other target compounds were within criteria. Acetone and dibromochloromethane were qualified estimated "J" for detections and no qualification for non-detections based upon the high %D/Drifts. Samples Trip Blank #14-0842 (1501116-01), 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) were analyzed using this continuing calibration.

V-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. A method blank analysis must be performed after the calibration standards and once every 12-hour time period beginning with the injection of BFB. No contaminants should be detected in any of the associated blanks > the MDL. The DoD QSM criteria specifies all concentrations should be less than one-half MRL (<MRL for common laboratory contaminants methylene chloride, acetone, and 2-butanone). Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, and 2-butanone (MEK), or 5 times (5X) the maximum amount for other volatile target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG. Trip blank sample Trip Blank #14-0842 (1501116-01) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (for this SDG)
02/04/15	5B04008-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	Acetone	9.32J	93.2	49MW02
02/04/15	Trip Blank #14-0842	All target <½MRL	NA	NA	None

J = Estimated value <MRL and >MDL.
NA = Not Applicable
MRL = Method Reporting Limit
MDL = Method Detection Limit
LOD = Level of Detection

VI-Laboratory Control Sample
Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. Percent recoveries (%Rs) should be within the specified control limits. DoD LCS aqueous recovery limits are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used.

- Sample 5B04008-BS1 was used as the aqueous LCS for the VOC analysis on 02/04/15. All criteria were met. No qualifiers were applied. Samples Trip Blank #14-0842 (1501116-01), 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this LCS.

VII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. The DoD MS/MSD aqueous recovery limits follow the LCS criteria and are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. The MS/MSD RPD should be ≤30%.

- Sample 48MW3 (1501116-05) was used as the aqueous MS/MSD for the VOC analysis on 02/04/15. Bromomethane (RPD=54.3%) was outside criteria for RPD; however both MS and MSD were within criteria. For all other target compounds, all criteria were met. Bromomethane was non-detect for the spiked sample; therefore, no qualifiers were applied based upon the high RPD. Samples Trip Blank #14-0842 (1501116-01), 49MW02 (1501116-02), 50MW02 (1501116-03), 49TM01 (1501116-04), 48MW3 (1501116-05), RB012714 (1501116-06), and 49TM02 (1501116-07) apply to this MS/MSD.

VIII-System Monitoring Compounds (Surrogates)
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Recoveries for system monitoring compounds in volatile samples and blanks must be within the specified control limits. DoD surrogate recovery limits are specified in Table G-3 of the DoD QSM (DoD, 2010). If the surrogate is not listed, then the laboratory criteria shall be used.

Aqueous Criteria:
4-Bromofluorobenzene (75-120%; RT±1.000)
Dibromofluoromethane (85-115%; RT±1.000)
1,2-Dichloroethane-d4 (70-120%; RT±1.000)
Toluene-d8 (85-120%; RT±1.000)

- All criteria were met. No qualifiers were applied.

IX-Internal Standards (IS)
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Specific criteria include: area counts (-50% to +100%) of the associated calibration standard, and retention time (± 30 seconds) from that of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

X-Field Duplicate Sample Analysis

Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 50% RPD for the aqueous samples.

- Field groundwater sample duplicate pair 50MW02 (1501116-03) and 49TM01 (1501116-04) was analyzed for TCL VOC analysis in this SDG. All detected VOCs found in the sample and its duplicate pair and associated %RPD are noted in **Table 3**. All other target analytes were non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

Table 3 Field Precision Analysis Summary for TCL VOCs for Duplicate Pair 50MW02 (1501116-03) and 49TM01 (1501116-04)

Compound	Original Sample (µg/L)	Duplicate Pair (µg/L)	%RPD
1,1,1-Trichloroethane	0.500U	0.251J	NA
1,1-Dichloroethane	0.313J	0.305J	2.6
Carbon tetrachloride	1.62	1.50	7.7
cis-1,2-Dichloroethene	0.384J	0.398J	3.6
m- and p-Xylene	0.804J	0.715J	11.7
o-Xylene	0.542J	0.514J	5.3
Tetrachloroethene	0.311J	0.299J	3.9
Trichloroethene	2.08	2.02	2.9

J = Estimated value <MRL and >MDL. Data point qualified was estimated "J".
U = Analyte non-detect as <LOD.
MDL = Method Detection Limit.
MRL = Method Reporting Limit.
LOD = Level of Detection.
NA = Not Applicable.

- Field groundwater sample duplicate pair 48MW3 (1501116-05) and 49TM02 (1501116-07) was analyzed for TCL VOC analysis in this SDG. All detected VOCs found in the sample and its duplicate pair and associated %RPD are noted in **Table 4**. All other target analytes were non-detect for the duplicate pair. All criteria were met. No qualifiers were applied.

Table 4 Field Precision Analysis Summary for TCL VOCs for Duplicate Pair 48MW3 (1501116-05) and 49TM02 (1501116-07)

Compound	Original Sample (µg/L)	Duplicate Pair (µg/L)	%RPD
Carbon tetrachloride	77.4	77.2	0.3
Chloroform	8.37	8.51	1.7
Ethylbenzene	0.500U	0.252J	NA
m- and p-Xylene	0.736J	0.705J	4.3
o-Xylene	0.495J	0.547J	10.0
Trichloroethene	12.4	12.7	2.4

J = Estimated value <MRL and >MDL. Data point qualified was estimated "J".
U = Analyte non-detect as <LOD.
MDL = Method Detection Limit.
MRL = Method Reporting Limit.
LOD = Level of Detection.
NA = Not Applicable.

XI-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 49MW02 (1501116-02), trichloroethene

Conc. (µg/L) = (Ax)*(Is)*(DF) / (Ais)*(RRF)

where: Ax is the compound area
Ais is the corresponding internal standard area
Is is the corresponding internal standard concentration (µg/L)
DF is the dilution factor
RRF is the relative response factor.

Conc. µg/L = (2440 * 30 µg/L * 2) / (893289 * 0.327063) = 0.501 µg/L

Reported Conc. = 0.501 µg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

Trip Blank 14-0842

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-01 File ID: 0111601A.D

Sampled: 01/27/15 08:00 Prepared: 02/04/15 10:42 Analyzed: 02/04/15 10:42

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	UX
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	U
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.69	99.0	75 - 120	
Dibromofluoromethane	30.00	29.37	97.9	85 - 115	
1,2-Dichloroethane-d4	30.00	29.61	98.7	70 - 120	

ANALYSIS DATA SHEET

Trip Blank 14-0842

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-01	File ID:	0111601A.D
Sampled:	01/27/15 08:00	Prepared:	02/04/15 10:42	Analyzed:	02/04/15 10:42
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B04008	Sequence:	5B03708	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.83	99.4	85 - 120	

ANALYSIS DATA SHEET

49MW02

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-02 File ID: 0111602B.D

Sampled: 01/27/15 10:55 Prepared: 02/04/15 13:27 Analyzed: 02/04/15 13:27

Solids: Preparation: 5030B Dilution: 2

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone	**14.0**	5.00	10.0	20.0	XJD	B
71-43-2	Benzene		0.500	1.00	2.00	U	
75-27-4	Bromodichloromethane		0.500	1.00	2.00	U	
75-25-2	Bromoform		0.500	1.00	2.00	U	
74-83-9	Bromomethane		1.00	2.00	4.00	U	
78-93-3	2-Butanone		5.00	10.0	20.0	U	
75-15-0	Carbon disulfide		0.500	1.00	2.00	U	
56-23-5	Carbon tetrachloride	**5.05**	0.500	1.00	2.00	D	
108-90-7	Chlorobenzene		0.500	1.00	2.00	U	
75-00-3	Chloroethane		1.00	2.00	4.00	U	
67-66-3	Chloroform	**1.55**	0.500	1.00	2.00	JD	J
74-87-3	Chloromethane		0.500	1.00	2.00	U	
124-48-1	Dibromochloromethane		0.500	1.00	2.00	UX	
75-34-3	1,1-Dichloroethane		0.500	1.00	2.00	U	
107-06-2	1,2-Dichloroethane		0.500	1.00	2.00	U	
75-35-4	1,1-Dichloroethene		0.500	1.00	2.00	U	
156-59-2	cis-1,2-Dichloroethene		0.500	1.00	2.00	U	
156-60-5	trans-1,2-Dichloroethene		0.500	1.00	2.00	U	
78-87-5	1,2-Dichloropropane		0.500	1.00	2.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.500	1.00	2.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.500	1.00	2.00	U	
100-41-4	Ethylbenzene	**1.13**	0.500	1.00	2.00	JD	J
591-78-6	2-Hexanone		2.50	5.00	10.0	U	
75-09-2	Methylene chloride		1.00	2.00	4.00	U	
108-10-1	4-Methyl-2-pentanone		2.50	5.00	10.0	U	
100-42-5	Styrene		0.500	1.00	2.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.500	1.00	2.00	U	
127-18-4	Tetrachloroethene		0.500	1.00	2.00	U	
108-88-3	Toluene		0.500	1.00	2.00	U	
79-00-5	1,1,2-Trichloroethane		0.500	1.00	2.00	U	
71-55-6	1,1,1-Trichloroethane		0.500	1.00	2.00	U	
79-01-6	Trichloroethene	**0.501**	0.500	1.00	2.00	JD	J
75-01-4	Vinyl chloride		0.500	1.00	2.00	U	
108-38-3/106-42-	m,p-Xylene	**4.06**	1.00	2.00	4.00	D	
95-47-6	o-Xylene	**2.91**	0.500	1.00	2.00	D	

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.73	99.1	75 - 120	
Dibromofluoromethane	30.00	30.56	102	85 - 115	
1,2-Dichloroethane-d4	30.00	29.14	97.1	70 - 120	

ANALYSIS DATA SHEET

49MW02

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-02	File ID:	0111602B.D
Sampled:	01/27/15 10:55	Prepared:	02/04/15 13:27	Analyzed:	02/04/15 13:27
Solids:		Preparation:	5030B	Dilution:	1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	30.05	100	85 - 120	

ANALYSIS DATA SHEET

50MW02

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-03 File ID: 0111603B.D

Sampled: 01/27/15 12:55 Prepared: 02/04/15 13:54 Analyzed: 02/04/15 13:54

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone		2.50	5.00	10.0	UX	
71-43-2	Benzene		0.250	0.500	1.00	U	
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U	
75-25-2	Bromoform		0.250	0.500	1.00	U	
74-83-9	Bromomethane		0.500	1.00	2.00	U	
78-93-3	2-Butanone		2.50	5.00	10.0	U	
75-15-0	Carbon disulfide		0.250	0.500	1.00	U	
56-23-5	Carbon tetrachloride	**1.62**	0.250	0.500	1.00		
108-90-7	Chlorobenzene		0.250	0.500	1.00	U	
75-00-3	Chloroethane		0.500	1.00	2.00	U	
67-66-3	Chloroform		0.250	0.500	1.00	U	
74-87-3	Chloromethane		0.250	0.500	1.00	U	
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX	
75-34-3	1,1-Dichloroethane	**0.313**	0.250	0.500	1.00	J	J
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U	
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U	
156-59-2	cis-1,2-Dichloroethene	**0.384**	0.250	0.500	1.00	J	J
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U	
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U	
100-41-4	Ethylbenzene		0.250	0.500	1.00	U	
591-78-6	2-Hexanone		1.25	2.50	5.00	U	
75-09-2	Methylene chloride		0.500	1.00	2.00	U	
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U	
100-42-5	Styrene		0.250	0.500	1.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U	
127-18-4	Tetrachloroethene	**0.311**	0.250	0.500	1.00	J	J
108-88-3	Toluene		0.250	0.500	1.00	U	
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U	
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U	
79-01-6	Trichloroethene	**2.08**	0.250	0.500	1.00		
75-01-4	Vinyl chloride		0.250	0.500	1.00	U	
108-38-3/106-42-	m,p-Xylene	**0.804**	0.500	1.00	2.00	J	J
95-47-6	o-Xylene	**0.542**	0.250	0.500	1.00	J	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	30.37	101	75 - 120	
Dibromofluoromethane	30.00	31.36	105	85 - 115	
1,2-Dichloroethane-d4	30.00	29.84	99.5	70 - 120	

ANALYSIS DATA SHEET

50MW02

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-03	File ID:	0111603B.D
Sampled:	01/27/15 12:55	Prepared:	02/04/15 13:54	Analyzed:	02/04/15 13:54
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B04008	Sequence:	5B03708	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	30.63	102	85 - 120	

ANALYSIS DATA SHEET

49TM01

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-04 File ID: 0111604B.D

Sampled: 01/27/15 12:55 Prepared: 02/04/15 14:22 Analyzed: 02/04/15 14:22

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone		2.50	5.00	10.0	UX	
71-43-2	Benzene		0.250	0.500	1.00	U	
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U	
75-25-2	Bromoform		0.250	0.500	1.00	U	
74-83-9	Bromomethane		0.500	1.00	2.00	U	
78-93-3	2-Butanone		2.50	5.00	10.0	U	
75-15-0	Carbon disulfide		0.250	0.500	1.00	U	
56-23-5	Carbon tetrachloride	**1.50**	0.250	0.500	1.00		
108-90-7	Chlorobenzene		0.250	0.500	1.00	U	
75-00-3	Chloroethane		0.500	1.00	2.00	U	
67-66-3	Chloroform		0.250	0.500	1.00	U	
74-87-3	Chloromethane		0.250	0.500	1.00	U	
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX	
75-34-3	1,1-Dichloroethane	**0.305**	0.250	0.500	1.00	J	J
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U	
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U	
156-59-2	cis-1,2-Dichloroethene	**0.398**	0.250	0.500	1.00	J	J
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U	
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U	
100-41-4	Ethylbenzene		0.250	0.500	1.00	U	
591-78-6	2-Hexanone		1.25	2.50	5.00	U	
75-09-2	Methylene chloride		0.500	1.00	2.00	U	
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U	
100-42-5	Styrene		0.250	0.500	1.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U	
127-18-4	Tetrachloroethene	**0.299**	0.250	0.500	1.00	J	J
108-88-3	Toluene		0.250	0.500	1.00	U	
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U	
71-55-6	1,1,1-Trichloroethane	**0.251**	0.250	0.500	1.00	J	J
79-01-6	Trichloroethene	**2.02**	0.250	0.500	1.00		
75-01-4	Vinyl chloride		0.250	0.500	1.00	U	
108-38-3/106-42-	m,p-Xylene	**0.715**	0.500	1.00	2.00	J	J
95-47-6	o-Xylene	**0.514**	0.250	0.500	1.00	J	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.85	99.5	75 - 120	
Dibromofluoromethane	30.00	30.49	102	85 - 115	
1,2-Dichloroethane-d4	30.00	29.21	97.4	70 - 120	

ANALYSIS DATA SHEET

491M01

Laboratory: Empirical Laboratories, LLC | SDG: 1501116

Client: CB&I | Project: Radford AAP

Matrix: Water | Laboratory ID: 1501116-04 | File ID: 0111604B.D

Sampled: 01/27/15 12:55 | Prepared: 02/04/15 14:22 | Analyzed: 02/04/15 14:22

Solids: | Preparation: 5030B | Dilution: 1

Batch: 5B04008 | Sequence: 5B03708 | Calibration: 5035003 | Instrument: MS-VOA6

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.92	99.7	85 - 120	

ANALYSIS DATA SHEET

48MW3

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-05 File ID: 0111605B.D

Sampled: 01/27/15 14:35 Prepared: 02/04/15 12:32 Analyzed: 02/04/15 12:32

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	UX
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	NU
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride	**77.4**	0.250	0.500	1.00	
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform	**8.37**	0.250	0.500	1.00	
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene	**12.4**	0.250	0.500	1.00	
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene	**0.736**	0.500	1.00	2.00	J
95-47-6	o-Xylene	**0.495**	0.250	0.500	1.00	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	30.31	101	75 - 120	
Dibromofluoromethane	30.00	30.81	103	85 - 115	
1,2-Dichloroethane-d4	30.00	29.34	97.8	70 - 120	

ANALYSIS DATA SHEET

48MW3

Laboratory	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-05	File ID:	0111605B.D
Sampled:	01/27/15 14:35	Prepared:	02/04/15 12:32	Analyzed:	02/04/15 12:32
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B04008	Sequence:	5B03708	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.37	97.9	85 - 120	

ANALYSIS DATA SHEET

RB012714

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-06 File ID: 0111606A.D

Sampled: 01/27/15 15:15 Prepared: 02/04/15 11:37 Analyzed: 02/04/15 11:37

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone	**9.32**	2.50	5.00	10.0	XJ
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	U
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

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Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.95	99.8	75 - 120	
Dibromofluoromethane	30.00	30.48	102	85 - 115	
1,2-Dichloroethane-d4	30.00	29.46	98.2	70 - 120	

ANALYSIS DATA SHEET

RB012714

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-06	File ID:	0111606A.D
Sampled:	01/27/15 15:15	Prepared:	02/04/15 11:37	Analyzed:	02/04/15 11:37
Solids:		Preparation:	5030B	Dilution:	1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.01	96.7	85 - 120	

ANALYSIS DATA SHEET

49TM02

Laboratory: Empirical Laboratories, LLC SDG: 1501116

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501116-07 File ID: 0111607B.D

Sampled: 01/27/15 14:35 Prepared: 02/04/15 14:49 Analyzed: 02/04/15 14:49

Solids: Preparation: 5030B Dilution: 1

Batch: 5B04008 Sequence: 5B03708 Calibration: 5035003 Instrument: MS-VOA6

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	UX
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride	**77.2**	0.250	0.500	1.00	
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform	**8.51**	0.250	0.500	1.00	
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	UX
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene	**0.252**	0.250	0.500	1.00	J
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene	**12.7**	0.250	0.500	1.00	
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene	**0.705**	0.500	1.00	2.00	J
95-47-6	o-Xylene	**0.547**	0.250	0.500	1.00	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.82	99.4	75 - 120	
Dibromofluoromethane	30.00	31.34	104	85 - 115	
1,2-Dichloroethane-d4	30.00	29.48	98.3	70 - 120	

ANALYSIS DATA SHEET

49TM02

Laboratory:	Empirical Laboratories, LLC			SDG:	1501116
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501116-07	File ID:	0111607B.D
Sampled:	01/27/15 14:35	Prepared:	02/04/15 14:49	Analyzed:	02/04/15 14:49
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B04008	Sequence:	5B03708	Calibration:	5035003
Instrument:	MS-VOA6				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.48	98.3	85 - 120	

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Eric.malarek@CBIfederalservices.com

MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Chloride, Nitrate, and Sulfate
Empirical Laboratories, LLC; SDG 1501124

DATE: February 20, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 28, 2015. Samples were analyzed for the chloride, nitrate, and sulfate using USEPA SW-846 9056A. A total of three aqueous samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
48MW2	1501124-03	48MW1	1501124-05
49MW01	1501124-04		

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Laboratory Duplicate Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate Sample
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/20/15
Date

RFAAP VALIDATION REPORT
ANIONS REVIEW
SDG 1501124

I-Holding Times and Preservation

The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C and 28 days for sulfate and chloride and Cool to 4°C±2°C with H_2SO_4 to pH<2 and 2 days for nitrate. The dates and times were compared between the sample collection and laboratory analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/28/15, the cooler was received by the laboratory (Empirical) on 01/29/15 at 4.1°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: Samples were collected on 01/28/15. The samples were prepped and analyzed on 01/29/15 for sulfate, chloride, and nitrate analysis. Sample collection dates may be found on the attached form 1s. All holding time criteria were met. No qualifiers were applied.

II-Initial and Continuing Calibration

Requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

Anions: 1 – blank
5 – standards ($r \geq 0.995$ or $r^2 \geq 0.99$)
ICV/CCV (90-110%)
Method Reporting Limit (MRL) (50-150%)

- Chloride, sulfate, and nitrate analysis was calibrated on 12/16/14 using linear equation techniques. All correlation coefficients were ≥0.995 for chloride, sulfate, and nitrate. All ICV/CCV/MRL criteria were met for all anions and runs. No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to these initial and continuing calibrations.

III-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <2MDL for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (for this SDG)
01/29/15	Chloride	ICB/CCBs	<LOD	NA	None
01/29/15	Sulfate	ICB/CCBs	<LOD	NA	None
01/29/15	Nitrate	ICB/CCBs	<LOD	NA	None
01/29/15	Chloride	5A29009-BLK1	<½MRL	NA	None
01/29/15	Sulfate	5A29009-BLK1	<½MRL	NA	None
01/29/15	Nitrate	5A29009-BLK1	<½MRL	NA	None
01/28/15	Chloride	RB012715	<½MRL	NA	None
01/28/15	Sulfate	RB012715	<½MRL	NA	None
01/28/15	Nitrate	RB012715	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample

The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Per DoD QSM, all LCS results must fall within the specified control limits: 80-120%

- Sample 5A29009-BS1 was used as the aqueous LCS for chloride, sulfate, and nitrate analysis on 01/29/15. All criteria were met. No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this LCS.

V-Duplicate Sample Analysis

Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. Per DoD QSM, RPDs must be within established control limits (≤25%RPD).

- No site lab duplicate was performed with this SDG; therefore, was not evaluated.

VI-Matrix Spike and Matrix Spike Duplicate
Matrix spikes (MSs) and MSDs are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples or preparatory batch of similar matrix. Per DoD QSM, MS/MSD recoveries and RPDs should be within the specified limits:

Anions: 80-120%; RPD≤20%

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for chloride, sulfate, and nitrate analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 48MW2 (1501124-03), sulfate

$Y = mX + b$

Y = Sample Area
m = slope of curve
X = Concentration (mg/L)
b = Y-intercept
DF = Dilution Factor

Given:
m = 0.202746
b = 0.0
Y = Area = 3.4142961
DF = 1

X = 16.8 mg/L * DF = 16.8 mg/L * 1 = 16.8 mg/L

Reported concentration = 16.8 mg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Total Organic Carbon
Empirical Laboratories, LLC; SDG 1501124

DATE: February 20, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 28, 2015. Samples were analyzed for Total Organic Carbon (TOC) using USEPA SW-846 9060A. A total of three aqueous samples were validated. The sample IDs are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
48MW2	1501124-03	48MW1	1501124-05
49MW01	1501124-04		

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Laboratory Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/20/15
Date

RFAAP VALIDATION REPORT
TOC REVIEW
SDG 1501124

I-Holding Times and Preservation
The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C, HCl pH<2, 28 days for TOC (USEPA criteria). The dates and times were compared between the sample collection and laboratory analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/28/15, the cooler was received by the laboratory (Empirical) on 01/29/15 at 4.1°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: The samples were collected on 01/28/15. The TOC analysis was run on 02/05/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifier was applied.

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial and continuing calibration (90-110%) must be within limits.

TOC: 1 - blank
5 - standards ($r \geq 0.995$)
ICV/CCV (80-120%)

- The TOC analysis was run on 02/05/15. The initial calibration for TOC was analyzed on 01/19/15 with a coefficient of determination of 0.9996. The ICV and CCVs were evaluated for where they bracketed reported samples. All ICV/CCVs that bracketed reported samples were within criteria. All criteria were met. No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to these initial and continuing calibrations.

III-Blank Analysis
The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <LOD (i.e. <2MDL) for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (For this SDG)
02/05/15	TOC	ICB/CCBs	<LOD	NA	None
02/05/15	TOC	5B05019-BLK1	<½MRL	NA	None
02/05/15	TOC	RB012714	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample
The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. All aqueous LCS results must fall within the control limits (80-120%).

- Sample 5B05019-BS1 was used as the aqueous LCS for TOC analysis on 02/05/15. All criteria were met. No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this LCS.

V-Matrix Spike and Spike Duplicate
Matrix spikes (MSs) and matrix spike duplicates (MSDs) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples of similar matrix. The percent recoveries (%Rs or RPD) must be within the specified control limits (75-125%; RPD≤20%).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VI-Laboratory Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits (≤20%RPD).

- No aqueous laboratory duplicate was analyzed for TOC with this SDG; therefore, it was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for TOC analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 5B05019-BS1, TOC

TOC: Y = m*X (mg/L) + b
m = 11.56
b = 0.00
Y = 322.2
DF = 1

TOC (mg/L) = X = (27.87 mg/L) * 1 = 27.87 mg/L

Reported Value = 27.87 mg/L
% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

ANALYSIS DATA SHEET

48MW2

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/28/15 12:00

SDG: 1501124
Project: Radford AAP
Laboratory ID: 1501124-03
Received: 01/29/15 09:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**2.65**	**0.170**	0.330	0.500	1		SW9056A	5A29009	01/29/15 14:18
14797-55-8	Nitrate as N	**0.754**	**0.0330**	0.100	0.250	1		SW9056A	5A29009	01/29/15 14:18
14808-79-8	Sulfate as SO4	**16.8**	**0.330**	1.00	2.50	1		SW9056A	5A29009	01/29/15 14:18
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 21:03

ANALYSIS DATA SHEET

49MW01

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/28/15 13:20

SDG: 1501124
Project: Radford AAP
Laboratory ID: 1501124-04
Received: 01/29/15 09:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**6.03**	**0.170**	0.330	0.500	1		SW9056A	5A29009	01/29/15 14:35
14797-55-8	Nitrate as N	**0.303**	**0.0330**	0.100	0.250	1		SW9056A	5A29009	01/29/15 14:35
14808-79-8	Sulfate as SO4		0.330	1.00	2.50	1	U	SW9056A	5A29009	01/29/15 14:35
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 21:26

ANALYSIS DATA SHEET

48MW1

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/28/15 14:30

SDG: 1501124
Project: Radford AAP
Laboratory ID: 1501124-05
Received: 01/29/15 09:45

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**3.10**	**0.170**	0.330	0.500	1		SW9056A	5A29009	01/29/15 14:53
14797-55-8	Nitrate as N	**1.35**	**0.0330**	0.100	0.250	1		SW9056A	5A29009	01/29/15 14:53
14808-79-8	Sulfate as SO4	**58.0**	**0.330**	1.00	2.50	1		SW9056A	5A29009	01/29/15 14:53
7440-44-0	Total Organic Carbon AVG		1.25	2.50	3.00	1	U	SW9060A	5B05019	02/05/15 21:48

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation – Methane, Ethane, and Ethene
Empirical Laboratories, LLC; SDG 1501124

DATE: February 20, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 28, 2015. The samples were analyzed for methane, ethane, and ethene using laboratory method RSK-175. A total of three aqueous samples were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
48MW2	1501124-03	48MW1	1501124-05
49MW01	1501124-04		

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial Calibration
	X	Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/20/15
Date

RFAAP VALIDATION REPORT
DISSOLVED GASES REVIEW
SDG 1501124

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For methane, ethane, and ethene, aqueous samples are cooled @ 4°C ± 2°C; the maximum holding time is 7 days un-preserved and 14 days preserved to pH<2 with HCl from sample collection to analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/28/15, the cooler was received by the laboratory (Empirical) on 01/29/15 at 4.1°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: The aqueous samples were collected on 01/28/15. They were prepped and analyzed for the dissolved gases on 02/04/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the calibration factors on which the quantitations are based. If linear regression is used for quantification, the correlation coefficient must be ≥0.995 for linearity fit (DoD QSM). If calibration factor method is used, the %RSD should be ≤20% (DoD QSM). All ICVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration performed on 11/30/14 on instrument GL-GCVOA, all target compounds were within criteria (%RSD≤20%%; RRF≥0.05) except for the following. Target compound methane (27.9%) was outside criteria. Methane (r^2=0.9991; quadratic) was quantified using second order regression with coefficient of determination r^2≥0.99; therefore, no qualifiers were applied based upon this outlier. All other target compounds were quantified using calibration factor method. All criteria were met. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this initial calibration.

III-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. If calibration factor method is used, the percent difference (%D) should all fall within the control criteria of ≤20% (DoD QSM). All CCVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration verification for methane, ethane, and ethene performed on 12/01/14 @00:44 on instrument GL-GCVOA, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this initial calibration verification.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @11:47 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @15:11 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @17:54 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

IV-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks. The DoD QSM criterion specifies all concentrations should be less than one-half MRL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤5 times (5x) the maximum amount for explosive target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (For this SDG)
02/04/15	5B04002-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	All target <½MRL	NA	NA	None

MRL = Method Reporting Limit
NA = Not Applicable

V-Laboratory Control Sample

Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. DoD LCS aqueous recovery limits are specified in the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. Percent recoveries (%Rs) should be within the specified control limits.

- Sample 5B04002-BS1 was used as LCS for methane, ethane, and ethene analysis performed on 02/04/15. All criteria were met. No qualifiers were applied. Samples 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this LCS.

VI-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. DoD QSM MS and MSD recovery limits use the LCS criteria, which currently is the use of in-house specified limits (DoD, 2010).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established in the Groundwater Monitored Natural Attenuation (GWMNA) QAPP at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results was verified and data results reviewed. The following was determined:

- The percent difference (%D) between the calculated and the reported values should be within 10% through the calculation from the raw data provided. The calculation verification was confirmed within 10% difference.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 5B04002-BS1, ethane

Conc. µg/L = (((Vhs*(Ax/CF))/Vs*Density)+((Ax/CF)/HLC)*55.5/1.137*(MW*1000))*DF

Where:

Ax	= Area of characteristic ion for compound being measured.
CF	= Average relative calibration factor for compound being measured (from ICAL)
MW	= molecular weight of analyte = 30.0 ug/umol
DF	= dilution factor 1
Vhs	= Volume of headspace = 5.5 mL
Vs	= Volume of sample = 0.015 L
Density	= 0.64356M,1.1262Ee,or 1.2067Ea
HLC	= Henry's Law Constant = 44900M,12700Ee, or 34200Ea

Conc. µg/L =
(((5.5*(561935/550513.3))/0.015*1.2067)+((561935/550513.3)/34200)*55.5/1.137*(30*1000))*1
= 495.3 µg/L

Reported Value = 495.3 µg/L

% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

48MW2

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-03	File ID:	025F2501.D\Report.TXT
Sampled:	01/28/15 12:00	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 16:59
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

49MW01

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-04	File ID:	026F2601.D\Report.TXT
Sampled:	01/28/15 13:20	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 17:13
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

ANALYSIS DATA SHEET

48MW1

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-05	File ID:	027F2701.D\Report.TXT
Sampled:	01/28/15 14:30	Prepared:	02/04/15 07:09	Analyzed:	02/04/15 17:27
Solids:		Preparation:	RSK175	Dilution:	1
Batch:	5B04002	Sequence:	5B03704	Calibration:	4335002
Instrument:	GL-GCVOA				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation - Volatiles
Empirical Laboratories, LLC; SDG 1501124

DATE: February 19, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 28, 2015. The samples were analyzed for volatile organic compounds (VOCs) using USEPA SW846 method 5030B/8260B for aqueous matrices. A total of five aqueous samples (includes one trip blank) were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
49MW03	1501124-01	49MW01	1501124-04
Trip Blank #14-0840	1501124-02	48MW1	1501124-05
48MW2	1501124-03		

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Instrument Performance Results
	X	Initial Calibration
X		Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike / Spike Duplicate Sample
	X	System Monitoring Compounds
	X	Internal Standards
	X	Field Sample Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/19/15
Date

RFAAP VALIDATION REPORT
VOLATILES REVIEW
SDG 1501124

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For aqueous samples, VOC compounds are shipped cooled (@4°C ± 2°C) and preserved pH≤2 HCl with a maximum holding time of 14 days (7 days if no HCl) from sample collection to determinative analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/28/15, the cooler was received by the laboratory (Empirical) on 01/29/15 at 4.1°C. All criteria were met. No qualifiers were applied.

- Holding Time Review: For the samples collected on 01/28/15, the aqueous VOCs were prepped and analyzed on 02/06/15. Sample collection and analysis dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check
The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, bromofluorobenzene (BFB), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the relative response factors on which the quantitations are based. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent relative standard deviation (%RSD) must be ≤15% for each target compound and must be ≤30% for each calibration check compound. For compounds analyzed using linear regression or second order, correlation coefficients must be >0.995 and coefficients of determination >0.99.

- For initial calibration performed on 10/16/14 on instrument MS-VOA3, target compounds bromomethane (22.4%), chloroethane (21.6%), and methylene chloride (23.9%) were outside criteria. All other target compounds were within criteria (%RSD≤15% or ≤30%; RRF≥0.05). Bromomethane, chloroethane, and methylene chloride were quantified using linear equation with correlation coefficients >0.995. All criteria were met. No qualifiers were applied. Samples 49MW03 (1501124-01), Trip Blank #14-0840 (1501124-02), 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) were analyzed using this initial calibration.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within 20% for all target compounds. The initial calibration verification should be between 80-120% recoveries.

- For initial calibration verification for the VOC analysis performed on 10/16/14 @17:56 on instrument MS-VOA3, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No samples reported were analyzed using this initial calibration verification.

- For continuing calibration for the VOC analysis performed on 02/06/15 @07:50 on instrument MS-VOA3, carbon tetrachloride (20.7%) was outside criteria (%D≤20%; %Drift≤20%; RRF≥0.05). All other target compounds were within criteria. Carbon tetrachloride was qualified estimated "J" for detections and no qualification for non-detections based upon the high %D. Samples 49MW03 (1501124-01), Trip Blank #14-0840 (1501124-02), 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) were analyzed using this continuing calibration.

V-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. A method blank analysis must be performed after the calibration standards and once every 12-hour time period beginning with the injection of BFB. No contaminants should be detected in any of the associated blanks > the MDL. The DoD QSM criteria specifies all concentrations should be less than one-half MRL (<MRL for common laboratory contaminants methylene chloride, acetone, and 2-butanone). Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, and 2-butanone (MEK), or 5 times (5X) the maximum amount for other volatile target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG. Trip blank sample Trip Blank #14-0840 (1501124-02) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (for this SDG)
02/06/15	5B06004-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	Acetone	9.32J	93.2	None
02/06/15	Trip Blank #14-0840	All target <½MRL	NA	NA	None

J = Estimated value <MRL and >MDL.
NA = Not Applicable
MRL = Method Reporting Limit
MDL = Method Detection Limit
LOD = Level of Detection

VI-Laboratory Control Sample
Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. Percent recoveries (%Rs) should be within the specified control limits. DoD LCS aqueous recovery limits are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used.

- Sample 5B06004-BS1 was used as the aqueous LCS for the VOC analysis on 02/06/15. All criteria were met. No qualifiers were applied. Samples 49MW03 (1501124-01), Trip Blank #14-0840 (1501124-02), 48MW2 (1501124-03), 49MW01 (1501124-04), and 48MW1 (1501124-05) apply to this LCS.

VII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. The DoD MS/MSD aqueous recovery limits follow the LCS criteria and are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. The MS/MSD RPD should be ≤30%.

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VIII-System Monitoring Compounds (Surrogates)
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Recoveries for system monitoring compounds in volatile samples and blanks must be within the specified control limits. DoD surrogate recovery limits are specified in Table G-3 of the DoD QSM (DoD, 2010). If the surrogate is not listed, then the laboratory criteria shall be used.

Aqueous Criteria: 4-Bromofluorobenzene (75-120%; RT±1.000)
Dibromofluoromethane (85-115%; RT±1.000)
1,2-Dichloroethane-d4 (70-120%; RT±1.000)
Toluene-d8 (85-120%; RT±1.000)

- All criteria were met. No qualifiers were applied.

IX-Internal Standards (IS)
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Specific criteria include: area counts (-50% to +100%) of the associated calibration standard, and retention time (± 30 seconds) from that of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

X-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

XI-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 48MW2 (1501124-03), trichloroethene

Conc. (µg/L) = (Ax)*(Is)*(DF) / (Ais)*(RRF)

where: Ax is the compound area
Ais is the corresponding internal standard area
Is is the corresponding internal standard concentration (µg/L)
DF is the dilution factor
RRF is the relative response factor.

Conc. µg/L = (103545 * 30 µg/L * 1) / (997636 * 0.2957519) = 10.5 µg/L

Reported Conc. = 10.5 µg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

49MW03

Laboratory: Empirical Laboratories, LLC SDG: 1501124

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501124-01 File ID: 0112401B.D

Sampled: 01/28/15 08:55 Prepared: 02/06/15 14:09 Analyzed: 02/06/15 14:09

Solids: Preparation: 5030B Dilution: 1

Batch: 5B06004 Sequence: 5B04025 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	UX
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene	**0.296**	0.250	0.500	1.00	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.06	96.9	75 - 120	
Dibromofluoromethane	30.00	31.10	104	85 - 115	
1,2-Dichloroethane-d4	30.00	29.72	99.1	70 - 120	

ANALYSIS DATA SHEET

49MW03

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-01	File ID:	0112401B.D
Sampled:	01/28/15 08:55	Prepared:	02/06/15 14:09	Analyzed:	02/06/15 14:09
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	28.93	96.4	85 - 120	

ANALYSIS DATA SHEET

Trip Blank 14-0840

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-02	File ID:	0112402A.D
Sampled:	01/28/15 08:00	Prepared:	02/06/15 10:48	Analyzed:	02/06/15 10:48
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	U
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	UX
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	28.29	94.3	75 - 120	
Dibromofluoromethane	30.00	30.14	100	85 - 115	
1,2-Dichloroethane-d4	30.00	30.21	101	70 - 120	

ANALYSIS DATA SHEET

Trip Blank 14-0840

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-02	File ID:	0112402A.D
Sampled:	01/28/15 08:00	Prepared:	02/06/15 10:48	Analyzed:	02/06/15 10:48
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	27.81	92.7	85 - 120	

ANALYSIS DATA SHEET

48MW2

Laboratory: Empirical Laboratories, LLC SDG: 1501124

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501124-03 File ID: 0112403B.D

Sampled: 01/28/15 12:00 Prepared: 02/06/15 14:34 Analyzed: 02/06/15 14:34

Solids: Preparation: 5030B Dilution: 1

Batch: 5B06004 Sequence: 5B04025 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone		2.50	5.00	10.0	U	
71-43-2	Benzene		0.250	0.500	1.00	U	
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U	
75-25-2	Bromoform		0.250	0.500	1.00	U	
74-83-9	Bromomethane		0.500	1.00	2.00	U	
78-93-3	2-Butanone		2.50	5.00	10.0	U	
75-15-0	Carbon disulfide		0.250	0.500	1.00	U	
56-23-5	Carbon tetrachloride	**118**	0.250	0.500	1.00	X	J
108-90-7	Chlorobenzene		0.250	0.500	1.00	U	
75-00-3	Chloroethane		0.500	1.00	2.00	U	
67-66-3	Chloroform	**7.46**	0.250	0.500	1.00		
74-87-3	Chloromethane		0.250	0.500	1.00	U	
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U	
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U	
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U	
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U	
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U	
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U	
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U	
100-41-4	Ethylbenzene	**0.469**	0.250	0.500	1.00	J	J
591-78-6	2-Hexanone		1.25	2.50	5.00	U	
75-09-2	Methylene chloride		0.500	1.00	2.00	U	
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U	
100-42-5	Styrene		0.250	0.500	1.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U	
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U	
108-88-3	Toluene		0.250	0.500	1.00	U	
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U	
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U	
79-01-6	Trichloroethene	**10.5**	0.250	0.500	1.00		
75-01-4	Vinyl chloride		0.250	0.500	1.00	U	
108-38-3/106-42-	m,p-Xylene	**1.32**	0.500	1.00	2.00	J	J
95-47-6	o-Xylene	**0.919**	0.250	0.500	1.00	J	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.65	98.8	75 - 120	
Dibromofluoromethane	30.00	30.75	102	85 - 115	
1,2-Dichloroethane-d4	30.00	30.47	102	70 - 120	

ANALYSIS DATA SHEET

48MW2

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-03	File ID:	0112403B.D
Sampled:	01/28/15 12:00	Prepared:	02/06/15 14:34	Analyzed:	02/06/15 14:34
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.01	96.7	85 - 120	

ANALYSIS DATA SHEET

49MW01

Laboratory: Empirical Laboratories, LLC SDG: 1501124

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501124-04 File ID: 0112404B.D

Sampled: 01/28/15 13:20 Prepared: 02/06/15 14:59 Analyzed: 02/06/15 14:59

Solids: Preparation: 5030B Dilution: 1

Batch: 5B06004 Sequence: 5B04025 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone		2.50	5.00	10.0	U	
71-43-2	Benzene		0.250	0.500	1.00	U	
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U	
75-25-2	Bromoform		0.250	0.500	1.00	U	
74-83-9	Bromomethane		0.500	1.00	2.00	U	
78-93-3	2-Butanone		2.50	5.00	10.0	U	
75-15-0	Carbon disulfide		0.250	0.500	1.00	U	
56-23-5	Carbon tetrachloride	**4.97**	0.250	0.500	1.00	X	J
108-90-7	Chlorobenzene		0.250	0.500	1.00	U	
75-00-3	Chloroethane		0.500	1.00	2.00	U	
67-66-3	Chloroform	**0.404**	0.250	0.500	1.00	J	J
74-87-3	Chloromethane		0.250	0.500	1.00	U	
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U	
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U	
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U	
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U	
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U	
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U	
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U	
100-41-4	Ethylbenzene	**0.262**	0.250	0.500	1.00	J	J
591-78-6	2-Hexanone		1.25	2.50	5.00	U	
75-09-2	Methylene chloride		0.500	1.00	2.00	U	
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U	
100-42-5	Styrene		0.250	0.500	1.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U	
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U	
108-88-3	Toluene		0.250	0.500	1.00	U	
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U	
71-55-6	1,1,1-Trichloroethane	**0.262**	0.250	0.500	1.00	J	J
79-01-6	Trichloroethene		0.250	0.500	1.00	U	
75-01-4	Vinyl chloride		0.250	0.500	1.00	U	
108-38-3/106-42-	m,p-Xylene	**0.690**	0.500	1.00	2.00	J	J
95-47-6	o-Xylene	**0.544**	0.250	0.500	1.00	J	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.07	96.9	75 - 120	
Dibromofluoromethane	30.00	30.83	103	85 - 115	
1,2-Dichloroethane-d4	30.00	29.13	97.1	70 - 120	

ANALYSIS DATA SHEET

49MW01

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-04	File ID:	0112404B.D
Sampled:	01/28/15 13:20	Prepared:	02/06/15 14:59	Analyzed:	02/06/15 14:59
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.35	97.8	85 - 120	

ANALYSIS DATA SHEET

48MW1

Laboratory: Empirical Laboratories, LLC SDG: 1501124

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501124-05 File ID: 0112405B.D

Sampled: 01/28/15 14:30 Prepared: 02/06/15 15:24 Analyzed: 02/06/15 15:24

Solids: Preparation: 5030B Dilution: 1

Batch: 5B06004 Sequence: 5B04025 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone		2.50	5.00	10.0	U	
71-43-2	Benzene		0.250	0.500	1.00	U	
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U	
75-25-2	Bromoform		0.250	0.500	1.00	U	
74-83-9	Bromomethane		0.500	1.00	2.00	U	
78-93-3	2-Butanone		2.50	5.00	10.0	U	
75-15-0	Carbon disulfide		0.250	0.500	1.00	U	
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	UX	
108-90-7	Chlorobenzene		0.250	0.500	1.00	U	
75-00-3	Chloroethane		0.500	1.00	2.00	U	
67-66-3	Chloroform		0.250	0.500	1.00	U	
74-87-3	Chloromethane		0.250	0.500	1.00	U	
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U	
75-34-3	1,1-Dichloroethane	**0.908**	0.250	0.500	1.00	J	J
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U	
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U	
156-59-2	cis-1,2-Dichloroethene	**0.914**	0.250	0.500	1.00	J	J
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U	
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U	
100-41-4	Ethylbenzene		0.250	0.500	1.00	U	
591-78-6	2-Hexanone		1.25	2.50	5.00	U	
75-09-2	Methylene chloride		0.500	1.00	2.00	U	
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U	
100-42-5	Styrene		0.250	0.500	1.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U	
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U	
108-88-3	Toluene		0.250	0.500	1.00	U	
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U	
71-55-6	1,1,1-Trichloroethane	**0.454**	0.250	0.500	1.00	J	J
79-01-6	Trichloroethene	**1.91**	0.250	0.500	1.00		
75-01-4	Vinyl chloride		0.250	0.500	1.00	U	
108-38-3/106-42-	m,p-Xylene	**0.535**	0.500	1.00	2.00	J	J
95-47-6	o-Xylene	**0.285**	0.250	0.500	1.00	J	J

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	28.55	95.2	75 - 120	
Dibromofluoromethane	30.00	30.89	103	85 - 115	
1,2-Dichloroethane-d4	30.00	30.15	100	70 - 120	

ANALYSIS DATA SHEET

48MW1

Laboratory:	Empirical Laboratories, LLC			SDG:	1501124
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501124-05	File ID:	0112405B.D
Sampled:	01/28/15 14:30	Prepared:	02/06/15 15:24	Analyzed:	02/06/15 15:24
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B06004	Sequence:	5B04025	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	27.91	93.0	85 - 120	

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Chloride, Nitrate, and Sulfate
Empirical Laboratories, LLC; SDG 1501134

DATE: February 24, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 29, 2015. Samples were analyzed for the chloride, nitrate, and sulfate using USEPA SW-846 9056A. A total of one aqueous sample was validated. The sample Id is:

Field Sample ID	Lab Sample ID
48MW06	1501134-03

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Laboratory Duplicate Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate Sample
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/24/15
Date

RFAAP VALIDATION REPORT
ANIONS REVIEW
SDG 1501134

I-Holding Times and Preservation

The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C and 28 days for sulfate and chloride and Cool to 4°C±2°C with H_2SO_4 to pH<2 and 2 days for nitrate. The dates and times were compared between the sample collection and laboratory analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/29/15, the cooler was received by the laboratory (Empirical) on 01/30/15 at 1.9°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: Samples were collected on 01/29/15. The samples were prepped and analyzed on 01/30/15 for nitrate analysis and on 02/10/15 for sulfate and chloride analysis. Sample collection dates may be found on the attached form 1s. All holding time criteria were met. No qualifiers were applied.

II-Initial and Continuing Calibration

Requirements for satisfactory instrument calibration are established to ensure that the instrument is capable of producing acceptable quantitative data. Initial calibration demonstrates that the instrument is capable of acceptable performance at the beginning of the analysis run, and continuing calibration verification documents that the initial calibration is still valid.

Anions: 1 – blank
5 – standards ($r \geq 0.995$ or $r^2 \geq 0.99$)
ICV/CCV (90-110%)
Method Reporting Limit (MRL) (50-150%)

- Chloride, sulfate, and nitrate analysis was calibrated on 12/16/14 using linear equation techniques. All correlation coefficients were ≥0.995 for chloride, sulfate, and nitrate. All ICV/CCV/MRL criteria were met for all anions and runs. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to these initial and continuing calibrations.

III-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <2MDL for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (for this SDG)
02/10/15	Chloride	ICB/CCBs	<LOD	NA	None
02/10/15	Sulfate	ICB/CCBs	<LOD	NA	None
01/30/15	Nitrate	ICB/CCBs	<LOD	NA	None
02/10/15	Chloride	5B10010-BLK1	<½MRL	NA	None
02/10/15	Sulfate	5B10010-BLK1	<½MRL	NA	None
01/30/15	Nitrate	5A30002-BLK1	<½MRL	NA	None
01/28/15	Chloride	RB012715	<½MRL	NA	None
01/28/15	Sulfate	RB012715	<½MRL	NA	None
01/28/15	Nitrate	RB012715	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample

The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Per DoD QSM, all LCS results must fall within the specified control limits: 80-120%

- Sample 5A30002-BS1 was used as the aqueous LCS for nitrate analysis on 01/29/15. All criteria were met. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to this LCS.

- Sample 5B10010-BS1 was used as the aqueous LCS for chloride and sulfate analysis on 02/10/15. All criteria were met. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to this LCS.

V-Duplicate Sample Analysis

Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. Per DoD QSM, RPDs must be within established control limits (≤25%RPD).

- No site lab duplicate was performed with this SDG; therefore, was not evaluated.

VI-Matrix Spike and Matrix Spike Duplicate
Matrix spikes (MSs) and MSDs are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples or preparatory batch of similar matrix. Per DoD QSM, MS/MSD recoveries and RPDs should be within the specified limits:

Anions: 80-120%; RPD≤20%

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for chloride, sulfate, and nitrate analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 48MW06 (1501134-03), sulfate

$Y = mX + b$

Y = Sample Area
m = slope of curve
X = Concentration (mg/L)
b = Y-intercept
DF = Dilution Factor

Given:
m = 0.202746
b = 0.0
Y = Area = 27.8491022
DF = 2

X = 137.57 mg/L * DF = 136.57 mg/L * 1 = 275 mg/L

Reported concentration = 275 mg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

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MEMORANDUM

TO: Tim Leahy, Shaw E&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, Shaw E&I Project Chemist

SUBJECT: RFAAP Data Validation – Total Organic Carbon
Empirical Laboratories, LLC; SDG 1501134

DATE: February 24, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 29, 2015. Samples were analyzed for Total Organic Carbon (TOC) using USEPA SW-846 9060A. A total of one aqueous sample was validated. The sample Id is:

Field Sample ID	Lab Sample ID
48MW06	1501134-03

Data were reviewed and validated using a combination of project QAPP, *DoD Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010), and method-specific criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial and Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Laboratory Duplicate
	X	Field Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/24/15
Date

RFAAP VALIDATION REPORT
TOC REVIEW
SDG 1501134

I-Holding Times and Preservation
The primary objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of sample analysis. Holding time criteria: Cool 4°C±2°C, HCl pH<2, 28 days for TOC (USEPA criteria). The dates and times were compared between the sample collection and laboratory analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/29/15, the cooler was received by the laboratory (Empirical) on 01/30/15 at 1.9°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: The samples were collected on 01/29/15. The TOC analysis was run on 02/05/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifier was applied.

II-Initial and Continuing Calibration
Bench and run summary sheets were reviewed to determine whether calibration was performed at the beginning of sample analysis using the following criteria. Percent recoveries for initial and continuing calibration (90-110%) must be within limits.

TOC: 1 - blank
5 - standards ($r \geq 0.995$)
ICV/CCV (80-120%)

- The TOC analysis was run on 02/05/15. The initial calibration for TOC was analyzed on 01/19/15 with a coefficient of determination of 0.9996. The ICV and CCVs were evaluated for where they bracketed reported samples. All ICV/CCVs that bracketed reported samples were within criteria. All criteria were met. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to these initial and continuing calibrations.

III-Blank Analysis
The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. One method blank per analytical batch must be run on each instrument used to analyze samples. Calibration blanks were analyzed initially and at a 10% frequency thereafter for each batch. No contaminants should be detected in any of the associated blanks >MDL. The DoD QSM criteria specifies all concentrations should be less than ½MRL (<MRL for common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters) and <LOD (i.e. <2MDL) for the calibration blanks. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, 2-butanone, and phthalate esters, or 5 times (5x) the maximum amount for other target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	Analysis	QC Blank ID	Max Conc. mg/L	Action Level mg/L	B qualified samples (For this SDG)
02/05/15	TOC	ICB/CCBs	<LOD	NA	None
02/05/15	TOC	5B05019-BLK1	<½MRL	NA	None
02/05/15	TOC	RB012714	<½MRL	NA	None

LOD = Limit of Detection
MRL = Method Reporting Limit
MDL = Method Detection Limit
NA = Not Applicable

IV-Laboratory Control Sample
The laboratory control sample (LCS) serve as a monitor of the overall performance of each step during the analysis, including the sample preparation. LCS are generated to determine long-term accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. All aqueous LCS results must fall within the control limits (80-120%).

- Sample 5B05019-BS1 was used as the aqueous LCS for TOC analysis on 02/05/15. All criteria were met. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to this LCS.

V-Matrix Spike and Spike Duplicate
Matrix spikes (MSs) and matrix spike duplicates (MSDs) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. Specific criteria include the analyses of matrix spike samples at a frequency of one MS/MSD per 20 samples of similar matrix. The percent recoveries (%Rs or RPD) must be within the specified control limits (75-125%; RPD≤20%).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VI-Laboratory Duplicate Sample Analysis
Duplicate sample determinations are used to demonstrate acceptable method precision by the laboratory at the time of analysis. Duplicate analysis is performed to generate data in order to determine the long-term precision of the analytical method on various matrices. RPDs must be within established control limits (≤20%RPD).

- No aqueous laboratory duplicate was analyzed for TOC with this SDG; therefore, it was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 25% RPD for the aqueous samples.

- No site field groundwater sample duplicate pair was analyzed for TOC analysis in this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%. The following calculations were performed for verification.

- Any sample value >MDL and <MRL was qualified as estimated, "J."

Sample: 48MW06 (1501134-03), TOC

TOC: Y = m*X (mg/L) + b
m = 11.56
b = 0.00
Y = 18.94
DF = 1

TOC (mg/L) = X = (1.64 mg/L) * 1 = 1.64 mg/L

Reported Value = 1.64 mg/L
% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Inorganic Data Review* (April, 1993).

Form I Copy

ANALYSIS DATA SHEET

48MW06

Laboratory: Empirical Laboratories, LLC
Client: CB&I
Matrix: Water
Sampled: 01/29/15 11:35

SDG: 1501134
Project: Radford AAP
Laboratory ID: 1501134-03
Received: 01/30/15 08:35

CAS NO.	Analyte	Conc. (mg/L)	DL	LOD	LOQ	D.F.	Q	Method	Batch	Analyzed
16887-00-6	Chloride	**9.36**	**0.340**	0.660	1.00	2	D	SW9056A	5B10010	02/10/15 14:17
14797-55-8	Nitrate as N	**5.88**	**0.0330**	0.100	0.250	1		SW9056A	5A30002	01/30/15 12:24
14808-79-8	Sulfate as SO4	**275**	**0.660**	2.00	5.00	2	D	SW9056A	5B10010	02/10/15 14:17
7440-44-0	Total Organic Carbon AVG	**1.64**	**1.25**	2.50	3.00	1	J	SW9060A	5B05019	02/05/15 23:11

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation – Methane, Ethane, and Ethene
Empirical Laboratories, LLC; SDG 1501134

DATE: February 23, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 29, 2015. The samples were analyzed for methane, ethane, and ethene using laboratory method RSK-175. A total of one aqueous sample was validated. The sample Id is:

Field Sample ID	Lab Sample ID
48MW06	1501134-03

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Initial Calibration
	X	Continuing Calibration
	X	Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike and Spike Duplicate
	X	Field Duplicate
	X	Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable.

Eric Malarek, Chemist

2/23/15
Date

RFAAP VALIDATION REPORT
DISSOLVED GASES REVIEW
SDG 1501134

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For methane, ethane, and ethene, aqueous samples are cooled @ 4°C ± 2°C; the maximum holding time is 7 days un-preserved and 14 days preserved to pH<2 with HCl from sample collection to analysis.

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/29/15, the cooler was received by the laboratory (Empirical) on 01/30/15 at 1.9°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: The aqueous sample was collected on 01/29/15. It was prepped and analyzed for the dissolved gases on 02/04/15. Sample collection dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the calibration factors on which the quantitations are based. If linear regression is used for quantification, the correlation coefficient must be ≥0.995 for linearity fit (DoD QSM). If calibration factor method is used, the %RSD should be ≤20% (DoD QSM). All ICVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration performed on 11/30/14 on instrument GL-GCVOA, all target compounds were within criteria (%RSD≤20%%; RRF≥0.05) except for the following. Target compound methane (27.9%) was outside criteria. Methane (r^2=0.9991; quadratic) was quantified using second order regression with coefficient of determination r^2≥0.99; therefore, no qualifiers were applied based upon this outlier. All other target compounds were quantified using calibration factor method. All criteria were met. Sample 48MW06 (1501134-03) applies to this initial calibration.

III-Continuing Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. If calibration factor method is used, the percent difference (%D) should all fall within the control criteria of ≤20% (DoD QSM). All CCVs should be within 80-120% recovery limits (DoD QSM).

- For initial calibration verification for methane, ethane, and ethene performed on 12/01/14 @00:44 on instrument GL-GCVOA, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this initial calibration verification.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @11:47 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @15:11 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. Sample 48MW06 (1501134-03) applies to this continuing calibration.

- For continuing calibration for methane, ethane, and ethene performed on 02/04/15 @17:54 on instrument GL-GCVOA, all criteria were met (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No groundwater samples were reported using this continuing calibration.

IV-Blank Analysis

The purpose of laboratory or field blank analyses is to determine the existence and magnitude of contamination problems resulting from laboratory or field activities. One method blank per analytical batch must be run on each instrument used to analyze samples. No contaminants should be present in the blanks. The DoD QSM criterion specifies all concentrations should be less than one-half MRL. Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤5 times (5x) the maximum amount for explosive target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (For this SDG)
02/04/15	5B04002-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	All target <½MRL	NA	NA	None

MRL = Method Reporting Limit
NA = Not Applicable

V-Laboratory Control Sample

Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. DoD LCS aqueous recovery limits are specified in the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. Percent recoveries (%Rs) should be within the specified control limits.

- Sample 5B04002-BS1 was used as LCS for methane, ethane, and ethene analysis performed on 02/04/15. All criteria were met. No qualifiers were applied. Sample 48MW06 (1501134-03) applies to this LCS.

VI-Matrix Spike/Matrix Spike Duplicate

Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. DoD QSM MS and MSD recovery limits use the LCS criteria, which currently is the use of in-house specified limits (DoD, 2010).

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VII-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were qualified rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established in the Groundwater Monitored Natural Attenuation (GWMNA) QAPP at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

VIII-Quantitation Verification and Data Review
The accuracy of analytical results was verified and data results reviewed. The following was determined:

- The percent difference (%D) between the calculated and the reported values should be within 10% through the calculation from the raw data provided. The calculation verification was confirmed within 10% difference.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 5B04002-BS1, ethane

Conc. µg/L = (((Vhs*(Ax/CF))/Vs*Density)+((Ax/CF)/HLC)*55.5/1.137*(MW*1000))*DF

Where:

Ax	= Area of characteristic ion for compound being measured.
CF	= Average relative calibration factor for compound being measured (from ICAL)
MW	= molecular weight of analyte = 30.0 ug/umol
DF	= dilution factor 1
Vhs	= Volume of headspace = 5.5 mL
Vs	= Volume of sample = 0.015 L
Density	= 0.64356M,1.1262Ee,or 1.2067Ea
HLC	= Henry's Law Constant = 44900M,12700Ee, or 34200Ea

Conc. µg/L =
(((5.5*(561935/550513.3))/0.015*1.2067)+((561935/550513.3)/34200)*55.5/1.137*(30*1000))*1
= 495.3 µg/L

Reported Value = 495.3 µg/L

% Difference = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

48MW06

Laboratory: Empirical Laboratories, LLC SDG: 1501134

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501134-03 File ID: 028F2801.D\Report.TXT

Sampled: 01/29/15 11:35 Prepared: 02/04/15 07:09 Analyzed: 02/04/15 17:40

Solids: Preparation: RSK175 Dilution: 1

Batch: 5B04002 Sequence: 5B03704 Calibration: 4335002 Instrument: GL-GCVOA

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
74-82-8	Methane		1.00	2.00	4.00	U
74-84-0	Ethane		1.00	2.00	4.00	U
74-85-1	Ethene		1.00	2.00	4.00	U

Total Target Analytes Reported 3 Project Analytes: 3

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MEMORANDUM

TO: Tim Leahy, CB&I Radford Army Ammunition Plant (RFAAP) Project Manager

FROM: Eric Malarek, CB&I RFAAP Project Chemist

SUBJECT: RFAAP Data Validation - Volatiles
Empirical Laboratories, LLC; SDG 1501134

DATE: February 24, 2015

The purpose of this memorandum is to present the data validation report for the samples collected at Main Manufacturing Area at RFAAP for SWMU48/49 RFI/MNA on January 29, 2015. The samples were analyzed for volatile organic compounds (VOCs) using USEPA SW846 method 5030B/8260B for aqueous matrices. A total of three aqueous samples (includes one trip blank) were validated. The sample Ids are:

Field Sample ID	Lab Sample ID	Field Sample ID	Lab Sample ID
Trip Blank	1501134-01	48MW06	1501134-03
48MW07	1501134-02		

Data were reviewed by Eric Malarek and validated using a combination of project QAPP, *Quality Systems Manual for Environmental Laboratories, Final Version 4.2, October 25, 2010* (DoD, 2010) (DoD QSM), method-specific criteria, and laboratory SOP criteria. The data qualifier scheme was consistent with the *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994). Parameters evaluated are presented in **Table 1**. Data associated with parameters in compliance with quality control specifications have not been qualified. Data associated with parameters that did not comply with quality control specifications and directly impacted project data have been qualified in accordance with USEPA Region III specifications.

Table 1 Laboratory Performance Criteria

Qualified Data		Parameter
Yes	No	
	X	Holding Times and Preservation
	X	Instrument Performance Results
	X	Initial Calibration
	X	Continuing Calibration
X		Blank Analysis
	X	Laboratory Control Sample
	X	Matrix Spike / Spike Duplicate Sample
	X	System Monitoring Compounds
	X	Internal Standards
	X	Field Sample Duplicate
X		Quantitation Verification and Data Review

The quality of data collected in support of this sampling activity is considered acceptable with noted qualifications.

Eric Malarek, Chemist

2/24/15
Date

RFAAP VALIDATION REPORT
VOLATILES REVIEW
SDG 1501134

I-Holding Times and Preservation
The objective is to ascertain the validity of results based on the holding time of the sample from time of collection to time of analysis. Holding time criteria: For aqueous samples, VOC compounds are shipped cooled (@4°C ± 2°C) and preserved pH≤2 HCl with a maximum holding time of 14 days (7 days if no HCl) from sample collection to determinative analysis (USEPA criteria).

- Temperature Review: The temperature blank was sent with each cooler and recorded by the laboratory upon receipt. For samples collected on 01/29/15, the cooler was received by the laboratory (Empirical) on 01/30/15 at 1.9°C. The cooler receipt was below criteria; however, there were no impacts to the data quality and no qualifiers were applied based upon this outlier.

- Holding Time Review: For the samples collected on 01/29/15, the aqueous VOCs were prepped and analyzed on 02/11/15. Sample collection and analysis dates may be found on the attached form 1s. All criteria were met. No qualifiers were applied.

II-Instrument Performance Check
The analysis of the instrument performance check solution must be performed at the beginning of each 12-hour period during which samples are analyzed.

- The instrument performance check, bromofluorobenzene (BFB), met the ion abundance criteria. No qualification was applied.

III-Initial Calibration
Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Initial calibration demonstrates that the instrument is capable of acceptable performance in the beginning of the analytical run and of producing a linear calibration curve and establishes the relative response factors on which the quantitations are based. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent relative standard deviation (%RSD) must be ≤15% for each target compound and must be ≤30% for each calibration check compound. For compounds analyzed using linear regression or second order, correlation coefficients must be >0.995 and coefficients of determination >0.99.

- For initial calibration performed on 10/16/14 on instrument MS-VOA3, target compounds bromomethane (22.4%), chloroethane (21.6%), and methylene chloride (23.9%) were outside criteria. All other target compounds were within criteria (%RSD≤15% or ≤30%; RRF≥0.05). Bromomethane, chloroethane, and methylene chloride were quantified using linear equation with correlation coefficients >0.995. All criteria were met. No qualifiers were applied. Samples Trip Blank (1501134-01), 48MW07 (1501134-02), and 48MW06 (1501134-03) were analyzed using this initial calibration.

IV-Continuing Calibration

Compliance requirements for satisfactory instrument calibration are established to ensure that the instrument used is capable of producing acceptable qualitative and quantitative data for volatile target compounds. Continuing calibration checks satisfactory performance of the instrument on a day-to-day basis. The RRF must be greater than 0.1 for chloromethane, 1,1-dichloroethane, and bromoform and greater than 0.3 for 1,1,2,2-tetrachloroethane and chlorobenzene. The minimum relative response factor (RRF) must be ≥0.05 for all other compounds. The DoD QSM specifies that the percent difference (%D) between the initial calibration RRF and the continuing calibration RRF must be within 20% for all target compounds. The initial calibration verification should be between 80-120% recoveries.

- For initial calibration verification for the VOC analysis performed on 10/16/14 @17:56 on instrument MS-VOA3, all target compounds were within criteria (%D≤20%; %Drift≤20%; RRF≥0.05). No qualifiers were applied. No samples reported were analyzed using this initial calibration verification.

- For continuing calibration for the VOC analysis performed on 02/11/15 @08:42 on instrument MS-VOA3, bromoform (20.3%) and carbon tetrachloride (23.9%) were outside criteria (%D≤20%; %Drift≤20%; RRF≥0.05). All other target compounds were within criteria. Bromoform and carbon tetrachloride were non-detect for all associated samples; therefore, no qualification was required based upon the high %Ds. Samples Trip Blank (1501134-01), 48MW07 (1501134-02), and 48MW06 (1501134-03) were analyzed using this continuing calibration.

V-Blank Analysis

The purpose of blank analyses is to determine the presence and magnitude of contamination problems resulting from field and laboratory activities. A method blank analysis must be performed after the calibration standards and once every 12-hour time period beginning with the injection of BFB. No contaminants should be detected in any of the associated blanks > the MDL. The DoD QSM criteria specifies all concentrations should be less than one-half MRL (<MRL for common laboratory contaminants methylene chloride, acetone, and 2-butanone). Positive sample results are reported and qualified "B", if the concentration of the compound in the sample is ≤10 times (10x) the maximum amount in any blank for the common laboratory contaminants methylene chloride, acetone, toluene, and 2-butanone (MEK), or 5 times (5X) the maximum amount for other volatile target compounds. **Table 2** summarizes the blank contamination analysis. Action levels are based upon dilution factor of one. Rinse blank sample RB012714 (1501116-06) applies to all groundwater samples collected in this SDG. Trip blank sample Trip Blank (1501134-01) applies to all groundwater samples collected in this SDG.

Table 2 Blank Contamination Analysis Summary

Analysis Date	QC Blank ID	Compound	Max Conc. µg/L	Action Level µg/L	B qualified samples (for this SDG)
02/11/15	5B11007-BLK1	All target <½MRL	NA	NA	None
02/04/15	RB012714	Acetone	9.32J	93.2	48MW06
02/11/15	Trip Blank	All target <½MRL	NA	NA	None

J = Estimated value <MRL and >MDL.
NA = Not Applicable
MRL = Method Reporting Limit
MDL = Method Detection Limit
LOD = Level of Detection

VI-Laboratory Control Sample
Data for laboratory control samples (LCS) are evaluated to determine long-term accuracy of the analytical method on various matrices. Percent recoveries (%Rs) should be within the specified control limits. DoD LCS aqueous recovery limits are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used.

- Sample 5B11007-BS1 was used as the aqueous LCS for the VOC analysis on 02/11/15. All criteria were met. No qualifiers were applied. Samples Trip Blank (1501134-01), 48MW07 (1501134-02), and 48MW06 (1501134-03) apply to this LCS.

VII-Matrix Spike/Matrix Spike Duplicate
Data for matrix spike/matrix spike duplicates (MS/MSD) are generated to determine long-term precision and accuracy of the analytical method on various matrices and to demonstrate acceptable compound recovery by the laboratory at the time of sample analysis. The percent recoveries (%Rs) and the relative percent difference (RPD) must be within the specified control limits. The DoD MS/MSD aqueous recovery limits follow the LCS criteria and are specified in Table G-4 of the DoD QSM (DoD, 2010). If the compound is not listed, then the laboratory criteria shall be used. The MS/MSD RPD should be ≤30%.

- No project specific MS/MSD was collected within this SDG; therefore, was not evaluated.

VIII-System Monitoring Compounds (Surrogates)
Laboratory performance on individual samples is evaluated through the review of surrogate spike samples. Recoveries for system monitoring compounds in volatile samples and blanks must be within the specified control limits. DoD surrogate recovery limits are specified in Table G-3 of the DoD QSM (DoD, 2010). If the surrogate is not listed, then the laboratory criteria shall be used.

Aqueous Criteria:
4-Bromofluorobenzene (75-120%; RT±1.000)
Dibromofluoromethane (85-115%; RT±1.000)
1,2-Dichloroethane-d4 (70-120%; RT±1.000)
Toluene-d8 (85-120%; RT±1.000)

- All criteria were met. No qualifiers were applied.

IX-Internal Standards (IS)
Internal standards performance criteria ensure that GC/MS sensitivity and response are stable during every analytical run. Specific criteria include: area counts (-50% to +100%) of the associated calibration standard, and retention time (± 30 seconds) from that of the associated calibration standard.

- All criteria were met. No qualifiers were applied.

X-Field Duplicate Sample Analysis
Field duplicates were collected to identify the cumulative precision of the sampling and analytical process and sent to the laboratory blind. The RPD was calculated only for those analytes which were detected at levels exceeding the method reporting limits in both samples of the duplicate pair. Analytes that were rejected (R-qualified) in either sample of the duplicate pair were excluded from the duplicate assessment. Precision control criterion was established at 50% RPD for the aqueous samples.

- No field groundwater sample duplicate pair was collected within this SDG; therefore, was not evaluated.

XI-Quantitation Verification and Data Review
The accuracy of analytical results is verified through the calculation of several parameters. The percent difference (%D) between the calculated and the reported values should be within 10%.

- Any sample value >MDL and <MRL was qualified as estimated, "J".

Sample: 48MW06 (1501134-03), trichloroethene

Conc. (µg/L) = (Ax)*(Is)*(DF) / (Ais)*(RRF)

where: Ax is the compound area
Ais is the corresponding internal standard area
Is is the corresponding internal standard concentration (µg/L)
DF is the dilution factor
RRF is the relative response factor.

Conc. µg/L = (13200 * 30 µg/L * 2) / (815038 * 0.2957519) = 3.29 µg/L

Reported Conc. = 3.29 µg/L
%D = 0.0%
Values were within 10% difference.

Laboratory and Data Validation Qualifiers

Qualifier	Definition
Laboratory Qualifiers[1]	
No Code	Confirmed identification.
U	Undetected at the limit of detection: The associated data value is the limit of detection, adjusted by any dilution factor used in the analysis.
J	Estimated: The analyte was positively identified; the quantitation is estimation.
B	Blank contamination: The analyte was detected above one-half the reporting limit in an associated blank.
N	Non-target analyte: The analyte is a tentatively identified compound (using mass spectroscopy).
Q	One or more quality control criteria failed.
USEPA Region III Data Validation Qualifiers[2]	
R	Unreliable result. Analyte may or may not be present in the sample. Supporting data necessary to confirm result.
B	Not detected substantially above the level of the reported in laboratory or field blanks.
J	Analyte present. Reported value may not be accurate or precise.
UJ	Not detected, quantitation limit may be inaccurate or imprecise.
N	Tentative Identification. Consider present. Special methods may be to confirm its presence or absence in future sampling efforts.
NJ	Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
K	Analyte present. Reported value may be biased high. Actual value is expected to be lower.
L	Analyte present. Reported value may be biased low. Actual value is expected to be higher.
UL	Not detected, quantitation limit is probably higher.

[1]The noted laboratory qualifiers are a minimum. If a laboratory has more and they are consistent with DoD and properly defined, the laboratory may use them. Data qualifiers may be combined when appropriate. Ref.: *DOD Quality Systems Manual for Environmental Laboratories, Final Version 4.2* (DoD, 2010).

[2]The USEPA data validation qualifiers are referenced from *Region III Modifications to the National Functional Guidelines for Organic Data Review* (September 1994).

ANALYSIS DATA SHEET

Trip Blank

Laboratory: Empirical Laboratories, LLC SDG: 1501134

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501134-01RE1 File ID: 0113401B.D

Sampled: 01/29/15 08:00 Prepared: 02/11/15 12:36 Analyzed: 02/11/15 12:36

Solids: Preparation: 5030B Dilution: 1

Batch: 5B11007 Sequence: 5B04309 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	UX
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	UX
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	29.40	98.0	75 - 120	
Dibromofluoromethane	30.00	30.64	102	85 - 115	
1,2-Dichloroethane-d4	30.00	28.68	95.6	70 - 120	

ANALYSIS DATA SHEET

Trip Blank

Laboratory:	Empirical Laboratories, LLC			SDG:	1501134
Client:	CB&I			Project:	Radford AAP
Matrix:	Water	Laboratory ID:	1501134-01RE1	File ID:	0113401B.D
Sampled:	01/29/15 08:00	Prepared:	02/11/15 12:36	Analyzed:	02/11/15 12:36
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B11007	Sequence:	5B04309	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	28.67	95.6	85 - 120	

ANALYSIS DATA SHEET

48MW07

Laboratory: Empirical Laboratories, LLC SDG: 1501134

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501134-02RE1 File ID: 0113402C.D

Sampled: 01/29/15 09:25 Prepared: 02/11/15 13:26 Analyzed: 02/11/15 13:26

Solids: Preparation: 5030B Dilution: 1

Batch: 5B11007 Sequence: 5B04309 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q
67-64-1	Acetone		2.50	5.00	10.0	U
71-43-2	Benzene		0.250	0.500	1.00	U
75-27-4	Bromodichloromethane		0.250	0.500	1.00	U
75-25-2	Bromoform		0.250	0.500	1.00	UX
74-83-9	Bromomethane		0.500	1.00	2.00	U
78-93-3	2-Butanone		2.50	5.00	10.0	U
75-15-0	Carbon disulfide		0.250	0.500	1.00	U
56-23-5	Carbon tetrachloride		0.250	0.500	1.00	UX
108-90-7	Chlorobenzene		0.250	0.500	1.00	U
75-00-3	Chloroethane		0.500	1.00	2.00	U
67-66-3	Chloroform		0.250	0.500	1.00	U
74-87-3	Chloromethane		0.250	0.500	1.00	U
124-48-1	Dibromochloromethane		0.250	0.500	1.00	U
75-34-3	1,1-Dichloroethane		0.250	0.500	1.00	U
107-06-2	1,2-Dichloroethane		0.250	0.500	1.00	U
75-35-4	1,1-Dichloroethene		0.250	0.500	1.00	U
156-59-2	cis-1,2-Dichloroethene		0.250	0.500	1.00	U
156-60-5	trans-1,2-Dichloroethene		0.250	0.500	1.00	U
78-87-5	1,2-Dichloropropane		0.250	0.500	1.00	U
10061-01-5	cis-1,3-Dichloropropene		0.250	0.500	1.00	U
10061-02-6	trans-1,3-Dichloropropene		0.250	0.500	1.00	U
100-41-4	Ethylbenzene		0.250	0.500	1.00	U
591-78-6	2-Hexanone		1.25	2.50	5.00	U
75-09-2	Methylene chloride		0.500	1.00	2.00	U
108-10-1	4-Methyl-2-pentanone		1.25	2.50	5.00	U
100-42-5	Styrene		0.250	0.500	1.00	U
79-34-5	1,1,2,2-Tetrachloroethane		0.250	0.500	1.00	U
127-18-4	Tetrachloroethene		0.250	0.500	1.00	U
108-88-3	Toluene		0.250	0.500	1.00	U
79-00-5	1,1,2-Trichloroethane		0.250	0.500	1.00	U
71-55-6	1,1,1-Trichloroethane		0.250	0.500	1.00	U
79-01-6	Trichloroethene		0.250	0.500	1.00	U
75-01-4	Vinyl chloride		0.250	0.500	1.00	U
108-38-3/106-42-	m,p-Xylene		0.500	1.00	2.00	U
95-47-6	o-Xylene		0.250	0.500	1.00	U

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	28.49	95.0	75 - 120	
Dibromofluoromethane	30.00	31.45	105	85 - 115	
1,2-Dichloroethane-d4	30.00	28.59	95.3	70 - 120	

ANALYSIS DATA SHEET

48MW07

Laboratory:	Empirical Laboratories, LLC			SDG:	1501134		
Client:	CB&I			Project:	Radford AAP		
Matrix:	Water	Laboratory ID:	1501134-02RE1	File ID:	0113402C.D		
Sampled:	01/29/15 09:25	Prepared:	02/11/15 13:26	Analyzed:	02/11/15 13:26		
Solids:		Preparation:	5030B	Dilution:	1		
Batch:	5B11007	Sequence:	5B04309	Calibration:	4295001	Instrument:	MS-VOA3

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	27.66	92.2	85 - 120	

ANALYSIS DATA SHEET

48MW06

Laboratory: Empirical Laboratories, LLC SDG: 1501134

Client: CB&I Project: Radford AAP

Matrix: Water Laboratory ID: 1501134-03RE1 File ID: 0113403C.D

Sampled: 01/29/15 11:35 Prepared: 02/11/15 13:51 Analyzed: 02/11/15 13:51

Solids: Preparation: 5030B Dilution: 2

Batch: 5B11007 Sequence: 5B04309 Calibration: 4295001 Instrument: MS-VOA3

CAS NO.	COMPOUND	CONC. (ug/L)	DL	LOD	LOQ	Q	
67-64-1	Acetone	**27.8**	5.00	10.0	20.0	D	B
71-43-2	Benzene		0.500	1.00	2.00	U	
75-27-4	Bromodichloromethane		0.500	1.00	2.00	U	
75-25-2	Bromoform		0.500	1.00	2.00	UX	
74-83-9	Bromomethane		1.00	2.00	4.00	U	
78-93-3	2-Butanone		5.00	10.0	20.0	U	
75-15-0	Carbon disulfide		0.500	1.00	2.00	U	
56-23-5	Carbon tetrachloride		0.500	1.00	2.00	UX	
108-90-7	Chlorobenzene		0.500	1.00	2.00	U	
75-00-3	Chloroethane		1.00	2.00	4.00	U	
67-66-3	Chloroform		0.500	1.00	2.00	U	
74-87-3	Chloromethane		0.500	1.00	2.00	U	
124-48-1	Dibromochloromethane		0.500	1.00	2.00	U	
75-34-3	1,1-Dichloroethane	**4.28**	0.500	1.00	2.00	D	
107-06-2	1,2-Dichloroethane		0.500	1.00	2.00	U	
75-35-4	1,1-Dichloroethene		0.500	1.00	2.00	U	
156-59-2	cis-1,2-Dichloroethene	**4.86**	0.500	1.00	2.00	D	
156-60-5	trans-1,2-Dichloroethene		0.500	1.00	2.00	U	
78-87-5	1,2-Dichloropropane		0.500	1.00	2.00	U	
10061-01-5	cis-1,3-Dichloropropene		0.500	1.00	2.00	U	
10061-02-6	trans-1,3-Dichloropropene		0.500	1.00	2.00	U	
100-41-4	Ethylbenzene		0.500	1.00	2.00	U	
591-78-6	2-Hexanone		2.50	5.00	10.0	U	
75-09-2	Methylene chloride		1.00	2.00	4.00	U	
108-10-1	4-Methyl-2-pentanone		2.50	5.00	10.0	U	
100-42-5	Styrene		0.500	1.00	2.00	U	
79-34-5	1,1,2,2-Tetrachloroethane		0.500	1.00	2.00	U	
127-18-4	Tetrachloroethene	**0.709**	0.500	1.00	2.00	JD	J
108-88-3	Toluene		0.500	1.00	2.00	U	
79-00-5	1,1,2-Trichloroethane		0.500	1.00	2.00	U	
71-55-6	1,1,1-Trichloroethane	**0.691**	0.500	1.00	2.00	JD	J
79-01-6	Trichloroethene	**3.29**	0.500	1.00	2.00	D	
75-01-4	Vinyl chloride		0.500	1.00	2.00	U	
108-38-3/106-42-	m,p-Xylene		1.00	2.00	4.00	U	
95-47-6	o-Xylene		0.500	1.00	2.00	U	

Total Target Analytes Reported 35 Project Analytes: 35

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Bromofluorobenzene	30.00	28.66	95.5	75 - 120	
Dibromofluoromethane	30.00	31.14	104	85 - 115	
1,2-Dichloroethane-d4	30.00	30.44	101	70 - 120	

ANALYSIS DATA SHEET

48MW06

Laboratory:	Empirical Laboratories, LLC		SDG:	1501134	
Client:	CB&I		Project:	Radford AAP	
Matrix:	Water	Laboratory ID:	1501134-03RE1	File ID:	0113403C.D
Sampled:	01/29/15 11:35	Prepared:	02/11/15 13:51	Analyzed:	02/11/15 13:51
Solids:		Preparation:	5030B	Dilution:	1
Batch:	5B11007	Sequence:	5B04309	Calibration:	4295001
Instrument:	MS-VOA3				

SYSTEM MONITORING COMPOUND	ADDED (ug/L)	CONC (ug/L)	% REC	QC LIMITS	Q
Toluene-d8	30.00	29.48	98.3	85 - 120	