Tables

Table 6.1 - Post-Closure and Corrective Action Cost Estimates

Facility: Tulsa West

Estimate Year: 2018

Unit	Unit / Site / Project	Summary of Scope	Closure		Post-Closure	Total Estimated Cost (not discounted)
			Estimated Investigation Cost	Estimated Remediation Cost	Estimated O&M Cost	
GW-Dis	Groundwater - Dissolved Phase Monitoring	IGPG developed but not approved by ODEQ. Potential additional standard development and/or agency interaction to adopt IGPGs in new RCRA Permit.	48,000	-	-	48,000
LNAPL	LNAPL Recovery Systems	Investigation of LNAPL in POC well 353 area. Potential LNAPL recovery system testing and expansion.	77,000	226,000	-	303,000
O&M	Facility Wide O&M	LTU and SWMU Inspections, RB inspections, O&M of LNAPL recovery systems, semi-annual compliance monitoring, data management, modeling and reporting.	-	-	16,640,630	16,640,630
VI	Vapor Intrusion	O&M of vapor recovery systems at Engineering Buildings and Transfer Center Control Room. VI system evaluation.	50,500	-	1,155,000	1,205,500
AOC 1	AOC 1 Abandoned Pipe Release Area Remediation	Submit remediation report and agency interactions.	-	800	43,449	44,249
Meter Pit	Meter Pit	Submit remediation report and agency interactions.	-	-	35,561	35,561
RCRA Permit	RCRA Permit Renewal	Prepare and submit RCRA Permit renewal application to ODEQ. Agency interaction.	-	-	450,000	450,000
RBDDI	RBDDI - Riverbank Final Remedy Due Diligence Investigation & Pilot Testing	Prepare risk assessment work plan, conduct data gap analysis, prepare SAP, collect and analyze additional data. Submit draft risk assessment report and agency interactions.	900,693	-	-	900,693
SWMU 6 Sheen	SWMU 6: Arkansas River Sheen - Initial Response and Inspection	Mitigate sheening with hard and sorbent booms. Develop and implement new IM Plan to remove waste from contact with river and mitigate sheening.	-	-	192,220	192,220
			1,076,193	**226,800**	**18,516,860**	**19,819,853**

Appendices

6.1 Cost Estimate Background Information

6.2 Financial Assurance Documentation

APPENDIX 6.1 – COST ESTIMATE BACKGROUND INFORMATION

COST ESTIMATE
GROUNDWATER - DISSOLVED PHASE MONITORING
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**Groundwater - Dissolved Phase Monitoring**				
	Senior Program Manager	Hr	160	165	26,400
	Environmental Professional V	Hr	160	110	17,600
	Environmental Technician IV	Hr	20	64	1,280
	CAD Technician III	Hr	20	80	1,600
	Administrative Assistant III	Hr	20	47	940
	ECS Vehicle	Day	2	85	170
	Equipment	LS	1	10	10
					48,000
				Total:	**$48,000**

Notes:

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COST ESTIMATE
LNAPL RECOVERY SYSTEMS
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

1.0 INVESTIGATE WELL 353 AREA

	Cost	Unit Price	Multiplier	Qty	Hull	Pass-Thru	Total
Task 1: Pre-Planning, Scoping, Bid Procurement, Estimating, HASP Prep. & Edits							
Scope Includes: Agency correspondence, Coordination with Refinery and Sub-Contractors, HASP Prep. and Edits, Field Work Preparation, Determination of Number and Location of LIF Points to Complete Investigation, Develop Maps and Plates to Develop Proposed Investigation Locations, Extract GPS Data for Field Verification, Evaluate Proposed LIF Locations for Obstacles.							
Senior Project Manager	120.00 hr	1	10	$1,200.00	$0.00	$1,200.00
Project Manager	110.00 hr	1	8	$880.00	$0.00	$880.00
Project Hydro	105.00 hr	1	5	$525.00	$0.00	$525.00
GIS Specialist	60.00 hr	1	2	$120.00	$0.00	$120.00
Clerical	40.00 hr	1	4	$160.00	$0.00	$160.00
Task1: Pre-Planning Total				$2,885.00	$0.00	$2,885.00
Task 2: Utility Pre-Clearing						
Scope Includes: Hydrovac L-shaped Clearance at Each LIF Location to 10' BGS Including Air Monitoring, Pre-Clearing Oversight and Support; Assumes Approximately Locations Will Be Completed Per Day (Due to Potential Waste and Debris), Up to 4 Total Locations, Per Diem, Hotel, and Airfare for a Hull Hydrogeologist to Assist with Investigation Point Scope Out for up to 2 Working Days + 1 Travel Day.							
Senior Project Manager	120.00 hr	1	4	$480.00	$0.00	$480.00
Project Hydro	105.00 hr	1	16	$1,680.00	$0.00	$1,680.00
Project Hydro - Travel (1/2 Billed)	105.00 hr	1	5	$525.00	$0.00	$525.00
Airfare - Hull	500.00 ls	1	1	$500.00	$0.00	$500.00
Hotel - Hull	110.00 dy	1	2	$220.00	$0.00	$220.00
Per Diem - Hull	42.00 dy	1	2	$84.00	$0.00	$84.00
Cargo Van/Truck - daily	120.00 dy	1	2	$240.00	$0.00	$240.00
GPS Trimble	125.00 dy	1	1	$125.00	$0.00	$125.00
Air Monitoring - Gas Alert MicroClip	30.00 dy	1	1	$30.00	$0.00	$30.00
Mobilization (mobile lab, MIP eqpt., Air Knife, Drill Rig)	1500.00	1	1	$0.00	$1,500.00	$1,500.00
Hydrovac - BGS	300.00 dy	1	2	$0.00	$600.00	$600.00
Air Monitoring for Hydrovac	45.00 hr	3	2	$0.00	$270.00	$270.00
Task 2: Utility Pre-Clearing Total				$3,884.00	$2,370.00	$6,254.00
Task 3: Monitoring Well Installation						
Scope Includes: Installation of Up to four 4-inch Monitoring Wells with Drill Rig, Air Monitoring, Oversight and Support of Monitoring Well Installation, Per Diem, and Hotel for Hull Personnel for 2 Working Days and 2 Standby Days. Airfare and Travel are Included in the Previous Tasks.							
Senior Project Manager	120.00 hr	2	2	$480.00	$0.00	$480.00
Project Hydro	105.00 hr	1	45	$4,725.00	$0.00	$4,725.00
Cargo Van/Truck	120.00 dy	1	4	$480.00	$0.00	$480.00
GPS Trimble	125.00 dy	1	1	$125.00	$0.00	$125.00
PID 10.6 eV Lamp	85.00 dy	1	2	$170.00	$0.00	$170.00
Samp. Supplies -Gloves/Baggies	58.00 ea	1	1	$29.00	$0.00	$29.00
Air Monitoring - Gas Alert MicroClip	30.00 dy	1	2	$60.00	$0.00	$60.00
Hotel - Hull	110.00 dy	1	4	$440.00	$0.00	$440.00
Per Diem - Hull	42.00 dy	1	4	$168.00	$0.00	$168.00
Drill Rig - BGS	1600.00	1	4	$0.00	$6,400.00	$6,400.00
4-inch PVC riser (10-ft)	49.00 ea	1	50	$0.00	$2,450.00	$2,450.00
4-inch PVC screen (10-ft)	62.00 ea	1	80	$0.00	$4,960.00	$4,960.00
4-inch locking cap	12.00 ea	1	4	$0.00	$48.00	$48.00
4.25-inch auger plug	10.00 ea	1	4	$0.00	$40.00	$40.00
Bentonite (bag)	9.00 ea	1	60	$0.00	$540.00	$540.00
Sand (bag)	11.00 ea	1	60	$0.00	$660.00	$660.00
Portland (bag)	12.00 ea	1	8	$0.00	$96.00	$96.00
Auger Decon. - BGS	65.00 ea	1	4	$0.00	$260.00	$260.00
Flushmount Well - BGS	65.00 ea	1	4	$0.00	$260.00	$260.00
Well Development - BGS	120.00 ea	1	4	$0.00	$480.00	$480.00
OK Well Registration - BGS	75.00 ea	1	4	$0.00	$300.00	$300.00
Per Diem - BGS	150.00 dy	2	4	$0.00	$1,200.00	$1,200.00
Air Mon. for LIF/MIP Invest. - AirGas	45.00 hr	2	4	$0.00	$360.00	$360.00
Task 3: Monitoring Well Installation Total				$6,677.00	$18,054.00	$24,731.00

COST ESTIMATE
LNAPL RECOVERY SYSTEMS
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

Task 4: Transmissivity Testing & Monthly Gauging

Scope Includes: Assumes ECC will gauge wells. Data Interpretation Will Occur After the Event is Over. Transmissivity Testing will Occur After LNAPL has had Sufficient Time to Enter New Monitoring Wells. Enviroclean to Implement Monthly Gauging of 10-15 Wells Surrounding POC Well 353 for LNAPL APT Trend Analysis. 10 Months Are Billed for Monthly Gauging Due to Semi-Annual Gauging of Wells.

Senior Project Manager	120.00	hr	1	4	$480.00	$0.00	$480.00
Project Hydro - Data Interpretation	105.00	hr	1	8	$840.00	$0.00	$840.00
Hydrogeologist - Enviroclean Gauging	1915.00	dy	1	4	$7,660.00	$0.00	$7,660.00
Transmissivity Testing Equipment	1,750.00	ls	1	1	$1,750.00	$0.00	$1,750.00
Air Monitoring - Gas Alert MicroClip	30.00	dy	1	4	$120.00	$0.00	$120.00
Interface Probe - Enviroclean	50.00	dy	1	4	$200.00	$0.00	$200.00
Task 4: Transmissivity Testing Total					$11,050.00	$0.00	$11,050.00

Task 5: POC Well 353 Vicinity LNAPL Forensics

Scope Includes: HiRes Fingerprinting of 6 Samples & PIANO Analysis of 3 Samples at Alpha Analytical. Includes Interpretation of Results by Geochemists. LNAPL Sampling Will Take Place During Enviroclean's Regular SMR Event.

Hi-Res Fingerprinting - Alpha	275.00	each	1	6	$0.00	$1,650.00	$1,650.00
PIANO Analysis - Alpha	400.00	each	1	3	$0.00	$1,200.00	$1,200.00
Jr. Chemist Fingerprinting Interpretation - Alpha	145.00	hr	1	4	$0.00	$580.00	$580.00
Sr. Chemist Fingerprinting Interpretation - Alpha	275.00	hr	1	6	$0.00	$1,650.00	$1,650.00
Task 5: POC Well 353 Vicinity LNAPL Forensics					$0.00	$5,080.00	$5,080.00

Task 6: Data Analysis & API Recovery Modeling

Scope Includes: Analysis of Transmissivity and Other Field Data; Development of API LNAPL Recovery Model for Potential Use in Active LNAPL Recovery

Senior Project Manager	120.00	hr	1	20	$2,400.00	$0.00	$2,400.00
Project Manager	110.00	hr	1	12	$1,320.00	$0.00	$1,320.00
Project Hydro	105.00	hr	1	20	$2,100.00	$0.00	$2,100.00
GIS Specialist	60.00	hr	1	12	$720.00	$0.00	$720.00
Clerical	40.00	hr	1	14	$560.00	$0.00	$560.00
Task 6: Data Analysis & API Recovery Modeling Total					$7,100.00	$0.00	$7,100.00

Task 7: POC Well 353 LNAPL Investigation and API Modeling Report

Scope Includes: Data Interpretation, Plate Creation, Report Drafting and Client Interfacing

Senior Project Manager	120.00	hr	1	40	$4,800.00	$0.00	$4,800.00
Project Manager	110.00	hr	1	40	$4,400.00	$0.00	$4,400.00
Project Hydro	105.00	hr	1	60	$6,300.00	$0.00	$6,300.00
GIS Specialist	60.00	hr	1	24	$1,440.00	$0.00	$1,440.00
Clerical	40.00	hr	1	24	$960.00	$0.00	$960.00
Task 7: POC Well 353 LNAPL Investigation and API Modeling Report Total					$17,900.00	$0.00	$17,900.00

POC WELL 353 LNAPL INVESTIGATION AND RECOVERY MODELING TOTAL					**$49,496.00**	**$25,504.00**	**$75,000.00**

COST ESTIMATE
LNAPL RECOVERY SYSTEMS
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
2.0	**LNAPL SYSTEM EXPANSION**				
	Senior Program Manager	Hr	50	165	8,250
	Environmental Professional V	Hr	100	110	11,000
	Environmental Technician IV	Hr	360	64	23,040
	CAD Technician III	Hr	80	80	6,400
	Administrative Assistant III	Hr	32	47	1,504
	ECS Vehicle	Day	28	85	2,380
	LNAPL Recovery Tanks	Ea	2	7,500	15,000
	Holly-Owned Equipment (Pumps, Hoses, etc.)	Ea	12	2,500	30,000
	Subcontractor - BGS				
	Drill and complete monitoring wells	Ea	12	3,500	42,000
	Subcontractor - CDH				
	Monitoring well surface completions	Ea	12	535.50	6,426
				Project Totals:	**146,000**
3.0	**LNAPL PILOT TESTING**				
	Senior Program Manager	Hr	60	165	9,900
	Environmental Professional V	Hr	200	110	22,000
	Environmental Technician IV	Hr	480	64	30,720
	CAD Technician III	Hr	120	80	9,600
	Administrative Assistant III	Hr	24	47	1,128
	ECS Vehicle	Day	68	85	5,780
	Holly-Owned Equipment Maintenance	LS	1	872	872
				Project Totals:	**80,000**
4.0	**2017 Carry-Over**				
	Lump Sum	LS	1	2,000	2,000
				Project Totals:	**2,000**
				Total:	**$303,000**

Notes:

(1) Cost estimate assumes 4 days/month for monthly gauging and testing

(2) Cost estimate assumes maintaining monthly gauging program in its current form

(3) Cost estimate assumes using existing well network

COST ESTIMATE
FACILITY WIDE OPERATION & MAINTENANCE
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**NEW LNAPL TANKS**				
	One-Time Purchase				
	Subcontractor - Smith Tanks	Ea	2	7,500	15,000
				Project Totals:	**15,000**
2.0	**POC AND GAUGING WELL SURVEY, TOTAL DEPTH EVALUATION, REDEVELOPMENT**				
	Permit required every 3 years (10x in 30 year estimate)				
2.1	**PERMIT REQUIRED WELL SURVEY**				
	Survey location and elevation of 159 program wells				
	Senior Program Manager	Hr	8	165	1,320
	Environmental Professional V	Hr	60	110	6,600
	Environmental Technician IV	Hr	80	64	5,120
	Survey Technician IV	Hr	80	64	5,120
	Survey Technician III	Hr	80	54	4,320
	CAD Technician III	Hr	12	80	960
	ECS Vehicle	Day	20	85	1,700
	Survey Equipment	Hr	80	55	4,400
				Project Subtotal:	**29,540**
2.2	**PERMIT REQUIRED WELL TOTAL DEPTH GAUGING**				
	Gauge total depth of all program wells				
	Senior Program Manager	Hr	4	165	660
	Environmental Professional V	Hr	16	110	1,760
	Environmental Technician IV	Hr	80	64	5,120
	CAD Technician III	Hr	4	80	320
	ECS Vehicle	Day	8	85	680
	ECS Equipment	LS	1	250	250
				Project Subtotal:	**8,790**
2.3	**REDEVELOPMENT OF SELECT WELLS**				
	Assumes the redevelopment of 20 program wells				
	Senior Program Manager	Hr	4	165	660
	Environmental Professional V	Hr	16	110	1,760
	Environmental Technician IV	Hr	80	64	5,120
	CAD Technician III	Hr	4	80	320
	ECS Vehicle	Day	7	85	595
	ECS Equipment	LS	1	645	645
				Project Subtotal:	**9,100**
				Project Totals:	**47,430**
				30 Yr Project Total:	**474,295**
3.0	**LNAPL RECOVERY TANK PAINTING**				
	Every 5 years (6x in 30 year estimate)				
	Subcontractor - Brock	LS	1	50,000	50,000
				Project Totals:	**50,000**
				30 Yr Project Total:	**300,000**
4.0	**SWMU & LTU INSPECTION, MOWING & MAINTENANCE**				
	Annual estimate				
	Lot Maintenance	LS	1	40,000	40,000
	Senior Program Manager	Hr	16	165	2,640
	Environmental Professional V	Hr	32	110	3,520
	Environmental Technician IV	Hr	16	64	1,024
	CAD Technician III	Hr	20	80	1,600
	Administrative Assistant III	Hr	16	47	752
	Misc Materials	LS	1	294	294
	ECS Vehicle	Day	2	85	170
				Project Totals:	**50,000**
				30 Yr Project Total:	**1,500,000**

COST ESTIMATE
FACILITY WIDE OPERATION & MAINTENANCE
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
5.0	**EROSION REPAIR FOR SWMUs**				
	Annual estimate (as needed)				
	Subcontractor - CDH	LS	1	10,000	10,000
				Project Totals:	**10,000**
				30 Yr Project Total:	**300,000**
6.0	**RIVERBANK INPSECTIONS AND REPORTING (BI-WEEKLY)**				
	Annual estimate				
	Subcontractor - Acme Boom	Ea	26	500	13,000
	Environmental Professional V	Hr	16	110	1,760
	Environmental Technician IV	Hr	202	64	12,928
	CAD Technician III	Hr	0	80	0
	Administrative Assistant III	Hr	0	47	0
	Misc Materials	LS	1	112	102
	ECS Vehicle	Day	26	85	2,210
				Project Totals:	**30,000**
				30 Yr Project Total:	**900,000**
7.0	**LNAPL CONTAINMENT SYSTEMS - VACUUM TRUCK**				
	Annual estimate				
	Subcontractor - Hydrochem	LS	1	110,000	110,000
				Project Totals:	**110,000**
				30 Yr Project Total:	**3,300,000**
8.0	**LNAPL CONTAINMENT SYSTEMS - EQUIPMENT**				
	Annual estimate (as needed)				
	Equipment (Water pumps, LNAPL recovery pumps, hoses, etc.	LS	1	30,000	30,000
				Project Totals:	**30,000**
				30 Yr Project Total:	**900,000**
9.0	**LNAPL CONTAINMENT SYSTEMS - WELL REHAB/REPAIR**				
	Annual estimate (as needed)				
	Senior Program Manager	Hr	4	165	660
	Environmental Professional V	Hr	20	110	2,200
	Environmental Technician IV	Hr	22	64	1,408
	CAD Technician III	Hr	4	80	320
	ECS Vehicle	Day	4	85	340
	Misc Materials	LS	1	72	72
	Subcontractor - BGS				
	Drill and complete monitoring wells	Ea	5	2,500	12,500
	Subcontractor - CDH				
	Monitoring well surface completion repair	Ea	5	500	2,500
				Project Totals:	**20,000**
				30 Yr Project Total:	**600,000**

COST ESTIMATE
FACILITY WIDE OPERATION & MAINTENANCE
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
10.0	**GROUNDWATER GAUGING, MONITORING, DATA EVALUATION, REPORTING**				
	Annual estimate				
10.1	**SEMI-ANNUAL MONITORING ACTIVITIES**				
	Senior Program Manager	Hr	16	165	2,640
	Environmental Professional V	Hr	100	110	11,000
	Environmental Technician IV	Hr	288	64	18,432
	CAD Technician III	Hr	2	80	160
	ECS Vehicle	Day	28	85	2,380
	ECS Equipment	LS	2	200	400
				Project Subtotal:	**35,012**
10.2	**SEMI-ANNUAL MONITORING REPORT**				
	Senior Program Manager	Hr	80	165	13,200
	Environmental Professional V	Hr	400	110	44,000
	CAD Technician III	Hr	40	80	3,200
	Administrative Assistant III	Hr	80	47	3,760
	Reproduction	LS	2	289	578
	Shipping	LS	2	125	250
				Project Subtotal:	**64,988**
				Project Totals:	**100,000**
				30 Yr Project Total:	**3,000,000**
11.0	**LABORATORY ANALYSIS FOR GROUNDWATER SAMPLES**				
	Annual estimate				
	Subcontractor - ALS (Samples)	Ea	80	500	40,000
				Project Totals:	**40,000**
				30 Yr Project Total:	**1,200,000**
12.0	**TECH SUPPORT**				
	Annual estimate (includes estimated HFTR staff salary)				
	Senior Program Manager	Hr	18	165	2,970
	Environmental Professional V	Hr	78	110	8,580
	Environmental Technician IV	Hr	1,248	64	79,872
	ECS Vehicle	Day	156	85	13,260
	Misc Materials	LS	1	318	318
	HollyFrontier Staff (37.5% of D. Korver)	LS	1	30,000	30,000
				Project Totals:	**135,000**
				30 Yr Project Total:	**4,050,000**
13.0	**2017 Carry-Over**				
	Lump Sum	LS	1	9,000	9,000
				Project Totals:	**9,000**
14.0	**LNAPL RECOVERY SYSTEM REPAIR**				
	Costs associated with restarting system after Turnaround				
	Senior Program Manager	Hr	1	165	165
	Environmental Professional V	Hr	12	110	1,320
	Environmental Technician IV	Hr	320	64	20,480
	ECS Vehicle	Day	40	85	3,400
	Misc Materials	LS	1	191	191
				Project Totals:	**25,556**

COST ESTIMATE
FACILITY WIDE OPERATION & MAINTENANCE
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
15.0	**REMEDIATION OF SWMU 5 SURFACE EXPRESSIONS**				
	Equus Environmental				
	Senior Program Manager	Hr	2	215	430
	Enviro Clean Services				
	Senior Program Manager	Hr	1	145	145
	Environmental Professional V	Hr	12	110	1,320
	ECS Vehicle	Day	2	85	170
	CDH				
	Excavation and Restoration	LS	1	5,000	5,000
	American Environmental Landfill				
	Roll off Box Rental	Day	60	2.50	150
	Roll off Box Liner	Ea	2	85	170
	Roll off Transport (Transport to Disposal)	Ea	2	160	320
	Impacted Soil Disposal	Ton	33	10.00	330
	State Haz Waste Fee	Ton	33	2.00	66
				Project Total:	**8,101**
16.0	**WEST LTU FENCING AND SIGNAGE**				
	CDH	Hr	1	17,000	17,000
				Project Totals:	**17,000**
17.0	**POC WELL REPAIR**				
	Wells 442A and 445A				
	CDH	LS	1	30,000	30,000
				Project Totals:	**30,000**
18.0	**SURVEY DEED RESTRICTED LTU PERIMETERS**				
	Survey of LTUs and legal description generation; CAD/GIS map generation; letter report of survey data, legal descriptions, maps.				
	Equus Environmental				
	Senior Program Manager	Hr	2	215	430
	Enviro Clean Services				
	Senior Program Manager	Hr	1	165	165
	Environmental Professional V	Hr	4	110	440
	ECS Vehicle	Day	1	85	85
	Enviro Clean Survey - Lemke	LS	1	3,650	3,650
	TRC Consultants				
	PRINCIPAL - II	hr	2	203	406
	PROJECT MANAGER -I	hr	16	125	2,000
	PROJECT MANAGER - III	hr	6	163	978
	SCIENTIST/ENGINEER IV	hr	16	109	1,744
	PROJECT SUPPORT - II	hr	2	60	120
	CADD/GIS - III	hr	20	83	1,660
				.	
				Project Totals:	**11,678**
				Total:	**$16,640,630**

Notes:

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COST ESTIMATE
VAPOR INTRUSION
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**VI SYSTEM EVALUATION**				
	Senior Program Manager	Hr	80	165	13,200
	Environmental Professional V	Hr	220	110	24,200
	Environmental Technician IV	Hr	80	64	5,120
	CAD Technician III	Hr	40	80	3,200
	ECS Vehicle	Day	40	85	3,400
	Holly-Owned Equipment Maintenance	LS	1	880	880
				Project Totals:	**50,000**
2.0	**ANNUAL OPERATION AND MAINTENANCE**				
	(Weekly checks of VES and SSDS systems, quarterly air sampling)				
	Senior Program Manager	Hr	26	165	4,290
	Environmental Professional V	Hr	52	110	5,720
	Environmental Technician IV	Hr	232	64	14,848
	CAD Technician III	Hr	8	80	640
	ECS Vehicle	Day	52	85	4,420
	Holly-Owned Equipment Maintenance	LS	1	1,082	1,082
				Project Totals:	**31,000**
				30 Yr Project Total:	**930,000**
3.0	**LABORATORY ANALYSIS**				
	ALS - Discharge-Air Samples (TO-15)	Ea	12	208	2,500
				Project Totals:	**2,500**
				30 Yr Project Total:	**75,000**
4.0	**ELECTRICAL REPAIRS**				
	Strickland Electrical	LS	1	5,000	5,000
				Project Totals:	**5,000**
				30 Yr Project Total:	**150,000**
5.0	**2017 Carry-Over**				
	Lump Sum	LS	1	500	500
				Project Totals:	**500**
				Total:	**1,205,500**

Notes:

(1) Cost Estimate assumes VES and SSDS will be checked weekly to confirm operation only.

(2) Cost Estimate assumes discharge-air samples will be collected quarterly from the VES system and SSDS systems operating at the Transfer Center Control Room and the Engineering Buildings to document the recovered vapor concentrations.

COST ESTIMATE
AOC 1 RELEASE AREA REMEDIATION AND RESTORATION
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**ANALYTICAL COSTS**				
	Subcontractor - ALS	Ea	10	500	5000
				Project Total:	**5,000**
2.0	**REMEDIATION OVERSIGHT**				
	Program Manager	Hr	10	145	1,450
	Environmental Professional V	Hr	12	110	1,320
	Environmental Professional IV	Hr	50	90	4,500
	CAD Technician III	Hr	8	80	640
	Administrative Assistant III	Hr	4	47	188
	ECS Vehicle	Day	5	85	425
	Survey Project Manager	Hr	2	125	250
	Survey Environmental Technician IV	Hr	10	64	640
	Survey Vehicle	Day	1	85	85
	Survey Equipment	Day	1	502	502
				Project Total:	**10,000**
3.0	**EXCAVATE AND RESTORE AREA**				
	Subcontractor - K&S				
	Excavation and Restoration	LS	1	10,000	7,114
	Subcontractor - American Environmental Landfill				
	Roll off Box Rental	Day	100	2.50	250
	Roll off Box Liner	Ea	5	85	425
	Roll off Transport (Transport to Disposal)	Ea	5	160	800
	Impacted Soil Disposal	Ton	55	10.00	550
	State Haz Waste Fee	Ton	55	2.00	110
				Project Total:	**9,249**
4.0	**REPORTING AND ODEQ INTERACTION**				
	Program Manager	Hr	60	145	8,700
	Environmental Professional V	Hr	36	110	3,960
	Environmental Professional IV	Hr	50	90	4,500
	CAD Technician III	Hr	16	80	1,280
	Administrative Assistant III	Hr	8	47	376
	Production	LS	1	214	214
	ECS Vehicle	Day	2	85	170
				Project Total:	**19,200**
5.0	**2017 Carry-Over**				
	Lump Sum	LS	1	800	**800**
				Project Totals:	**800**
				Total:	**44,249**

Notes:

(1)

(2)

(3)

COST ESTIMATE
METER PIT
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**METER PIT - AGENCY INTERACTION**				
	Senior Program Manager	Hr	120	165	19,800
	Environmental Professional V	Hr	120	110	13,200
	CAD Technician III	Hr	16	80	1,280
	Administrative Assistant III	Hr	16	47	752
	Production	LS	1	189	189
	ECS vehicle	Day	4	85	340
					35,561
				Total:	**$35,561**

Notes:

COST ESTIMATE
RCRA PERMIT RENEWAL
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

2018 Draft RCRA Permit Application

Phase 1 Prepare Permit Application

Scope Includes: Preparation of a draft permit application

PRINCIPAL - III	---	203.00 hr	1	60	$12,180
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PRINCIPAL - I	---	183.00 hr	1	24	$4,392
PROJECT MANAGER - III	---	163.00 hr	1	80	$13,040
PROJECT MANAGER - I	---	125.00 hr	1	40	$5,000
SCIENTIST| ENGINEER - III	---	91.00 hr	1	100	$9,100
SCIENTIST| ENGINEER - II	---	82.00 hr	1	140	$11,480
PROJECT SUPPORT - III	---	70.00 hr	1	24	$1,680
PROJECT SUPPORT - I	---	50.00 hr	1	80	$4,000
Phase I Prepare Draft Permit Application Completion Total					**$68,992**

Phase 2 Incorporate Comments

Scope Includes: Incorporating comments on the draft permit application

PRINCIPAL - III	---	203.00 hr	1	40	$8,120
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PROJECT MANAGER - III	---	163.00 hr	1	60	$9,780
SCIENTIST| ENGINEER - III	---	91.00 hr	1	80	$7,280
SCIENTIST| ENGINEER - II	---	82.00 hr	1	120	$9,840
PROJECT SUPPORT - I	---	50.00 hr	1	60	$3,000
TRC EXPENSES	---		1		$3,070
Phase 2 Incorporate Comments Completion Total					**$49,210**

Phase 3 Review Meetings

Scope Includes: meeting preparation and attendance in Tulsa and Ok City

PRINCIPAL - III	---	203.00 hr	1	57	$11,571
PROJECT MANAGER - III	---	163.00 hr	1	66	$10,758
SCIENTIST| ENGINEER - III	---	91.00 hr	1	67	$6,097
TRAVEL EXPENSES	---	hr	1		$3,372
Phase 3 Review Meetings Completion Total					**$31,798**
				TOTAL	**$150,000**

2028 Draft RCRA Permit Application

Phase 1 Prepare Permit Application

Scope Includes: Preparation of a draft permit application

PRINCIPAL - III	---	203.00 hr	1	60	$12,180
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PRINCIPAL - I	---	183.00 hr	1	24	$4,392
PROJECT MANAGER - III	---	163.00 hr	1	80	$13,040
PROJECT MANAGER - I	---	125.00 hr	1	40	$5,000
SCIENTIST| ENGINEER - III	---	91.00 hr	1	100	$9,100
SCIENTIST| ENGINEER - II	---	82.00 hr	1	140	$11,480
PROJECT SUPPORT - III	---	70.00 hr	1	24	$1,680
PROJECT SUPPORT - I	---	50.00 hr	1	80	$4,000
Phase I Prepare Draft Permit Application Completion Total					**$68,992**

Phase 2 Incorporate Comments

Scope Includes: Incorporating comments on the draft permit application

PRINCIPAL - III	---	203.00 hr	1	40	$8,120
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PROJECT MANAGER - III	---	163.00 hr	1	60	$9,780
SCIENTIST| ENGINEER - III	---	91.00 hr	1	80	$7,280
SCIENTIST| ENGINEER - II	---	82.00 hr	1	120	$9,840
PROJECT SUPPORT - I	---	50.00 hr	1	60	$3,000
TRC EXPENSES	---		1		$3,070
Phase 2 Incorporate Comments Completion Total					**$49,210**

COST ESTIMATE
RCRA PERMIT RENEWAL
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

Phase 3 Review Meetings					
Scope Includes: meeting preparation and attendance in Tulsa and Ok City					
PRINCIPAL - III	---	203.00 hr	1	57	$11,571
PROJECT MANAGER - III	---	163.00 hr	1	66	$10,758
SCIENTIST| ENGINEER - III	---	91.00 hr	1	67	$6,097
TRAVEL EXPENSES	---	hr	1		$3,372
Phase 3 Review Meetings Completion Total					**$31,798**
				TOTAL	**$150,000**

2038 Draft RCRA Permit Application

Phase 1 Prepare Permit Application					
Scope Includes: Preparation of a draft permit application					
PRINCIPAL - III	---	203.00 hr	1	60	$12,180
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PRINCIPAL - I	---	183.00 hr	1	24	$4,392
PROJECT MANAGER - III	---	163.00 hr	1	80	$13,040
PROJECT MANAGER - I	---	125.00 hr	1	40	$5,000
SCIENTIST| ENGINEER - III	---	91.00 hr	1	100	$9,100
SCIENTIST| ENGINEER - II	---	82.00 hr	1	140	$11,480
PROJECT SUPPORT - III	---	70.00 hr	1	24	$1,680
PROJECT SUPPORT - I	---	50.00 hr	1	80	$4,000
Phase I Prepare Draft Permit Application Completion Total					**$68,992**
Phase 2 Incorporate Comments					
Scope Includes: Incorporating comments on the draft permit application					
PRINCIPAL - III	---	203.00 hr	1	40	$8,120
PRINCIPAL - II	---	203.00 hr	1	40	$8,120
PROJECT MANAGER - III	---	163.00 hr	1	60	$9,780
SCIENTIST| ENGINEER - III	---	91.00 hr	1	80	$7,280
SCIENTIST| ENGINEER - II	---	82.00 hr	1	120	$9,840
PROJECT SUPPORT - I	---	50.00 hr	1	60	$3,000
TRC EXPENSES	---		1		$3,070
Phase 2 Incorporate Comments Completion Total					**$49,210**
Phase 3 Review Meetings					
Scope Includes: meeting preparation and attendance in Tulsa and Ok City					
PRINCIPAL - III	---	203.00 hr	1	57	$11,571
PROJECT MANAGER - III	---	163.00 hr	1	66	$10,758
SCIENTIST| ENGINEER - III	---	91.00 hr	1	67	$6,097
TRAVEL EXPENSES	---	hr	1		$3,372
Phase 3 Review Meetings Completion Total					**$31,798**
				TOTAL	**$150,000**
				GRAND TOTAL	**$450,000**

COST ESTIMATE
WEST REFINERY RIVERFRONT AREA
HFTR-TULSA WEST REFINERY
TULSA, OKALHOMA

Task Description	Cost	Unit Price	Multiplier	Qty	Total
Phase 1 Risk Assessment Work Plan Completion					
Task 1					
Scope Includes:					
Completion of Phase 1 of the Risk Assessment Work Plan					
PRINCIPAL - II	---	203.00 hr	1	124	$25,172.00
PROJECT MANAGER - III	---	163.00 hr	1	98	$15,974.00
PROJECT MANAGER - II	---	143.00 hr	1	102	$14,586.00
PROJECT SUPPORT - III	---	70.00 hr	1	71	$4,963.00
Phase 1 Risk Assessment Work Plan Completion Total					**$60,695**
Phase 2 Data Gap Analysis and Sampling Analysis Plan					
Task 1					
Scope Includes:					
Completion of a Data Gap Analysis and Sampling Analysis Plan					
PRINCIPAL - II	---	203.00 hr	1	50	$10,150.00
PROJECT MANAGER - III	---	163.00 hr	1	56	$9,128.00
PROJECT MANAGER - II	---	143.00 hr	1	58	$8,294.00
SR SCIENTIST| ENGINEER - II	---	133.00 hr	1	96	$12,768.00
DESIGNER| TECHNICIAN - IV	---	100.00 hr	1	58	$5,783.00
PROJECT SUPPORT - III	---	70.00 hr	1	55	$3,874.50
Phase 2 Data Gap and Sampling Analysis Plan Completion Total					**$49,998**
Phase 3 Field Work/Laboratory Analysis					
Task 1					
Scope Includes:					
Completion of Field Work Activities and Laboratory Sample Analysis					
SR SCIENTIST| ENGINEER - II	---	133.00 hr	1	160	$21,280.00
SCIENTIST| ENGINEER - IV	---	109.00 hr	1	130	$14,170.00
SCIENTIST| ENGINEER - II	---	82.00 hr	1	124	$10,168.00
DESIGNER| TECHNICIAN - IV	---	100.00 hr	1	39	$3,912.00
LABORATORY	---	--- ---	1		$175,468.00
Phase 3 Field Work/Laboratory Analysis Completion Total					**$224,998**
Phase 4 Risk Assessment and Data Reporting					
Task 1					
Scope Includes:					
Data Reporting and Completion of the Risk Assessment					
PRINCIPAL - II	---	203.00 hr	1	180	$36,540.00
PROJECT MANAGER - III	---	163.00 hr	1	400	$65,200.00
PROJECT MANAGER - II	---	143.00 hr	1	550	$78,650.00
SR SCIENTIST| ENGINEER - II	---	133.00 hr	1	10	$1,330.00
DESIGNER| TECHNICIAN - IV	---	100.00 hr	1	100	$10,000.00
PROJECT SUPPORT - III	---	70.00 hr	1	118	$8,277.50
Phase 4 Risk Assessment and Data Reporting Completion Total					**$199,998**

COST ESTIMATE
WEST REFINERY RIVERFRONT AREA
HFTR-TULSA WEST REFINERY
TULSA, OKALHOMA

Phase 5 Meetings

Task 1

Scope Includes:
Preparing for and attending internal and regulatory meetings

PRINCIPAL - II	---	203.00 hr	1	569	$115,576.02
PROJECT MANAGER - III	---	163.00 hr	1	100	$16,251.10
PROJECT MANAGER - II	---	143.00 hr	1	80	$11,454.30
TRAVEL EXPENSES	---		1		$36,720.00
Phase 5 Meetings Completion Total					**$180,001**

Phase 6 Remedial Alternative Report

Task 1

Scope Includes:
Preparing Remedial Alternatives Report

PRINCIPAL - II	---	203.00 hr	1	137	$27,811.00
PRINCIPAL - I	---	183.00 hr	1	40	$7,320.00
PROJECT MANAGER - III	---	163.00 hr	1	275	$44,825.00
PROJECT MANAGER - II	---	143.00 hr	1	152	$21,736.00
SR SCIENTIST| ENGINEER - II	---	133.00 hr	1	129	$17,090.50
PROJECT SUPPORT - III	---	70.00 hr	1	89	$6,212.50
Phase 6 Remedial Alternative Report Completion Total					**$124,995**

Phase 7 PM Coordination

Task 1

Scope Includes:
Project management and account management

PRINCIPAL - II	---	203.00 hr	1	195	$39,585.00
PROJECT MANAGER - III	---	163.00 hr	1	80	$13,040.00
PROJECT SUPPORT - III	---	70.00 hr	1	20	$1,374.80
Phase 7 PM Coordination Completion Total					**$54,000**

Phase 8 2017 Carry-Over

Task 1

Scope Includes:
Carry-over of tasks from 2017

PRINCIPAL - II	---	203.00 hr	1	30	$6,008.80
Phase 8 2017 Carry-Over Completion Total					**$6,009**

$900,693

COST ESTIMATE
FACILITY WIDE OPERATION & MAINTENANCE
HFTR-TULSA WEST REFINERY
TULSA, OKLAHOMA

TASK No.	TASK DESCRIPTION	UNITS	UNITS REQUIRED	UNIT COST $	ESTIMATED COST $
1.0	**SWMU 6 SHEEN SUPPORT**				
	(Coordinate hard and sorbent boom deployment and maintenance, inspect sheen area 3 times per week, review and edit Interim Measure Plans, develop modified approach to address sheen area)				
	Equus Environmental				
	Senior Principal	Hr	8	215	1,720
	Professional Engineer VIII	Hr	16	160	2,560
	Environmental Professional IX	Hr	24	140	3,360
	Environmental Professional VIII	Hr	24	130	3,120
	CAD Technician III	Hr	18	95	1,710
	Environmental Technician VI	Hr	90	85	7,650
	Administrative Assistant III	Hr	8	50	400
	Equus Vehicle	Day	20	85	1,700
	Acme Environmental				
	Boom Deployment and Maintenance	Mo	5	34,000	170,000
				Project Totals:	**192,220**
				Total:	**$192,220**

Notes:

(1)

(2)

(3)

APPENDIX 6.2 – FINANCIAL ASSURANCE DOCUMENTATION

HOLLYFRONTIER

March 27, 2018

Mr. Scott Thompson
Executive Director
Oklahoma Department of Environmental Quality
707 N. Robinson Avenue
Oklahoma City, OK 73101

Re: Financial Assurance
Liability Coverage, Closure and Post-Closure Care Costs
HollyFrontier Tulsa Refining LLC
EPA #OKD058078775 and #OKD990750960

Dear Mr. Thompson:

Pursuant to our financial assurance requirements with respect to our Tulsa, Oklahoma Refining facilities (EPA # OKD058078775, 1700 South Union Ave. Tulsa, Oklahoma 74107 and EPA #OKD990750960, 902 W. 25th St., Tulsa, Oklahoma 74107), we are providing the following financial assurance instruments in satisfaction of our *liability coverage and closure and post-closure care* requirements to the Oklahoma Department of Environment Quality:

1) Chief Financial Officer's letter evidencing satisfaction of the various tests for financial assurance;

2) The relevant SEC Form 10-K Annual Report can be viewed at http://investor.hollyfrontier.com/financial-information/sec-filings. Please advise whether HollyFrontier will need to submit a hard copy of this report or if reference to the link will be sufficient.

3) Report of Independent Auditors;

4) Corporate Guarantee signed by the Chief Financial Officer for closure and post-closure costs;

5) Corporate Guarantee signed by the Chief Financial Officer for liability coverage; and

6) Cost Estimate Summary Tables.

I trust the enclosed documents are in order. Should you have any questions, please call me at (214) 954-6556.

Sincerely,

Richard L. Voliva III
Executive Vice President and
Chief Financial Officer

The HollyFrontier Companies
2828 N. Harwood, Suite 1300 • Dallas, TX 75201
(214) 871-3555 • Fax (214) 871-3560
http://www.hollyfrontier.com

HOLLYFRONTIER

March 27, 2018

Mr. Scott Thompson
Executive Director
Oklahoma Department of Environmental Quality
707 N. Robinson Avenue
Oklahoma City, OK 73101

Re: Financial Assurance
Liability Coverage and Closure and Post-Closure Care Costs
HollyFrontier Tulsa Refining LLC
#OKD058078775 and #OKD990750960

Dear Mr. Thompson:

I am the Chief Financial Officer of HollyFrontier Corporation, 2828 North Harwood, Suite 1300, Dallas, Texas 75201. This letter is in support of the use of the financial test to demonstrate financial responsibility for liability coverage and closure and/or post-closure care as specified in subpart H of 40 CFR parts 264 and 265.

The firm identified above is the owner or operator of the following facilities for which liability coverage for both sudden and nonsudden accidental occurrences is being demonstrated through the financial test specified in subpart H of 40 CFR parts 264 and 265: None.

The firm identified above guarantees through the guarantee specified in subpart H of 40 CFR parts 264 and 265, liability coverage for both sudden and nonsudden accidental occurrences at the following facilities owned or operated by the following:

OKD058078775
HollyFrontier Tulsa Refining LLC
Tulsa Refining West Facility
1700 South Union Avenue
Tulsa, OK 74107

OKD990750960
HollyFrontier Tulsa Refining LLC
Tulsa Refining East Facility
902 W. 25th Street
Tulsa, OK 74107

EPA Identification Number KSD007233422
UIC Permit Number: KS-01-115-001
HollyFrontier El Dorado Refining LLC
1401 Douglas Road
El Dorado, Kansas 67042-3674

NMD048918817
HollyFrontier Navajo Refining LLC
501 East Main
Artesia, New Mexico 88210

EPA Identification Number: WYD051843613
HollyFrontier Cheyenne Refining LLC
300 Morrie Ave.
Cheyenne, WY 82007

The firm identified above is the direct higher-tier parent corporation of the owner or operator.

1. The firm identified above owns or operates the following facilities for which financial assurance for closure or post-closure care or liability coverage is demonstrated through the financial test specified in subpart H of 40 CFR parts 264 and 265. The current closure and/or post-closure cost estimate covered by the test are shown for each facility: None.

2. The firm identified above guarantees, through the guarantee specified in subpart H of 40 CFR parts 264 and 265, the closure and post-closure care or liability coverage of the following facilities owned or operated by the guaranteed party. The current cost estimates for closure or post-closure care so guaranteed are shown for each facility:

OKD058078775
HollyFrontier Tulsa Refining LLC
Tulsa Refining West Facility
1700 South Union Avenue
Tulsa, OK 74107

Closure: $ 1,311,993
Post-Closure: $ 18,237,433

OKD990750960
HollyFrontier Tulsa Refining LLC
Tulsa Refining East Facility
902 W. 25th Street
Tulsa, OK 74107

Closure: $ 8,971,840
Post-Closure: $ 9,920,000

3. In States where DEQ is not administering the financial requirements of subpart H of 40 CFR parts 264 and 265, this firm is demonstrating financial assurance for the closure or post-closure care of the following facilities through the use of a test equivalent or substantially equivalent to the financial test specified in subpart H of 40 CFR parts 264 and 265. The current closure or post-closure cost estimates covered by such a test are shown for each facility:

NMD048918817
HollyFrontier Navajo Refining LLC
501 East Main
Artesia, New Mexico 88210

Closure: $ 1,711,250
Post-Closure: $ 21,497,830

EPA Identification Number: KSD007233422
HollyFrontier El Dorado Refining LLC
1401 Douglas Road
El Dorado, Kansas 67042-3674

HollyFrontier El Dorado Refining LLC 's obligations under Administrative Order on Consent, *In the Matter of: Frontier El Dorado Refining LLC and Equilon Enterprises LLC d/b/a Shell Oil Products US*, U.S. Environmental Protection Agency, Region 7, EPA Docket No. RCRA-07-2011-0011: $1,516,938

EPA Identification Number: WYD051843613
HollyFrontier Cheyenne Refining LLC
300 Morrie Ave.
Cheyenne, WY 82007

Porter Draw:	$209,400
Groundwater Remediation:	$16,700,585
Hazardous Waste Landfill post-closure care:	$1,485,103
1995 WDEQ Corrective Action Order:	$2,193,918

4. The firm identified above owns or operates the following hazardous waste management facilities for which financial assurance for closure or, if a disposal facility, post-closure care, is not demonstrated either to EPA or a State through the financial test or any other financial assurance mechanisms specified in subpart H of 40 CFR parts 264 and 265 or equivalent or substantially equivalent State mechanisms. The current closure and/or post-closure cost estimates not covered by such financial assurance are shown for each facility: None.

5. This firm is the owner or operator or guarantor of the following UIC facilities for which financial assurance for plugging and abandonment is required under part 144 and is assured through a financial test. The current closure cost estimates as required by 40 CFR 144.62 are shown for each facility:

EPA Identification Number: KSD007233422
HollyFrontier El Dorado Refining LLC
1401 Douglas Road
El Dorado, Kansas 67042-3674

Class I disposal well plugging and abandonment: $109,200

This firm is required to file a Form 10K with the Securities and Exchange Commission (SEC) for the latest fiscal year.

The fiscal year of this firm ends on December 31. The figures for the following items marked with an asterisk are derived from this firm's independently audited, year-end financial statements for the latest completed fiscal year, ended December 31, 2017.

Alternative II

1.	Sum of current closure and post-closure cost estimates (total of all cost estimates listed in the five paragraphs above)		$ 83,865,490
2.	Amount of annual aggregate liability coverage to be demonstrated		$ 8,000,000
3.	Sum of lines 1 and 2		$ 91,865,490
4.	Current bond rating of most recent issuance and name of rating service		Baa3, Moody's
5.	Date of issuance of bond		11/16/2016
6.	Date of maturity of bond		4/1/2026
*7.	Tangible net worth (if any portion of the closure or post-closure cost estimates is included in "total liabilities" on your financial statements you may add that portion to this line)		$ 3,557,021,000
*8.	Total assets in U.S. (required only if less than 90% of firm's assets are located in the U.S.)		$ 9,478,255,000
9.	Is line 7 at least $10 million?		Yes
10.	Is line 7 at least 6 times line 3?		Yes
*11.	Are at least 90% of assets located in the U.S.? If not, complete line 12.		No
12.	Is line 8 at least 6 times line 3?		Yes

I hereby certify that the wording of this letter is identical to the wording specified in 40 CFR 264.151(g) and the United States Environmental Protection Agency approved amendment, for the State of Oklahoma as such regulations were constituted on the date shown immediately below.

HOLLYFRONTIER CORPORATION

Richard L. Voliva III
Executive Vice President and
Chief Financial Officer

March 27, 2018

HOLLYFRONTIER

Guarantee for Liability Coverage

Guarantee made this March 27, 2018 by HollyFrontier Corporation, a business corporation organized under the laws of the State of Delaware, herein referred to as guarantor. This guarantee is made on behalf of HollyFrontier Tulsa Refining LLC of 1700 South Union Ave., Tulsa, Oklahoma 74107, which is our subsidiary, to any and all third parties who have sustained or may sustain bodily injury or property damage caused by sudden and/or nonsudden accidental occurrences arising from operation of the facilities covered by this guarantee.

Recitals

1. Guarantor meets or exceeds the financial test criteria and agrees to comply with the reporting requirements for guarantors as specified in 40 CFR 264.147(g) and 265.147(g).

2. HollyFrontier Tulsa Refining LLC owns or operates the following hazardous waste management facilities covered by this guarantee:

EPA ID # OKD058078775, Tulsa Refining West facility, 1700 South Union Ave., Tulsa, Oklahoma 74107.

EPA ID # OKD990750960, Tulsa Refining East Facility, 902 W. 25th St., Tulsa, Oklahoma 74107.

This corporate guarantee satisfies RCRA third-party liability requirements for "both sudden and nonsudden" accidental occurrences in above-named owner or operator facilities for coverage in the amount of $4 million for each occurrence and $8 million annual aggregate.

3. For value received from HollyFrontier Tulsa Refining LLC, guarantor guarantees to any and all third parties who have sustained or may sustain bodily injury or property damage caused by sudden and nonsudden accidental occurrences arising from operations of the facilities covered by this guarantee that in the event that HollyFrontier Tulsa Refining LLC fails to satisfy a judgment or award based on a determination of liability for bodily injury or property damage to third parties caused by sudden and nonsudden accidental occurrences, arising from the operation of the above-named facilities, or fails to pay an amount agreed to in settlement of a claim arising from or alleged to arise from such injury or damage, the guarantor will satisfy such judgment(s), award(s) or settlement agreement(s) up to the limits of coverage identified above.

4. Such obligation does not apply to any of the following:

(a) Bodily injury or property damage for which HollyFrontier Tulsa Refining LLC is obligated to pay damages by reason of the assumption of liability in a contract or agreement. This exclusion does not apply to liability for damages that HollyFrontier Tulsa Refining LLC would be obligated to pay in the absence of the contract or agreement.

(b) Any obligation of HollyFrontier Tulsa Refining LLC under a workers' compensation, disability benefits, or unemployment compensation law or any similar law.

(c) Bodily injury to:

(1) An employee of HollyFrontier Tulsa Refining LLC arising from, and in the course of, employment by HollyFrontier Tulsa Refining LLC; or

(2) The spouse, child, parent, brother, or sister of that employee as a consequence of, or arising from, and in the course of employment by HollyFrontier Tulsa Refining LLC. This exclusion applies:

(A) Whether HollyFrontier Tulsa Refining LLC may be liable as an employer or in any other capacity; and

(B) To any obligation to share damages with or repay another person who must pay damages because of the injury to persons identified in paragraphs (1) and (2).

(d) Bodily injury or property damage arising out of the ownership, maintenance, use, or entrustment to others of any aircraft, motor vehicle or watercraft.

(e) Property damage to:

(1) Any property owned, rented, or occupied by HollyFrontier Tulsa Refining LLC;

(2) Premises that are sold, given away or abandoned by HollyFrontier Tulsa Refining LLC if the property damage arises out of any part of those premises;

(3) Property loaned to HollyFrontier Tulsa Refining LLC;

(4) Personal property in the care, custody or control of HollyFrontier Tulsa Refining LLC;

(5) That particular part of real property on which HollyFrontier Tulsa Refining LLC or any contractors or subcontractors working directly or indirectly on behalf of HollyFrontier Tulsa Refining LLC are performing operations, if the property damage arises out of these operations.

5. Guarantor agrees that if, at the end of any fiscal year before termination of this guarantee, the guarantor fails to meet the financial test criteria, guarantor shall send within 90 days, by certified mail, notice to the Director and to HollyFrontier Tulsa Refining LLC that he intends to provide alternate liability coverage as specified in 40 CFR 264.147 and 265.147, as applicable, in the name of HollyFrontier Tulsa Refining LLC. Within 120 days after the end of such fiscal year, the guarantor shall establish such liability coverage unless HollyFrontier Tulsa Refining LLC has done so.

6. The guarantor agrees to notify the Director by certified mail of a voluntary or involuntary proceeding under title 11 (Bankruptcy), U.S. Code, naming guarantor as debtor, within 10 days after commencement of the proceeding.

7. Guarantor agrees that within 30 days after being notified by the Director of a determination that guarantor no longer meets the financial test criteria or that he is disallowed from continuing as a guarantor, he shall establish alternate liability coverage as specified in 40 CFR 264.147 or 265.147 in the name of HollyFrontier Tulsa Refining LLC, unless HollyFrontier Tulsa Refining LLC has done so.

8. Guarantor reserves the right to modify this agreement to take into account amendment or modification of the liability requirements set by 40 CFR 264.147 and 265.147, provided that such modification shall become effective only if the Director does not disapprove the modification within 30 days of receipt of notification of the modification.

9. Guarantor agrees to remain bound under this guarantee for so long as HollyFrontier Tulsa Refining LLC must comply with the applicable requirements of 40 CFR 264.147 and 265.147 for the above-listed facilities, except as provided in paragraph 10 of this agreement.

10. Guarantor may terminate this guarantee by sending notice by certified mail to the Director and to HollyFrontier Tulsa Refining LLC, provided that this guarantee may not be terminated unless and until HollyFrontier Tulsa Refining LLC obtains, and the Director approves, alternate liability coverage complying with 40 CFR 264.147 and/or 265.147.

11. Guarantor hereby expressly waives notice of acceptance of this guarantee by any party.

12. Guarantor agrees that this guarantee is in addition to and does not affect any other responsibility or liability of the guarantor with respect to the covered facilities.

13. The Guarantor shall satisfy a third-party liability claim only on receipt of one of the following documents:

(a) Certification from the Principal and the third-party claimant(s) that the liability claim should be paid. The certification must be worded as follows, except that instructions in brackets are to be replaced with the relevant information and the brackets deleted:

Certification of Valid Claim

The undersigned, as parties [insert Principal] and [insert name and address of third-party claimant(s)], hereby certify that the claim of bodily injury and/or property damage caused by a [sudden or nonsudden] accidental occurrence arising from operating [Principal's] hazardous waste treatment, storage, or disposal facility should be paid in the amount of $.

[Signatures]_____
Principal_____
(Notary) Date_____
[Signatures]_____
Claimant(s)_____
(Notary) Date_____

(b) A valid final court order establishing a judgment against the Principal for bodily injury or property damage caused by sudden or nonsudden accidental occurrences arising from the operation of the Principal's facility or group of facilities.

14. In the event of combination of this guarantee with another mechanism to meet liability requirements, this guarantee will be considered primary coverage.

I hereby certify that the wording of the guarantee is identical to the wording specified in 40 CFR 264.151(h)(2), and the United States Environmental Protection Agency approved amendment for the State of Oklahoma as such regulations were constituted on the date shown immediately below.

Effective date: March 27, 2018

HollyFrontier Corporation

Richard L. Voliva III
Executive Vice President and
Chief Financial Officer

Signature of witness or notary:

BERNICE BLUDAU
Notary Public, State of Texas
Comm. Expires 06-13-2018
Notary ID 452259-1

HOLLYFRONTIER

Corporate Guarantee for Closure or Post-Closure Care

Guarantee made this March 27, 2018 by HollyFrontier Corporation, a business corporation organized under the laws of the State of Delaware, herein referred to as guarantor. This guarantee is made on behalf of HollyFrontier Tulsa Refining LLC of 1700 South Union Ave., Tulsa, Oklahoma 74107, which is our subsidiary to the Oklahoma Department of Environmental Quality ("the Department or DEQ"), an agency of the State of Oklahoma.

Recitals

1. Guarantor meets or exceeds the financial test criteria and agrees to comply with the reporting requirements for guarantors as specified in 40 CFR 264.143(f), 264.145(f), 265.143(e), and 265.145(e).

2. HollyFrontier Tulsa Refining LLC owns or operates the following hazardous waste management facilities covered by this guarantee:

EPA ID # OKD058078775, Tulsa Refining West facility, 1700 South Union Ave., Tulsa, Oklahoma 74107, Guarantee for closure and post-closure care.

EPA ID # OKD990750960, Tulsa Refining East facility, 902 W. 25th St., Tulsa, Oklahoma 74107, Guarantee for closure and post-closure care.

3. "Closure plans" and "post-closure plans" as used below refer to the plans maintained as required by subpart G of 40 CFR parts 264 and 265 for the closure and post-closure care of facilities as identified above.

4. For value received from HollyFrontier Tulsa Refining LLC, guarantor guarantees to DEQ that in the event that HollyFrontier Tulsa Refining LLC fails to perform closure and post-closure care of the above facilities in accordance with the closure or post-closure plans and other permit or interim status requirements whenever required to do so, the guarantor shall do so or establish a trust fund as specified in subpart H of 40 CFR part 264 or 265, as applicable, in the name of HollyFrontier Tulsa Refining LLC in the amount of the current closure or post-closure cost estimates as specified in subpart H of 40 CFR parts 264 and 265.

5. Guarantor agrees that if, at the end of any fiscal year before termination of this guarantee, the guarantor fails to meet the financial test criteria, guarantor shall send within 90 days, by certified mail, notice to the Director and to HollyFrontier Tulsa Refining LLC that he intends to provide alternate financial assurance as specified in subpart H of 40 CFR part 264 or 265, as applicable, in the name of HollyFrontier Tulsa Refining LLC. Within 120 days after the end of such fiscal year, the guarantor shall establish such financial assurance unless HollyFrontier Tulsa Refining LLC has done so.

6. The guarantor agrees to notify the Director by certified mail, of a voluntary or involuntary proceeding under Title 11 (Bankruptcy), U.S. Code, naming guarantor as debtor, within 10 days after commencement of the proceeding.

7. Guarantor agrees that within 30 days after being notified by the Director of a determination that guarantor no longer meets the financial test criteria or that he is disallowed from continuing as a guarantor of closure or post-closure care, he shall establish alternate financial assurance as specified in subpart H of 40 CFR part 264 or 265, as applicable, in the name of HollyFrontier Tulsa Refining LLC unless HollyFrontier Tulsa Refining LLC has done so.

8. Guarantor agrees to remain bound under this guarantee notwithstanding any or all of the following: amendment or modification of the closure or post-closure plan, amendment or modification of the permit, the extension or reduction of the time of performance of closure or post-closure, or any other modification or alteration of an obligation of the owner or operator pursuant to 40 CFR part 264 or 265.

9. Guarantor agrees to remain bound under this guarantee for as long as HollyFrontier Tulsa Refining LLC must comply with the applicable financial assurance requirements of subpart H of 40 CFR parts 264 and 265 for the above-listed facilities, except as provided in paragraph 10 of this agreement.

10. Guarantor may terminate this guarantee by sending notice by certified mail to the Director and to HollyFrontier Tulsa Refining LLC provided that this guarantee may not be terminated unless and until HollyFrontier Tulsa Refining LLC obtains, and the Director approves, alternate closure and/or post-closure care coverage complying with 40 CFR 264.143, 264.145, 265.143, and/or 265.145.

11. Guarantor agrees that if HollyFrontier Tulsa Refining LLC fails to provide alternate financial assurance as specified in subpart H of 40 CFR part 264 or 265, as applicable, and obtain written approval of such assurance from the Director within 90 days after a notice of cancellation by the guarantor is received by the Director from guarantor, guarantor shall provide such alternate financial assurance in the name of HollyFrontier Tulsa Refining LLC.

12. Guarantor expressly waives notice of acceptance of this guarantee by the DEQ or by HollyFrontier Tulsa Refining LLC. Guarantor also expressly waives notice of amendments or modifications of the closure and/or post-closure plan and of amendments or modifications of the facility permit(s).

I hereby certify that the wording of this guarantee is identical to the wording specified in 40 CFR 264.151(h), and the United States Environmental Protection Agency approved amendment for the State of Oklahoma, as such regulations were constituted on the date first above written.

Effective date: March 27, 2018

HollyFrontier Corporation

Richard L. Voliva III
Executive Vice President and
Chief Financial Officer

Signature of witness or notary:

BERNICE BLUDAU
Notary Public, State of Texas
Comm. Expires 06-13-2018
Notary ID 452259-1

Building a better working world

Report of Independent Accountants on
Applying Agreed-Upon Procedures

To the Management of HollyFrontier Corporation

We have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States), the consolidated balance sheet of HollyFrontier Corporation (the Company) as of December 31, 2017, and the related consolidated statements of income, comprehensive income, cash flows and equity for the year then ended, and the related notes of the Company and have issued our report thereon dated February 21, 2018. We expressed an unqualified opinion on the consolidated financial statements.

We have performed the procedures enumerated below, which were agreed to by management of the Company, solely to assist management with respect to the use of the financial test to demonstrate financial responsibility for liability coverage and closure and/or post-closure care, as specified in subpart H of 40 CFR parts 264 and 265 (the Regulations). Management is responsible for determining compliance with the financial test that is presented on the basis specified by the Regulations. It is the Company's understanding that these procedures are those required by the Oklahoma Department of Environmental Quality (the Department). The sufficiency of these procedures is solely the responsibility of the parties specified in this report. Consequently, we make no representation regarding the sufficiency of the procedures described below either for the purpose for which this report has been requested or for any other purpose.

We have performed the following procedures with respect to amounts in Alternative II, items marked with an asterisk, included in the 2017 Chief Financial Officer's accompanying letter dated March 27, 2018, to the Department (the Letter):

Item 7 - Tangible net worth

We obtained a schedule, prepared by management, which calculates the tangible net worth as of December 31, 2017. We recomputed the Company's schedule, and agreed amounts included in the calculation with those included in the Company's audited consolidated financial statements referred to above, and found such amounts to be in agreement. We compared the dollar amount of tangible net worth as of December 31, 2017 from this schedule to line item 7 in the Letter and found it to be in agreement.

Item 8 - Total assets in U.S

We obtained a schedule of assets by geography, prepared by management, which reflects all of the

Company's assets as of December 31, 2017, including total U.S. assets. We agreed the schedule to the Company's accounting records, and we agreed the amount for total US assets per the schedule to the amount shown in Item 8 in the Letter.

Item 11 - Are at least 90% of assets located in the U.S.?

We obtained a schedule of assets by geography, prepared by management, which reflects all of the Company's assets as of December 31, 2017 by location, including refineries, corporate, and subsidiaries. We agreed the schedule in total and by location to the Company's accounting records. We recomputed the Company's schedule, and agreed amounts included in the calculation with those included in the Company's audited consolidated financial statements referred to above, and found that the percentage of the Company's assets located in the U.S. was less than 90%.

This agreed-upon procedures engagement was conducted in accordance with attestation standards established by the American Institute of Certified Public Accountants. We were not engaged to and did not conduct an examination or review, the objective of which would be the expression of an opinion or conclusion, respectively, on compliance with the specified requirements. Accordingly, we do not express such an opinion or conclusion. Had we performed additional procedures, other matters might have come to our attention that would have been reported to you.

This report is intended solely for the information and use of the Company and the Department and is not intended to be and should not be used by anyone other than these specified parties.

Ernst & Young LLP

March 27, 2018

After printing this label:
1. Use the 'Print' button on this page to print your label to your laser or inkjet printer.
2. Fold the printed page along the horizontal line.
3. Place label in shipping pouch and affix it to your shipment so that the barcode portion of the label can be read and scanned.

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Use of this system constitutes your agreement to the service conditions in the current FedEx Service Guide, available on fedex.com.FedEx will not be responsible for any claim in excess of $100 per package, whether the result of loss, damage, delay, non-delivery,misdelivery,or misinformation, unless you declare a higher value, pay an additional charge, document your actual loss and file a timely claim.Limitations found in the current FedEx Service Guide apply. Your right to recover from FedEx for any loss, including intrinsic value of the package, loss of sales, income interest, profit, attorney's fees, costs, and other forms of damage whether direct, incidental,consequential, or special is limited to the greater of $100 or the authorized declared value. Recovery cannot exceed actual documented loss.Maximum for items of extraordinary value is $1,000, e.g. jewelry, precious metals, negotiable instruments and other items listed in our ServiceGuide. Written claims must be filed within strict time limits, see current FedEx Service Guide.

7 GEOLOGY AND HYDROGEOLOGY REPORT

This section identifies the uppermost aquifer beneath the HollyFrontier Tulsa Refining LLC (HFTR), Tulsa West Refinery (the Refinery), and provides information on the Refinery geology. This section also includes a discussion of groundwater flow direction and rate and the basis for such identification (i.e., the information obtained from hydrogeologic investigations of the Refinery area). The information provided in this section of the Refinery's Part B Permit Renewal Application (the Renewal Application) satisfies the requirements of Title 40 Part 270.14(c)(2) of the Code of Federal Regulations (40 CFR 270.14(c)(2)). The Refinery groundwater monitoring program maintained for compliance with 40 CFR 264 Subpart F is described in Section 8 of this Renewal Application.

7.1 Arkansas River

The Refinery property is situated adjacent to the Arkansas River (the River), with the northern property boundary abutting the River for approximately two miles. A levee is present along the northern boundary of the Refinery, adjacent to the River.

Flow in the River adjacent to the Refinery is controlled by releases from Keystone Dam, located approximately 14 miles upstream, and is highly variable. The stage of the River has a direct effect on the elevation of groundwater measured in Refinery groundwater monitoring wells nearest the River, indicating groundwater/surface water interaction.

Surface water from the River is not a municipal water supply in the Tulsa area; water supply for the City of Tulsa is drawn from Spavinaw Lake and Lake Eucha on Spavinaw Creek and Oologah Lake on the Verdigris River. Lake Hudson on Grand River serves as an emergency source of water.

7.2 Geology

The Refinery property is located within the Cherokee Platform geologic province of northeastern Oklahoma. The shallow subsurface stratigraphy beneath the Refinery is comprised of Quaternary flood plain alluvium and bedrocks of the Pennsylvanian-age Coffeyville, Checkerboard Limestone, or Seminole Formations. The Refinery is generally flat to the River levee, where the elevation then drops toward the River. The Refinery is underlain by Quaternary-age floodplain alluvium deposited by the River that rests unconformably upon the eroded surface of the underlying Pennsylvanian-age bedrock. The floodplain alluvium ranges in thickness from 25 to 40 feet (ft) and consists primarily of very fine to coarse sand, gravelly sand and discontinuous layers of silt. In general, the lower portion of the alluvial section is composed of a coarse to gravelly sand and finer deposits above (SAIC, 2011).

The Pennsylvanian-age bedrock is encountered at depths ranging from approximately 25 to 40 ft below ground surface (bgs). The underlying bedrock units beneath the alluvium are the Coffeyville Formation, Checkerboard Limestone Formation, or Seminole Formation (Marcher and

Bingham, 1971). The Coffeyville Formation consists of 200 to 300 ft of gray and black shale, fine- to medium-grained well-cemented siltstones and sandstones, and local thin coal seams. Underlying the Coffeyville Formation is the Checkerboard Limestone Formation. The Checkerboard Limestone Formation is a single crystalline limestone unit that ranges from 2 to 15 ft in thickness. The Checkerboard Limestone Formation forms a prominent natural low-water crossing that spans the River extending south to north from the Refinery to the City of Tulsa's Newblock Park (on the River's north bank). Underlying the Checkerboard Limestone Formation is the Seminole Formation. The Seminole Formation consists of brown shale, sandstones and localized thin coal beds and is approximately 150 ft thick in the region. Figure 7-1 (reproduced from [SAIC, 2011]) presents a regional geologic map depicting the distribution of the major geologic units near the Refinery.

Based upon available information, no faulting or major structures are known to exist near the Refinery (SAIC, 2011). Except where modified by local structures, the Pennsylvanian-age bedrock dips to the west at approximately 50 ft/mile. No principal bedrock aquifer is present beneath the Refinery.

7.3 Hydrogeology

Groundwater beneath the Refinery exists within the Quaternary-age alluvial sands and gravels, under unconfined conditions. Hydraulically connected aquifers beneath the Refinery are not apparent. The base of the alluvium is defined by fine grained, dense and essentially impermeable Pennsylvanian bedrocks of the Coffeeville Formation, Checkerboard Limestone Formation and Seminole Formation. As such, the only significant source of groundwater beneath the Refinery is the flood plain alluvium along the River (Stone, Bennison & Kent, 1972).

Hydraulic testing of the alluvial aquifer has been conducted several times since the 1980s. According to the *Current Conditions Report and Comprehensive Site Conceptual Model*, prepared by The Source Group, Inc. and Atkins Benham, Inc. Environmental Division in July, 2002 (Current Conditions Report [SGI-ABI, 2002]), hydraulic conductivity testing in 1980 indicated hydraulic conductivity estimates of 136 ft/day; testing in 1982 yielded an estimated hydraulic conductivity range of 13 to 401 ft/day; and testing in 1993 yielded hydraulic conductivity estimates of 479 to 986 ft/day. Excluding the hydraulic conductivity measurements for the upper fine sands (which were considered to be low and un-representative), the measurements were averaged resulting in a mean hydraulic conductivity of 681 ft/day (SGI-ABI, 2002). Hydraulic conductivity values were recalculated in 2005 (SGI-ABI, 2005), yielding an average hydraulic conductivity of 585 ft/day.

Based on the findings from the recent groundwater monitoring event performed in April 2018, the average groundwater saturated thickness beneath the Refinery is approximately 13.32 ft, encountered at depths ranging from 6.12 to 34.33 bgs. The groundwater surface elevation within the alluvium ranged from 618.87 to 630.31 ft above mean sea level (AMSL). The groundwater potentiometric surface map of corrected groundwater elevations collected from April 2-10, 2018 is shown in Figure 7-2 (reproduced from [Enviro Clean, 2018]). This figure provides a snapshot

of groundwater potentiometric surface elevations at a time near the Renewal Application submittal; updated potentiometric surfaces maps will be included in the Refinery semi-annual groundwater monitoring reports submitted under separate cover.

Groundwater beneath the Refinery generally flows from south to north, ultimately discharging to the River. Using Darcy's Law, a hydraulic conductivity of 585 ft/day (SGI-ABI, 2005), a hydraulic gradient of 0.0024 ft/ft calculated from the April 2018 potentiometric surface map, an average saturated thickness of 13.32 ft from the April 2018 gauging event, and an east-west cross-sectional length across the Refinery of 11,624 ft, the volumetric flux beneath the Refinery discharging to the River is calculated to be approximately 217,384 ft^3/day.

Darcy's Law is as follows:

$Q = KiA$

Where:

Q = volumetric flow rate (ft^3/day)

K = hydraulic conductivity (ft/day)

i = hydraulic gradient (ft/ft)

A = cross-sectional area perpendicular to flow (ft^2).

From August 2009 to February 2011, SAIC Energy, Environment & Infrastructure (SAIC) performed a study, to determine the effect of seasonal changes on groundwater levels at the Refinery in response to the River stage. The results of the study revealed that the alluvium groundwater beneath the Refinery is dynamic and fluctuates in response to River stage, especially in the areas directly adjacent to the River (SAIC, 2011). Light non-aqueous phase liquid (LNAPL) is present beneath the Refinery, and the groundwater fluctuations resulted in this LNAPL being distributed over several to multiple feet of vadose zone. Following the findings presented by SAIC, HFTR conducted Cone Penetrometer Testing (CPT) in Area B (as shown on Figure 3-1) along the River and determined that hydrocarbons near the River have smeared upwards of 13 vertical ft (SGI, 2009).

The groundwater fluctuations frequently result in short-term reversals of the groundwater gradient in the areas directly adjacent to the River, as was observed April 3-12, 2017 (see Figure 7-3 reproduced from [Enviro Clean, 2017]). Areas that experience these gradient reversals and larger than typical vertical groundwater fluctuation have developed a three-phase zone of air, LNAPL and water within the subsurface soil pore spaces. This zone promotes dispersion, dilution and volatilization of the constituents of concern (COCs) and enhances oxygenation and subsequent natural biodegradation of the hydrocarbons (SAIC, 2011).

7.4 References

Enviro Clean, 2017. Semi-Annual Monitoring Report, January through June 2017. Enviro Clean Services, LLC. August 11, 2017.

Enviro Clean, 2018. Semi-Annual Monitoring Report, January through June 2018. Enviro Clean Services, LLC. August 14, 2018.

Marcher and Bingham, 1971. Hydrologic Atlas 2, Reconnaissance of the Water Resources of the Tulsa Quadrangle, Northeastern Oklahoma. Marcher and Bingham. 1971.

SAIC, 2011. Development of Interim Groundwater Protection Goals. SAIC Energy, Environment & Infrastructure, LLC. July 11, 2011.

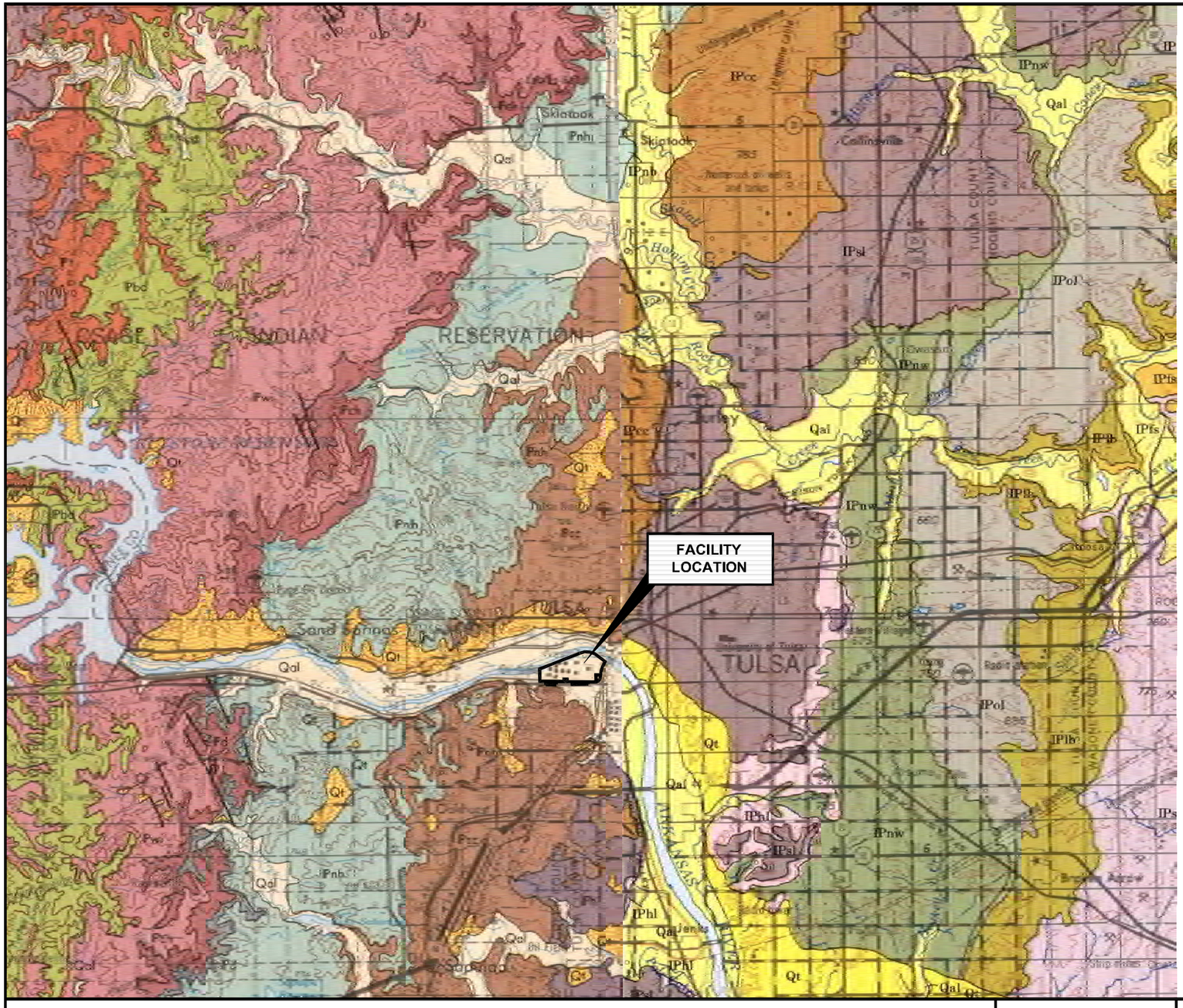
SGI-ABI, 2002. Current Conditions Report and Comprehensive Site Conceptual Model. The Source Group, Inc. and Atkins Benham, Inc. Environmental Division, July 17, 2002.

SGI-ABI, 2005. Assessment of Potential Impact of Groundwater Discharges on the Arkansas River. The Source Group, Inc. and Atkins Benham, Inc. July 28, 2005.

SGI, 2009. Riverbank Area B Investigation, Sunoco Tulsa Refinery, Tulsa, Oklahoma. The Source Group, Inc. May 15, 2009.

Stone, Bennison & Kent, 1972. Tulsa's Physical Environment, Quaternary Geology of Tulsa County, Oklahoma. John E. Stone, Allan P. Bennison, and Douglas C. Kent.

Figures



EXPLANATION

ALLUVIUM
Qal — Gravel, sand, silt, and clay. Yields moderate to large amounts of fair- to good-quality water along the Arkansas River and small to moderate amounts of fair- to good-quality water locally along the Verdigris and Neosho Rivers.

TERRACE DEPOSITS
Qt — Fine gravel, sand, silt, and clay. Yields moderate to large amounts of fair- to good-quality water locally along the Arkansas River.

COFFEYVILLE AND CHECKERBOARD FORMATIONS
IPcc — *Coffeyville Formation*, shale and thin-bedded sandstone. Yields only small amounts of fair- to poor-quality water.
Checkerboard Formation, limestone and some shale. Yields only small amounts of fair- to poor-quality water.

SEMINOLE FORMATION
IPsl — Shale, sandstone, and thin coal beds. Yields only small amounts of fair- to poor-quality water.

RECONNAISSANCE OF THE WATER RESOURCES OF THE TULSA QUADRANGLE, NORTHEASTERN OKLAHOMA

MELVIN V. MARCHER AND ROY H. BINGHAM

1971

Scale 1:250,000

5 0 5 10 15 20 Statute Miles

5 0 5 10 15 20 25 30 Kilometers

Contour interval: 100 feet
Supplementary contours at 50-foot intervals
Datum: Mean sea level

SAIC. From Science to Solutions

Energy, Environment & Infrastructure, LLC
One West Third Street, Suite 100
Tulsa, Oklahoma 74103
(918) 492-1600
www.SAIC.com/EEandI

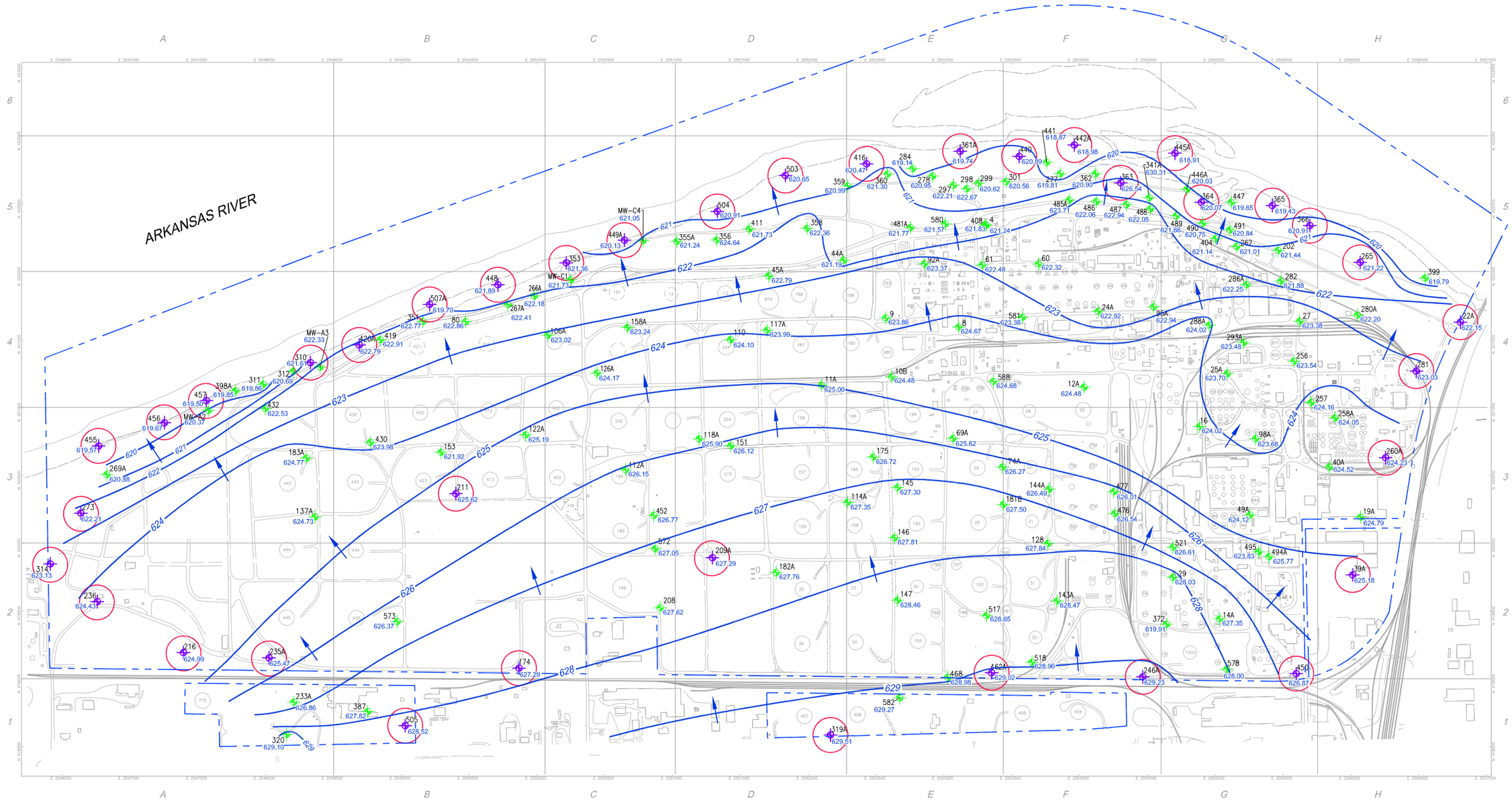
FIGURE TITLE
GEOLOGY MAP

DOCUMENT TITLE
DEVELOPMENT OF INTERIM GROUNDWATER PROTECTION GOALS

CLIENT
HOLLY REFINING & MARKETING - TULSA LLC

LOCATION
HOLLY-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DATE	7/8/2011
SCALE	AS SHOWN
DESIGNED BY	BEM
APPROVED BY	BEM\GHR
DRAWN BY	SKG
PROJECT NUMBER	4100907002
FIGURE NUMBER	7-1



LEGEND

- LOCATION OF GAUGING PROGRAM MONITORING WELL (2009 Permit)
- LOCATION OF POINT OF COMPLIANCE (POC) WELL (2009 Permit)
- 625 — CONTOUR OF GROUNDWATER POTENTIOMETRIC SURFACE APRIL 2–10, 2018, FEET AMSL
- GROUNDWATER FLOW DIRECTION
- NM — NOT MEASURED

375 0 375 750
SCALE FEET

N

ENVIRO CLEAN SERVICES, LLC

Enviro Clean Services, LLC

7060 South Yale Avenue, Suite 603
Tulsa, Oklahoma 74136
918.794.7828
www.ECCGRP.com

DOCUMENT TITLE
SEMI-ANNUAL MONITORING REPORT
JANUARY 2018 THROUGH JUNE 2018

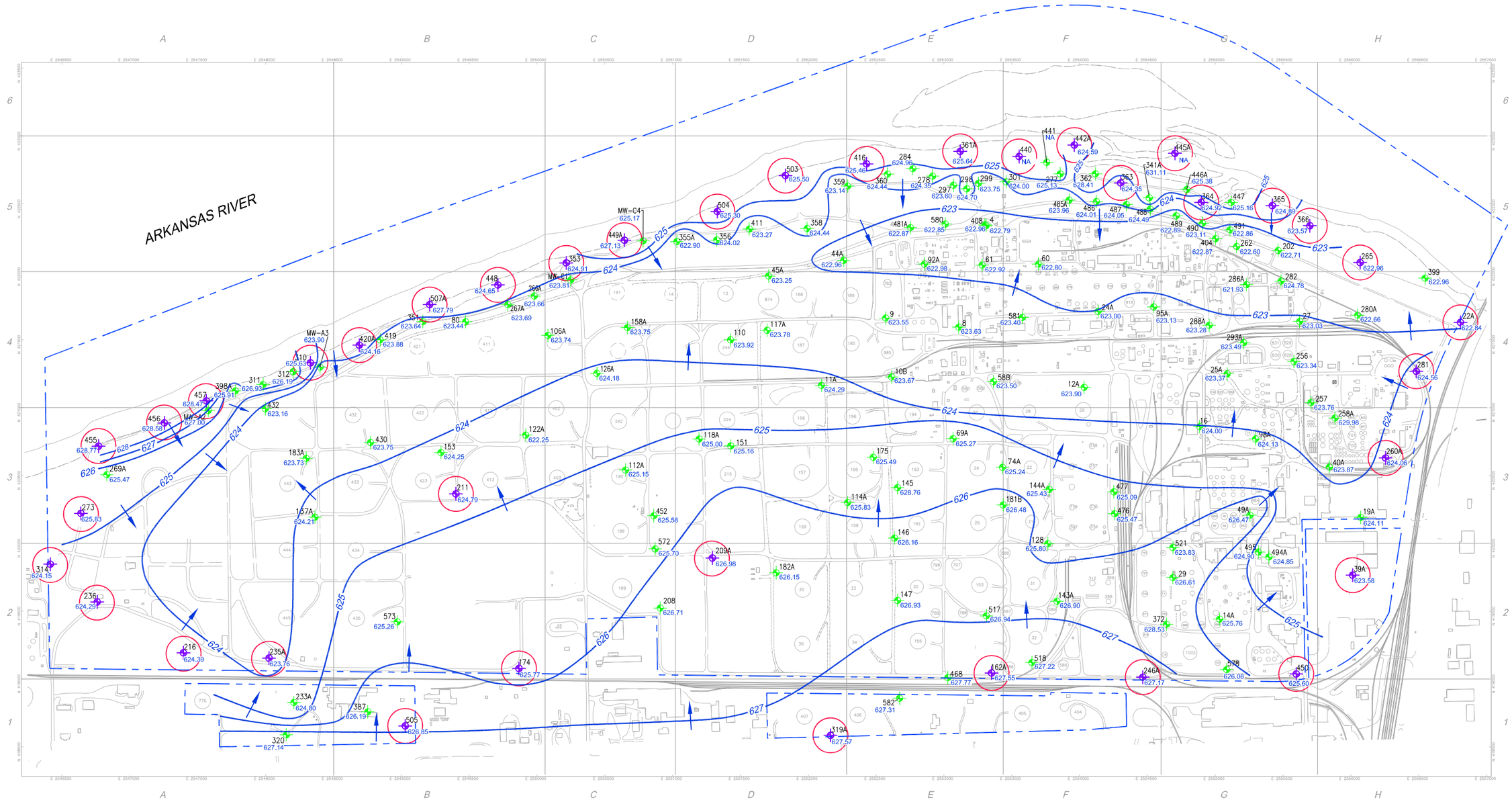
FIGURE TITLE
GROUNDWATER POTENTIOMETRIC SURFACE, CORRECTED GROUNDWATER ELEVATIONS, APRIL 2-10, 2018, FEET AMSL

CLIENT HOLLYFRONTIER TULSA REFINING LLC

LOCATION HFTR-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DESIGNED BY	PCR\CNA		
APPROVED BY	CNA	SCALE	1"= 750'
DRAWN BY	SKG	DATE	8/14/2018

PROJECT NUMBER	FIGURE NUMBER
HFCHHTW003	7-2



LEGEND

- LOCATION OF GAUGING PROGRAM MONITORING WELL (2009 Permit)
- LOCATION OF POINT OF COMPLIANCE (POC) WELL (2009 Permit)
- CONTOUR OF GROUNDWATER POTENTIOMETRIC SURFACE APRIL 3–12, 2017, FEET AMSL
- GROUNDWATER FLOW DIRECTION

375 0 375 750
SCALE FEET

N

ENVIRO CLEAN SERVICES, LLC

Enviro Clean Services, LLC

7060 South Yale Avenue, Suite 603
Tulsa, Oklahoma 74136
918.794.7828

www.ECCGRP.com

DOCUMENT TITLE
SEMI-ANNUAL MONITORING REPORT
JANUARY 2017 THROUGH JUNE 2017

FIGURE TITLE
GROUNDWATER POTENTIOMETRIC SURFACE, CORRECTED GROUNDWATER ELEVATIONS, APRIL 3-12, 2017, FEET AMSL

CLIENT HOLLYFRONTIER TULSA REFINING LLC

LOCATION HFTR-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DESIGNED BY	PCR\BEM		
APPROVED BY	BEM	SCALE	1"= 750'
DRAWN BY	SKG	DATE	8/11/2017

PROJECT NUMBER	FIGURE NUMBER
HFCHHTW003	7-3

8 GROUNDWATER MONITORING AND LNAPL MANAGEMENT PLAN

8.1 Introduction

This *Groundwater Monitoring and LNAPL Management Plan* (Plan) details the groundwater monitoring program and light non-aqueous phase liquid (LNAPL) recovery program at HollyFrontier Tulsa Refining LLC (HFTR), Tulsa West Refinery (the Refinery) located at 1700 South Union Street in Tulsa, Oklahoma. The Refinery currently operates under a Resource Conservation and Recovery Act (RCRA) Post-Closure and Corrective Action Permit (Permit No. 058078775-PC) issued by the Oklahoma Department of Environmental Quality (ODEQ) on June 1, 2009 (2009 Permit).

In accordance with Title 40 Part 270.14(c) of the Code of Federal Regulations (40 CFR 270.14(c)), HFTR is including this Plan as part of the RCRA Part B Permit Renewal Application (Renewal Application). This Plan describes programs in place at HFTR to promote the protection of groundwater in compliance with applicable Federal and State rules and regulations and to support remedial activity at the Refinery. The Plan replaces both the *Facility-Wide Groundwater Performance Monitoring Plan* and *Light Non-Aqueous Phase Liquid (LNAPL) Recovery Plan* that were previously submitted to the ODEQ in February 2003 and January 2007, respectively.

This Plan provides one integrated, Refinery-wide groundwater monitoring plan that details the performance monitoring necessary for compliance with applicable regulatory programs. The Plan includes the following items:

- Detailed plans describing the proposed groundwater monitoring program to be implemented, as required for the Refinery's RCRA-permitted Land Treatment Units (LTUs) and Solid Waste Management Units (SWMUs)[1];
- Location of groundwater monitoring wells and the point of compliance (POC) wells;
- Plans to contain the LNAPL plume within the Refinery boundaries and the process for LNAPL removal within the interior and upgradient areas of the Refinery;
- Description of the semi-annual report submittals to the ODEQ in which HFTR will document the implementation of this Plan;
- Proposed groundwater screening levels for the Refinery; and
- Summary of LNAPL recovery progress at the time of this Renewal Application submittal.

[1] The requirements of 40 CFR 270.14(c)(5) are addressed in the *Current Conditions Report and Comprehensive Site Conceptual Model,* prepared for Sunoco (R&M) by The Source Group, Inc and Atkins Benham, Inc. Environmental Division in July 2002 (SGI-ABI, 2002). The report provides a summary of the Refinery's SWMUs, Riverbank Area of Concern (AOC), corrective actions, and the hydrogeologic/contaminant conditions that were present at the time of submittal.

This Plan describes Refinery-wide groundwater monitoring that includes groundwater monitoring related to the SWMUs near the Arkansas River (the River) and groundwater monitoring for the three closed LTUs located within the interior of the Refinery.

As allowed under 40 CFR 264.90(f) (adopted by USEPA on October 22, 1998 and incorporated by reference by the ODEQ) and in adherence with applicable federal RCRA policy guidance (USEPA 2001) relevant to appropriate alternative groundwater monitoring priorities and requirements during overarching corrective actions at RCRA facilities, the ODEQ has directed HFTR to implement a Refinery-wide groundwater monitoring program, as opposed to maintaining a groundwater monitoring program in accordance with 40 CFR 264.91 through 264.100 specific to the LTUs.

According to 40 CFR 264.90(f), the standard groundwater monitoring requirements for regulated units provided in 40 CFR 264.91 through 264.100 may be replaced with alternative requirements when:

- The regulated unit is situated among solid waste management units (or areas of concern [AOCs]), a release has occurred, and both the regulated unit and one or more solid waste management unit(s) (or AOCs) are likely to have contributed to the release; and
- It is not necessary to apply the groundwater monitoring and corrective action requirements of Sections 264.91 through 264.100 because alternative requirements will protect human health and the environment.

Historical releases have impacted the groundwater beneath the Refinery. Groundwater impacts as a result of these releases preclude an accurate determination of the potential impacts from the regulated LTUs. As a result, LTU-specific monitoring does not provide any meaningful information. HFTR has committed to conduct groundwater monitoring across the entire refinery in accordance with this comprehensive Plan to assist in an overall cleanup of the Refinery and to institute remedial actions to protect human health and the environment.

This Plan also addresses LNAPL from refinery operations not associated with historical waste-management activities. Because LNAPL is present in the proximity of the LTUs and SWMUs, HFTR is committing to monitor the potential and anticipated effects of LNAPL plumes in the areas of LTUs and SWMUs. Although this Plan includes monitoring wells located upgradient and downgradient of the LTUs, the data generated from monitoring those wells will be used when evaluating other corrective action and LNAPL management activities.

Monitoring under this Plan will provide the necessary information for HFTR to evaluate current conditions and the effectiveness of ongoing remedial activities at the Refinery and will provide information for developing additional or modified corrective measures, if warranted, as environmental conditions change. This Plan will also result in data collection that can be used to prioritize projects and resources in areas that require attention in order to provide the best protection of human health and the environment.

8.2 Interim Groundwater Conditions and Screening Levels

The 2009 Permit required a proposed method to develop the interim goals for contaminated groundwater and required this be submitted to the ODEQ within 180 days of permit issuance. Within 180 days of approval of the method, HFTR was required to develop the interim goals. HFTR submitted the *Work Plan for Development of Interim Groundwater Protection Goals* to the ODEQ on October 9, 2009 and it was approved on September 17, 2010. HFTR implemented the work plan in October of 2010. HFTR submitted the *Development of Interim Groundwater Protections Goals* (IGPG Report) on July 11, 2011, detailing efforts made by HFTR throughout the previous years to assess the interaction between the groundwater that discharges from beneath the Refinery to the River.

The ODEQ did not approve the protection goals proposed in the IGPG Report and recommended that at least three additional semi-annual sampling events be conducted at the Refinery for which groundwater samples collected from monitoring wells would be tied to near-shore surface water samples collected from the River. The intention was that this would provide a performance-based demonstration of the relationship between the concentrations of the constituents of concern (COCs) present in the Refinery's groundwater to the concentration of these COCs observed in the surface water within the River, and support calculation of Refinery-specific allowable concentrations of COCs in point of compliance wells which are located upgradient of potential points of exposure (POE).

The results of the three additional sampling events were reported in a document titled *Proposed Performance-Based Interim Groundwater Protection Goals* (Enviro Clean, 2014), in which HFTR presented the data to illustrate the relationship between Refinery groundwater concentrations and River surface water. The IGPG report also proposed numeric screening levels for COCs at downgradient point of compliance wells. Following submittal, the ODEQ communicated that operations at the Refinery were not impacting the River at that time, and that HFTR was to closely monitor the groundwater condition along the River to minimize any adverse impacts on the River. In correspondence dated March 16, 2016, the ODEQ requested that HFTR not use the screening levels in *Proposed Performance-Based Interim Groundwater Protection Goals.*

HFTR is now proposing steps to develop new screening levels. HFTR proposes performance of a Refinery-wide risk assessment from which risk-based screening levels (RBSLs) will be calculated. The selection of COCs is based on the Refinery's historical analytical dataset (2003 to 2018). HFTR is proposing that the following nine COCs be retained in the monitoring program: arsenic, barium, benzene, ethylbenzene, lead, methyl tertiary butyl ether (MTBE), toluene, total xylenes, and zinc. The COCs were selected by analyzing the historical dataset and removing analytes that were not detected or were detected at less than 10% frequency. Following approval from the ODEQ of the RBSLs, HFTR will begin comparing COC analytical results to the approved RBSLs.

Since submittal of the 2009 Permit, sampling results have been submitted in eighteen (18) semi-annual monitoring reports (SMRs). The most recent semi-annual event in April 2018 (SMR submitted August 14, 2018) revealed detected concentrations of barium at POC wells, with the lowest concentration observed at well 364 (120 µg/L) and the highest concentration at well 504 (2,460 µg/L). There were no detections of ethylbenzene at any of the wells. During April 2018, the remaining seven COCs were observed at a range from below the laboratory analytical detection limit to:

- 43.1 µg/L arsenic (well 504),
- 2.91 µg/L lead (well 504),
- 55.8 µg/L zinc (well 504),
- 370 µg/L benzene (well 361A),
- 640 µg/L MTBE (well 442A),
- 7.2 µg/L toluene (well 448), and
- 13 µg/L total xylenes (well 448).

The concentrations of benzene, toluene, ethylbenzene, total xylenes and MTBE observed at POC wells for the April 2018 event are shown on Figure 8-4. The majority of the POC wells exhibited stable or decreasing concentration trends. The above analytical data summary is a snapshot of Refinery conditions at the time of this permit application. Data from future sampling events will be presented in SMRs.

8.3 Program Schedule and Procedures

8.3.1 Schedule

The proposed groundwater monitoring program will consist of well gauging, groundwater sampling, monitoring of LNAPL recovery systems, and a visual inspection of each LTU and SWMU. HFTR will perform semi-annual groundwater monitoring in April and October of each year. Elements of the groundwater monitoring program include the following:

- Semi-annual sampling of downgradient POC boundary wells;
- Semi-annual gauging of wells for depth to groundwater and LNAPL;
- Annual sampling of POC upgradient wells;
- Semi-annual reporting of gauging data and sample results; and
- Semi-annual reporting of LNAPL recovery progress, and any modifications to the LNAPL recovery systems.

8.3.2 Field Documentation

Monitoring wells will be screened for pH, temperature, conductivity and dissolved oxygen using portable analysis equipment prior to sample collection. Field documentation will be recorded each day in a bound field logbook and well-associated field sampling form. Each page of the logbook will be signed by the person(s) making entries on that page and will be reviewed to ensure completeness.

8.3.3 Well Inspection and Maintenance

The HFTR well network consists of a combination of gauging wells and POC wells (collectively known as Program Wells). All Program Wells and their primary function are included in Table 8-3. HFTR is proposing to cease sampling of the interior LTU wells based on prior analytical results.

During each gauging and sampling event, Program Wells will be inspected for well integrity. The information will be recorded on the groundwater gauging form. Each inspection will include:

- Inspection of the condition of the protective well casing, outer steel casing, and well covers;
- Inspection of well locking lids;
- Inspection of the presence or absence and condition of padlocks; and
- Inspection of concrete pads for cracks and settling.

Personnel will ensure each well lid is locked upon completion of sampling. Well Network

The Program Wells will be gauged for total depth, redeveloped, and surveyed every five (5) years. The most-recent total depth measurement, survey, and redevelopment activities were conducted in 2018.

8.3.4 Well Gauging

During each semi-annual monitoring event, sampling personnel will complete fluid level gauging at all Program Wells, prior to conducting groundwater sampling. Wells will be gauged for depth to water and depth to product (if present). Table 8-3 provides a list of wells to be gauged for water table elevation and LNAPL. Total monitoring well depth is measured every five (5) years. Prior to gauging, each well cap will be removed to allow groundwater to equilibrate. Fluid level measurements will be collected using a decontaminated electronic water level meter with an accuracy of 0.01 feet. To ensure that the electronic water level is not contaminated or cross contaminated by materials and equipment used during the investigation, the meter is decontaminated between each well.

For wells with a measurable accumulation of LNAPL, additional data analysis will be conducted to calculate a water table elevation value corrected for the presence of LNAPL and an LNAPL thickness value that is corrected to approximate the formation thickness of LNAPL in the vicinity of the well as opposed to the apparent thickness measured in the well.

The gauging well network will provide comprehensive Refinery-wide groundwater and LNAPL elevation data, sufficient to evaluate groundwater flow conditions and apparent LNAPL thickness. If LNAPL is encountered in a well, the corrected water elevation will be incorporated into the water elevation maps. LNAPL thickness maps for each event are compared to previous data to evaluate trends in shape, thickness and movement of the LNAPL plume. HFTR may add or delete specific wells in this gauging network without a Permit modification, although such changes will be noted in the next SMR described in Section 8.5.

LNAPL Evaluation

For monitoring wells with a measured LNAPL thickness, additional evaluation is necessary to determine a corrected LNAPL thickness that approximates the LNAPL thickness observed in the porous media located immediately adjacent to the well.

To calculate a corrected LNAPL thickness, a product density is necessary for each well. In 2006, The Source Group, Inc. (SGI) sampled 161 Refinery wells, active at the time of sampling, to determine each well's specific gravity and viscosity (SGI, 2006). For wells that weren't analyzed, the closest well is used to identify a LNAPL density.

Consistent with the analyses presented in the *Current Conditions Report and Comprehensive Site Conceptual Model,* prepared by The Source Group, Inc and Atkins Benham, Inc. Environmental Division in July 2002 (Current Conditions Report [SGI-ABI, 2002]), the apparent LNAPL thickness can be multiplied by a conversion factor to achieve the corrected LNAPL thickness. The ratio of actual to apparent LNAPL thickness is a function of product density. As such, the wells in the 2006 gauging event were grouped by product density and assigned a conversion factor. The density groupings and corresponding conversion factors set in the Current Conditions Report are as follows:

Product Classification	Density	Conversion Factor
Light Product	0.74 gm/cm^3	0.308
Medium Product	0.83 gm/cm^3	0.219
Heavy Product	0.87 gm/cm^3	0.161

The above product classifications have been expanded to account for a range of densities, by using the midpoint between densities. The ranges are as follows:

- Light Product $\leq$0.785 gm/cm^3

- 0.785 gm/cm^3 <Medium Product <0.85 gm/cm^3
- Heavy Product ≥0.85 gm/cm^3

Gauging data will be corrected per the following equations:

- Measured LNAPL Thickness x Conversion Factor = Corrected LNAPL Thickness
- Depth-to-Water – (Measured Product Thickness x LNAPL Density) = Corrected Depth-to-Water

8.3.5 Groundwater Sampling

Groundwater will be sampled in accordance with HFTR's *Sampling and Analysis Plan and Quality Assurance Project Plan* (SAP-QAPP), which is presented in Appendix 8.1. Thirty-six (36) wells are included in the Refinery's sampling well network, presented in Table 8-2. Downgradient POC wells will be sampled on a semi-annual basis in April and October of each year. The upgradient wells will be sampled annually, concurrently with the downgradient wells during the April monitoring event. HFTR is proposing to sample all wells for the following nine COCs: arsenic, barium, benzene, ethylbenzene, lead, MTBE, toluene, total xylenes, and zinc. These analytes were chosen by utilizing the 10% frequency of detection criterion developed in concurrence with the ODEQ and based on groundwater monitoring data from 2003 to April 2018.

HFTR will not typically collect a groundwater sample from any monitoring well determined at the time of the monitoring event to contain any detectable LNAPL, including any hydrocarbon sheen or globules. In such cases, HFTR will report the occurrence, measured thickness, and corrected thickness of LNAPL in the well in the subsequent SMR. The report will also include an evaluation of the need to replace such wells in the monitoring network and may include a notice of this effect.

8.3.6 Sample Handling and Quality Assurance/Quality Control

Detailed sampling, gauging and quality assurance/quality control (QA/QC) procedures are included in the Refinery's SAP-QAPP (Appendix 8.1). The procedures are intended for use in the field. The SAP-QAPP will be updated periodically without modification to the Permit; as such, in the future there may be minor changes to the groundwater sampling and analysis procedures, which will be noted in the routine SMRs, described in Section 8.5. Alternate, published, U.S. EPA-recommended methods may be used with prior approval from the ODEQ provided that the SAP-QAPP measurement quality objectives are met. Permit modification will not be required when using an update of a method appearing in the SAP-QAPP or an alternate method published by the U.S. EPA that has been approved for use. This provides the necessary flexibility to use the most recently updated sample preparation and/or analysis methods after new updates to SW-846 are promulgated, and/or when field methods are added or updated, while safeguarding data comparability.

8.4 Program Modifications

Changes to groundwater monitoring wells and monitoring parameters may occur as new data are evaluated, and as corrective measures advance or are completed. Changes to wells such as number of wells, new well location(s), or changes to depth or design are Class 2 permit modifications. The installation of replacement wells without changing location (less than 50 feet from original location), and without changes to design, or depth is a Class 1 modification. Wells can only be removed from the monitoring program following approval by the ODEQ. Well plugging and abandonment methods and certification shall be submitted to the ODEQ within 90 days from the date the wells are removed from the monitoring program. Changes in groundwater sampling or analysis procedures or monitoring schedule, with prior approval from the ODEQ, are Class 1 modifications.

8.5 LNAPL Recovery Activities

The following section outlines the LNAPL recovery program in place at HFTR. The *LNAPL Recovery Plan* was originally submitted to the ODEQ in November 2002 and was resubmitted in 2007. Since that time, no substantial changes to the previous recovery plan have been made; however, this document reflects current site conditions and practices.

The Refinery LNAPL recovery program consists of riverbank containment systems and interior recovery systems. The systems are shown on Figure 8-2. LNAPL recovery volumes are greatly affected by fluctuation of the groundwater levels beneath the Refinery. LNAPL recovery generally decreases during periods of high or fluctuating groundwater levels and increases during low or stable groundwater levels.

To maximize efficiency in LNAPL recovery, HFTR will continue to operate existing LNAPL recovery systems, and conduct enhancements if and where advisable. Optimization efforts may include:

- Installation of new recovery wells;
- Installation of skimmer pumps into existing wells;
- Rehabilitation of dual phase recovery wells; and
- Installation of new dual-phase recovery wells.

8.5.1 Arkansas River LNAPL Inspection

Section 3 (Inspection Plan) describes plans and procedures for routine inspection of the River's south bank. HFTR shall conduct weekly inspections for hydrocarbon sheening along the length of the riverbank property owned by HFTR to detect the presence of hydrocarbon discharge

to the River. Inspections will be conducted during representative flow conditions[2]. If hydrocarbon sheening is observed, HFTR will undertake actions as outlined in Section 3.3.

8.5.2 Riverbank LNAPL Containment Systems

There are currently eight Riverbank Areas (A through H) along the Refinery. Seven of the Riverbank Areas (A through G) have LNAPL containment systems. Lists of active riverbank recovery wells are provided in Tables 8-4 and 8-5.

Groundwater for all the riverbank containment systems is pumped through dedicated piping to various collection locations and then to the on-site Refinery wastewater treatment system (WWTS) for treatment and discharge to the River under the Refinery's Oklahoma Pollution Discharge Elimination Systems permit. Recovered LNAPL for all riverbank containment systems is collected in storage tanks and then undergoes the oil refining process.

Area A Containment System

The Area A Containment System (installed in 1995) is in the Northwest corner of the Refinery. The system combines a 1,100-foot-long slurry wall and five dual phase recovery wells (DEW-A1 through DEW-A5) located immediately upgradient of the slurry wall.

Area B Containment System

The Area B Containment System (installed in October 2005) is in the Northwest portion of the Refinery. The recovery wells consist of 2 sets of well pairs. One well in each pair is used for dual-phase recovery, and the other is utilized for additional LNAPL recovery. The four Area B wells are identified as wells 496/497 and 498/499.

Area C Containment System

The Area C Containment System (installed 1987-1988) is in the North-Central portion of the Refinery. The system consists of 5 dual phase recovery wells DEW-C1 through DEW-C5.

Area D Containment System

The Area D Containment System (installed in 2003) is in the North-Central portion of the Refinery. The system consists of a 210-foot long, steel sheet-piling cut-off wall installed immediately downgradient of 3 dual-phase recovery wells DEW-D1 through DEW-D3. The steel cut-off wall is V-shaped and is installed into the bedrock to facilitate LNAPL containment and recovery.

Area E Containment System

The Area E Containment System (installed in 1998) is in the Central-North East portion of the Refinery. The Area E Containment System consists of six (6) dual-phase extraction wells DEW-E3 through DEW-E5, 482, 514A and R12.

[2] To ensure representative flow conditions during riverbank inspections, HFTR will record the River flow, water level, and wind direction/strength.

Area F Containment System

The Area F Containment System (installed in 2007) is located in the northeast portion of the Refinery. The Area F Containment System is comprised of three dual-phase recovery wells 483A, 484A and 515.

Area G Containment System

The area G Containment System (installed in 2007) is located in the northeast portion of the Refinery. The Area G Containment System is comprised of two dual-phase recovery wells 512A and 513A.

8.5.3 Interior LNAPL Recovery Systems

The interior recovery systems are generally located in the tank farm and process areas where mobile and recoverable LNAPL is potentially present. Interior extraction wells are summarized in Table 8-5. Recovery may be conducted at additional existing wells if/where conditions warrant. Performance of these systems is evaluated by the volume of LNAPL recovered. Systems are named based on proximity to fixed features in the Refinery. Changes in which wells are pumped, installation of new recovery wells/recovery systems, and description of design and operation are provided in the SMRs.

In general, LNAPL recovery at interior locations is achieved via skimming and in some cases with groundwater depression. LNAPL collected by the interior recovery operations is temporarily pumped into storage tanks and then undergoes the oil refining process.

8.6 LNAPL System Operation and Maintenance

The following section details the routine operation and maintenance (O&M) performed by HFTR to keep recovery and containment systems operational. In general, riverbank containment systems and interior recovery systems are inspected regularly as necessary to optimize system performance. This includes measurement of recovered LNAPL volumes, adjusting groundwater flow and LNAPL recovery rates and performing maintenance of critical mechanical and electrical system components. Recovered groundwater and LNAPL volumes for all systems are monitored and reported to the ODEQ in the SMRs.

8.6.1 Riverbank Containment Systems O&M

Operation of the riverbank containment systems requires extensive monitoring and maintenance to optimize performance. Adjustments are made in response to rapidly changing groundwater fluctuations and conditions along the Riverbank Area. HFTR will not request prior approval for system operations modifications such as field adjustments and maintenance activities. Replacement of equipment with equipment which is of a comparable or similar type, function or design is considered a Class 1 permit modification.

Prior to any other system modifications, including proposed (planned) system shutdown, HFTR will submit a written request to the ODEQ proposing the modification. The type and scale

of the proposed system(s) modification may trigger a permit modification under CFR 270.42. The request(s) will include technical reasons for the proposed modification, as well as a schedule for implementation. Upon receiving approval from the ODEQ, HFTR will implement any such modification, pursuant to the schedule included in the request to the ODEQ.

A system or a portion of a system may be shut down if/where recovery is below a practical endpoint; if/where there have been no recent ongoing detections of petroleum hydrocarbon sheen in the River; if/where declining groundwater concentrations indicate it is appropriate; and if/where fluid level measurements indicate it is appropriate. A "shutdown" is considered to be the complete cessation of activities by one (1) or more of the riverbank containment systems. Shutdowns for unscheduled or unexpected maintenance, including replacement of equipment, shall not be considered an interruption of operation, provided the shutdown(s) are no longer than seventy-two (72) hours from discovery and last no longer than seventy-two (72) hours in any thirty (30) day period. Where shutdown is related to conditions beyond HFTR control; such as power failure, extreme weather, labor disruption, terrorist activity, *etc*., there will be no violation of the Permit, and the system(s) should be made operational as soon as practical.

8.6.2 Interior Recovery Systems O&M

Interior Recovery systems will be operated and managed to optimize protection of the River and enhance LNAPL recovery. Additions, modifications, enhancements, deletions, and maintenance will be conducted at the discretion of HFTR provided the overall effectiveness of the system(s) is (are) not reduced. Prior approval from the ODEQ for these modifications will not be required; however, all changes will be communicated to the ODEQ in SMRs.

8.7 Semi-Annual Monitoring Report

Groundwater monitoring from each calendar year will be documented in SMRs. The report will include gauging data and groundwater analytical results from the April and October gauging events, and LNAPL containment and recovery efforts during the applicable six-month period.

At a minimum, the SMRs will include the following:

- Text describing sampling and analysis activities (focusing on deviation from this Plan and the SAP-QAPP), regulated units, LNAPL recovery activities, and groundwater and LNAPL monitoring data;
- Figures showing property location, property boundaries, location of sampling and gauging locations;
- Summary table of semi-annual groundwater and LNAPL gauging data during the reporting period, with corrected water table elevation for all wells containing LNAPL;
- Potentiometric surface maps depicting the groundwater gradient for each semi-annual monitoring event of the reporting period, including site features and the direction and magnitude of the hydraulic gradient;

- Summary of laboratory analytical data during the reporting period;
- Summary of LNAPL recovery system performance including:
    - LNAPL thickness isopleth maps for each semi-annual monitoring event during the reporting period;
    - Tabulation of the monthly and cumulative volume of LNAPL removed from extraction wells or containment systems during the reporting period;
    - Detail of each LNAPL recovery system including well numbers and information on wells; and
    - Evaluation of the Refinery's containment and interior recovery systems during the reporting period, any significant changes to the systems during the reporting period, and any proposed system modifications and improvements to optimize the riverbank and interior recovery systems for the next semi-annual period.
- Conclusions regarding:
    - The effectiveness of ongoing remedial efforts, including interim and final corrective measures;
    - Observed trends relative to the quality of groundwater POC wells; and
    - Observed trends relative to the subsurface distribution of LNAPL.
- Recommendations regarding:
    - Proposed changes to the COCs to be sampled and analyzed under this Plan;
    - Proposed changes to the numbers or locations of monitoring or gauging wells;
    - Proposed modification of the sampling procedures, QA/QC, or other written details of this Plan; and
    - Proposed investigations or corrective actions to investigate or mitigate potential releases.
- Complete laboratory data reports; and
- A list of references and appendices of supporting documents.

Laboratory analytical and well gauging data are due by electronic mail to the ODEQ 45 calendar days from the completion of the sampling event. The SMRs are due to the ODEQ on or before February 15 and August 15 of each calendar year.

8.8 Groundwater Corrective Action Plan

After comparing the groundwater results to the screening levels and evaluating groundwater data using statistical methods as outlined in the SAP-QAPP, if downgradient wells are observed to have concentrations exceeding the RBSLs for two consecutive semi-annual

sampling periods, an assessment will be proposed. Within 90 days after submittal of the second consecutive report of an exceedance of RBSLs, a report will be submitted identifying proposed risk management plans, potential data needs/investigations planned, changes to the methods of comparison, validation or confirmation that should be made, and/or whether remedial measures should be undertaken.

Any changes, concerns, or substandard conditions observed during the groundwater monitoring assessment will be brought to the attention of the Refinery's Environmental Manager. The Environmental Manager will arrange to have any groundwater monitoring network deficiencies corrected as soon as practical by the Refinery maintenance staff, and the corrective actions will be noted in the following SMR.

8.9 References

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SGI-ABI, 2005. Assessment of Potential Impact of Groundwater Discharges on the Arkansas River. The Source Group, Inc. and Atkins Benham, Inc. July 28, 2005.

SGI, 2006, LNAPL Reservoir Management Plan. The Source Group, Inc. March 29, 2006.

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USEPA, 2015. Region 6 Corrective Action Strategy (CAS). U.S. EPA Region 6 Multimedia Planning and Permitting Division. February 2015.

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Tables

Table 8-1. Groundwater Sample Analyte List

Analyte
Inorganics
Arsenic
Barium
Lead
Zinc
Volatile Organics
Benzene
Ethylbenzene
Methyl Tertiary Butyl Ether
Toluene
Xylenes (total)

Table 8-2. Groundwater Monitoring List of Point of Compliance Monitoring Wells and Functions

Sorted by Well Number	
Monitoring Wells	**Function**
22A	Downgradient
39A	Downgradient
162A	Upgradient
174	Upgradient
216	Upgradient
235A	Upgradient
236	Upgradient
246A	Upgradient
260A	Downgradient
265	Downgradient
273	Downgradient
281	Downgradient
310	Downgradient
314	Downgradient
319A	Upgradient
353	Downgradient
361A	Downgradient
363	Downgradient
364	Downgradient
365	Downgradient
366	Downgradient
416	Downgradient
420A	Downgradient
440	Downgradient
442A	Downgradient
445A	Downgradient
448	Downgradient
449A	Downgradient
450	Upgradient
455	Downgradient
456	Downgradient
457	Downgradient
503	Downgradient
504	Downgradient
505	Upgradient
507A	Downgradient
Total Active Wells	**36**

Sorted by Function	
Monitoring Wells	**Function**
162A	Upgradient
174	Upgradient
216	Upgradient
235A	Upgradient
236	Upgradient
246A	Upgradient
319A	Upgradient
450	Upgradient
505	Upgradient
273	Downgradient
22A	Downgradient
39A	Downgradient
260A	Downgradient
265	Downgradient
281	Downgradient
310	Downgradient
314	Downgradient
353	Downgradient
361A	Downgradient
363	Downgradient
364	Downgradient
365	Downgradient
366	Downgradient
416	Downgradient
420A	Downgradient
440	Downgradient
442A	Downgradient
445A	Downgradient
448	Downgradient
449A	Downgradient
455	Downgradient
456	Downgradient
457	Downgradient
503	Downgradient
504	Downgradient
507A	Downgradient

Notes:
Upgradient wells are sampled annually (April).
Downgradient boundary wells are sampled semi-annually (April and October).

Table 8-3. Program Well Network

Well Number[1]	Well Use	Grid Location[2]
4	Gauging	E5
8	Gauging	E4
9	Gauging	E4
10B	Gauging	E4
11A	Gauging	D4
12A	Gauging	F4
14A	Gauging	G2
16	Gauging	G3
19A	Gauging	H3
22A	POC	H4
24A	Gauging	F4
25A	Gauging	G4
27	Gauging	G4
39A	POC	H2
40A	Gauging	H3
44A	Gauging	D5
45A	Gauging	D4
49A	Gauging	G3
58B	Gauging	E4
60	Gauging	F5
61	Gauging	E5
74A	Gauging	E3
80	Gauging	B4
92A	Gauging	E5
95A	Gauging	F4
106A	Gauging	C4
110	Gauging	D4
112A	Gauging	C3
114A	Gauging	E3
118A	Gauging	D3
122A	Gauging	B3
128	Gauging	F2
137A	Gauging	A3
143A	Gauging	F2
145	Gauging	E3
146	Gauging	E3
147	Gauging	E2
151	Gauging	D3

Table 8-3. Program Well Network (cont.)

Well Number	Well Use	Grid Location
158A	Gauging	C4
162A	POC	E2
174	POC	B2
175	Gauging	E3
181B	Gauging	F3
182A	Gauging	D2
202	Gauging	G5
208	Gauging	C2
209A	Gauging	D2
211	Gauging	B3
216	POC	A2
235A	POC	A2
236	POC	A2
246A	POC	F2
257	Gauging	G4
258A	Gauging	H3
260A	POC	H3
262	Gauging	G5
265	POC	H5
266A	Gauging	B4
267A	Gauging	B4
269A	Gauging	A3
273	POC	A3
277	Gauging	F5
278	Gauging	E5
280A	Gauging	H4
281	POC	H4
282	Gauging	G4
284	Gauging	E5
286A	Gauging	G4
288A	Gauging	G4
297	Gauging	E5
299	Gauging	E5
310	POC	A4
312	Gauging	A4
314	POC	A2
319A	POC	D1
320	Gauging	A1
353	POC	C5
356	Gauging	D5

Table 8-3. Program Well Network (cont.)

Well Number	Well Use	Grid Location
358	Gauging	D5
359	Gauging	E5
360	Gauging	E5
361A	POC	E5
362	Gauging	F5
363	POC	F5
364	POC	G5
365	POC	G5
366	POC	G5
372	Gauging	G2
387	Gauging	B1
399	Gauging	H4
404	Gauging	G5
411	Gauging	D5
416	POC	E5
419	Gauging	B4
420A	POC	B4
430	Gauging	B3
432	Gauging	A3
440	POC	F5
441	Gauging	F5
442A	POC	F5
445A	POC	G5
446A	Gauging	G5
447	Gauging	G5
448	POC	B5
449A	POC	C5
450	POC	G2
452	Gauging	C3
455	POC	A3
456	POC	A4
457	POC	A4
468	Gauging	E2
481A	Gauging	E5
485A	Gauging	F5
487	Gauging	F5
489	Gauging	G5
494A	Gauging	G2
503	POC	D5
504	POC	D5

Table 8-3. Program Well Network (cont.)

Well Number	Well Use	Grid Location
505	POC	B1
507A	POC	B4
517	Gauging	E2
518	Gauging	F2
521	Gauging	G2
573	Gauging	B2
578	Gauging	G2
581	Gauging	F4
582	Gauging	E1
MW-A2	Gauging	A3
MW-A3	Gauging	A4
MW-C1	Gauging	C4
MW-C4	Gauging	C5

Notes:
[1] #A: Replacement well (e.g., 10A).
[2] Grid locations shown on Figure 8-1.
Per the permit, all Program Wells are surveyed every five (5) years.

Table 8-4. LNAPL Riverbank Containment System Wells

Location	Extraction Well
Area A	DEW-A1
	DEW-A2
	DEW-A3
	DEW-A4
	DEW-A5
Area B	496/497
	498/499
Area C	DEW-C1
	DEW-C2
	DEW-C3
	DEW-C4
	DEW-C5
Area D	DEW-D1
	DEW-D2
	DEW-D3
Area E	DEW-E3
	DEW-E4
	DEW-E5
	482
	514A
	R12
Area F	483A
	484A
	515
Area G	512A
	513A
Total Active Wells	**26**

Table 8-5. LNAPL Recovery System Wells Organized by Tank

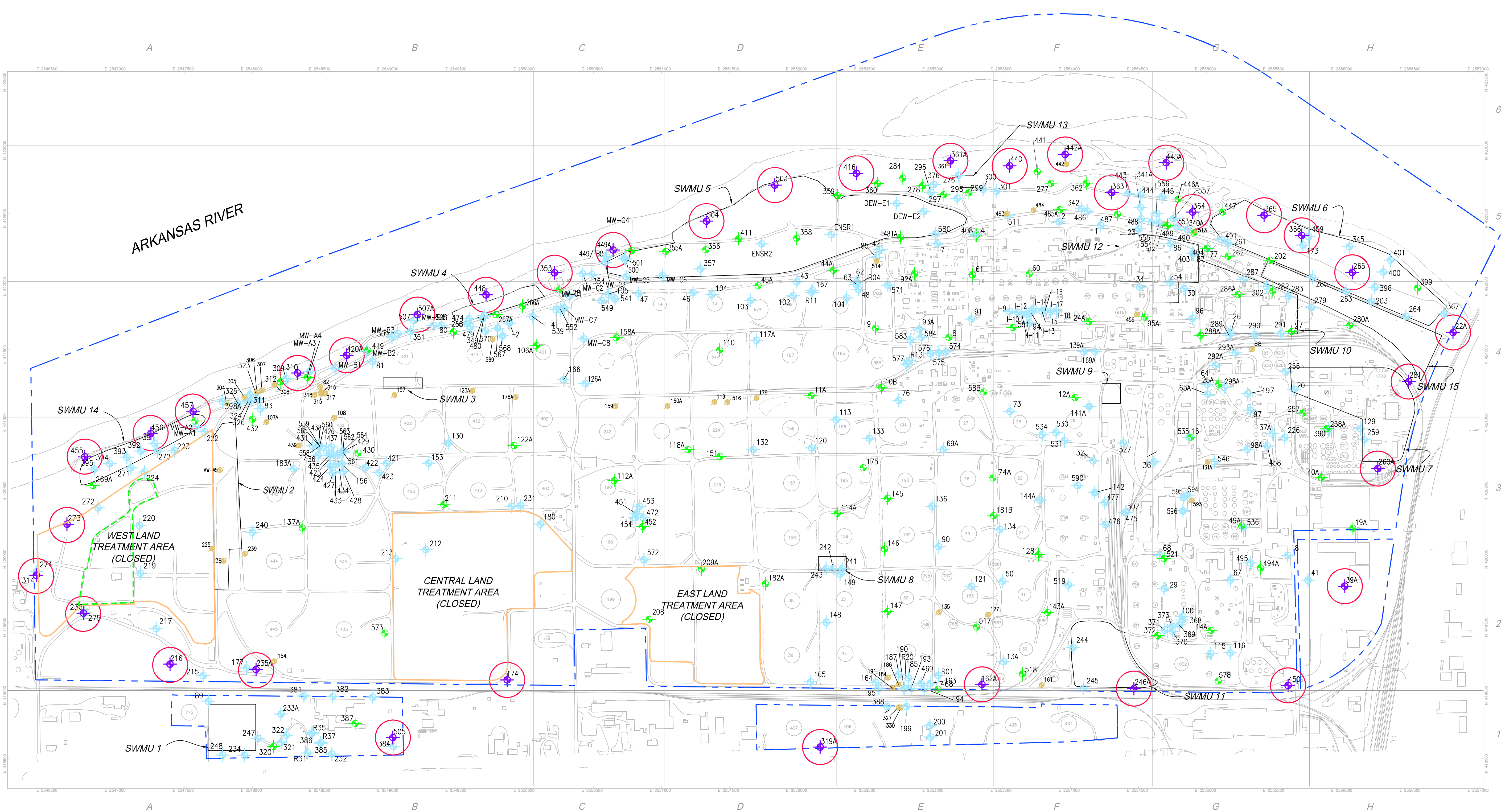
Tank	Area	System Location	Active LNAPL Extraction Wells		
			Skimmer	Dual Extraction	Total
1014	Proc. Unit	N of Platformer	R24, R25, 408	R02, 389	5
1016	Proc. Unit	Trn Cntr, E of road	461, 476, 477		3
1018	Proc. Unit	SW of #3 CT	579, R21, R22, R23		4
1020	Proc. Unit	Trn Cntr, E of 317 tk	462, 478, 589, 616, 617		5
1022	Proc. Unit	#4 CT	R28, R29, 170A	R17	4
1024	Proc. Unit	Trn Cntr, E of 318 tk	374, 375, R32, R33		4
1028	Proc. Unit	E of Loading Dock	R06, R26, R27		3
1029	Proc. Unit	S of Towner Pit	249, 250, 251		3
1065	Proc. Unit	NE of Tank 546	252		1
1066	Proc. Unit	S of CCU	253, 255, 397	R16	4
1067	Proc. Unit	E of Zone B Office	66A, 406, 407	R05	4
1069	Proc. Unit	Trn Cntr, E of 314 tk	17, 465, 467, 520A		4
1071	Proc. Unit	N of Club Room	99A	R19	2
1074	Proc. Unit	W of Zone B	55A, 52A	R03[1]	3
1075	Proc. Unit	W of Zone B Off.	R30, R34, 21A, 54A	R03[1]	4
1081	Proc. Unit	Trn Cntr, NE of 315 tk	463, 464, 466		3
1082	Proc. Unit	S of Lab	542, 543, 544, 545		4
1083	Proc. Unit	N of 4 CT	293A, 522		2
1084	Proc. Unit	SW of 28 tk	R09, 84A		2
1085	Proc. Unit	E of Pent	602, 603, 604	R07	4
1086	Proc. Unit	SE of 28 tk	57A, 492, 493		3
1087	Proc. Unit	NE of Merox	140A		1
1175	Proc. Unit	W. of Club Room	495		1
1178	Proc. Unit	SE 27 tk	51A		1
1179	Proc. Unit	SE of 828 Tank	256		1
1181	Proc. Unit	SW of Bundle Bldg	532, 533, 529		3
1182	Proc. Unit	SE of Bundle Bldg	528		1
1183	Proc. Unit	W of Zone B Off.	460, 53A, 526		3
1184	Proc. Unit	N of Perc	56A, 523, 524		3
1185	Proc. Unit	W of 267 tank	540, 550		2
1186	Proc. Unit	E of 4 CT	294A		1
1187	Proc. Unit	N of Perc	525		1
1188	Proc. Unit	W of tk 74	551		1
1189	Proc. Unit	NE of 29 tk	12A		1
1191	Proc. Unit	S. of 74 tk	547, 98A		2
1192	Proc. Unit	S. of 233 tk	548		1
1208	Proc. Unit	NE Maint. Bldg	597, 598, 599, 600, 601, 606		6

Table 8-5. LNAPL Recovery System Wells Organized by Tank (cont.)

Tank	Area	System Location	Active LNAPL Extraction Wells		
			Skimmer	Dual Extraction	Total
1209	Proc. Unit	Transfer Center	607, 609, 610, 611, 612		5
1210	Proc. Unit	Transfer Center	605, 608, 613, 614, 615		5
Tote 4	Proc. Unit	Variable			0
1053	Riverbank	Area A		DEW-A1, -A2, -A3	3
1055	Riverbank	Area A		DEW-A4, -A5	2
1056	Riverbank	Area B, C	496, 498	335A, 497, 499, DEW-C1-DEW-C5	10
1058	Riverbank	Sep Bldg			0
1068	Riverbank	Area E		482, DEW-E3, -E4, -E5	4
1079	Riverbank	Area D		DEW-D1, -D2, -D3	3
1105	Riverbank	N. of 9 CT, Area E	585, 586	514A, R12	4
1106	Riverbank	N. of CCU, Area G		512A, 513A	2
1107	Riverbank	Plat Flare, Area F		483A, 484A	2
1108	Riverbank	Coker, Area F		515	1
1054	Tank Farm	NE of Tank 406	328, 329, 470, 471, 482, 591, 592		7
1060	Tank Farm	E of Tank 775		R15	1
1076	Tank Farm	SE of Tank 401	124A, 126A, 196	R10	4
1166	Tank Farm	N of Tank 401	I-5, 537, 538, 552, 566, 570		6
1173	Tank Farm	775 tk	233A, 237A		2
1193	Tank Farm	E. of Tank 25	R18, 171A, 587, 588		4
Total					**165**

Notes:
[1]R03 feeds into multiple tanks (1074 and 1075).

Figures



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LEGEND

- LOCATION OF NON-PROGRAM MONITORING WELL
- LOCATION OF GAUGING PROGRAM MONITORING WELL
- LOCATION OF POINT OF COMPLIANCE (POC) WELL
- LOCATION OF PLUGGED MONITORING WELL
- LOCATION OF LAND TREATMENT UNIT (LTU) CLOSED
- LOCATION OF NON-WASTE AREA IN LTU

HOLLYFRONTIER

EQUUS Environmental, LLC
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Tulsa, Oklahoma 74136-5065
918.921.5331
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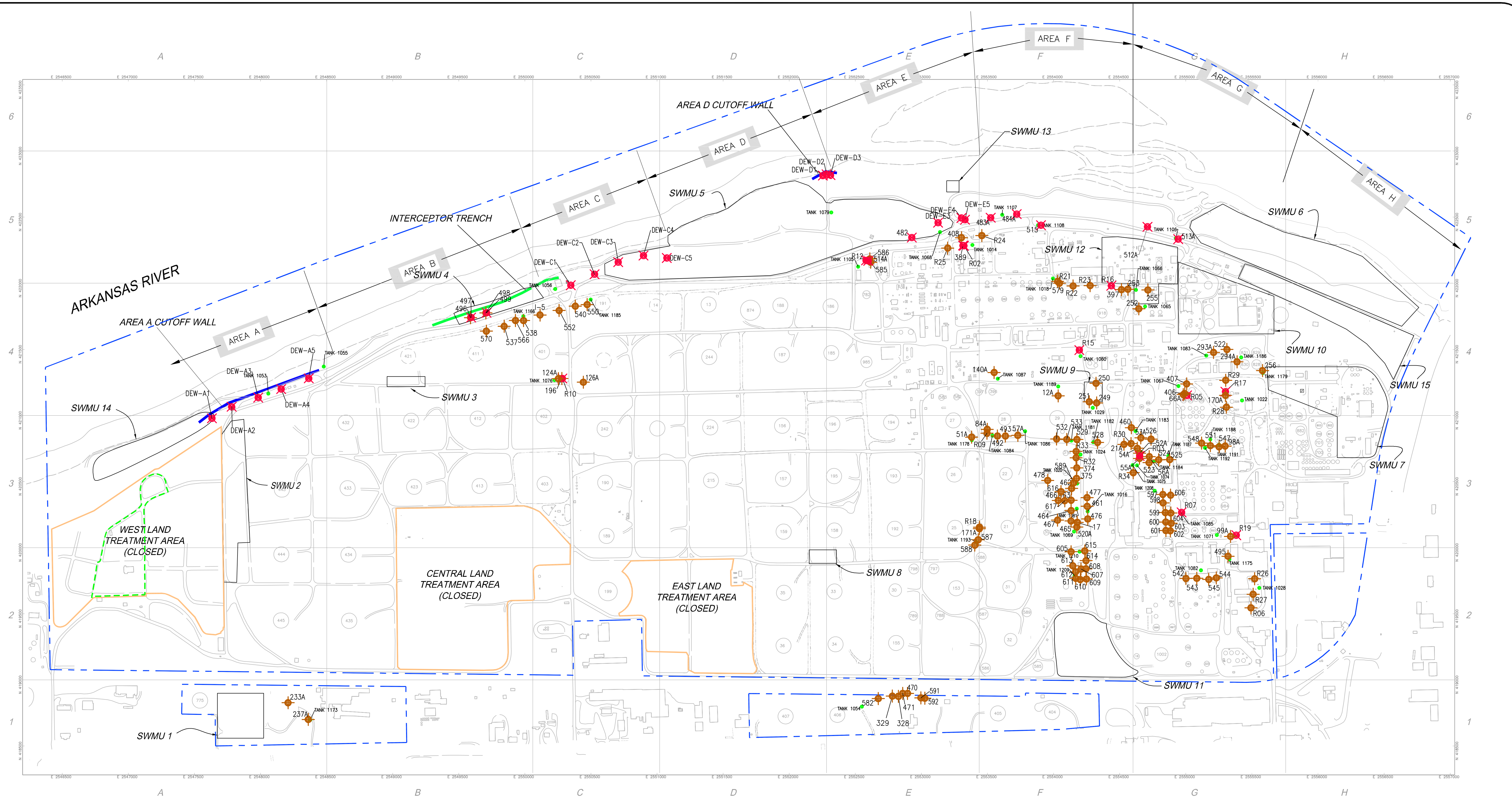
DOCUMENT TITLE	TULSA WEST REFINERY PERMIT NO. 058078775-PC
FIGURE TITLE	*FACILITY BASE MAP*
CLIENT	HOLLYFRONTIER TULSA REFINING LLC TULSA, OKLAHOMA
LOCATION	HFTR-TULSA WEST REFINERY 1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA
DESIGNED BY	CNA
APPROVED BY	CNA\BEM
DRAWN BY	SKG
SCALE	1"=750'
DATE	11/28/2018
PROJECT NUMBER	HFTRWEST:H18009
FIGURE NUMBER	8-1



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LEGEND

- LOCATION OF LNAPL PHASE EXTRACTION WELL
- LOCATION OF DUAL PHASE EXTRACTION WELL
- TANK 1055 LOCATION OF LNAPL RECOVERY TANK
- LOCATION OF LAND TREATMENT UNIT (LTU) CLOSED
- LOCATION OF NON-WASTE AREA IN LTU

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DOCUMENT TITLE	TULSA WEST REFINERY PERMIT NO. 058078775-PC	FIGURE TITLE	LNAPL RECOVERY SYSTEMS DECEMBER 2018	
CLIENT	HOLLYFRONTIER TULSA REFINING LLC TULSA, OKLAHOMA	DESIGNED BY: CNA	PROJECT NUMBER	FIGURE NUMBER
LOCATION	HFTR-TULSA WEST REFINERY 1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA	APPROVED BY: CNA\BEM; DRAWN BY: SKG; SCALE: 1" = 750'; DATE: 11/28/2018	HFTRWEST:H18009	8-2

COMPARATIVE CORRECTED GROUNDWATER ELEVATIONS, FEET AMSL		
WELL	*OCTOBER 2017*	*APRIL 2018*
503	621.04	620.65
11A	626.23	625.00
319A	629.64	629.51

ARKANSAS RIVER

WEST LAND TREATMENT AREA (CLOSED)

CENTRAL LAND TREATMENT AREA (CLOSED)

EAST LAND TREATMENT AREA (CLOSED)

LEGEND

- LOCATION OF GAUGING PROGRAM MONITORING WELL
- LOCATION OF POINT OF COMPLIANCE (POC) WELL
- LNAPL 0.00 TO 0.20 FEET IN THICKNESS
- LNAPL 0.21 TO 0.40 FEET IN THICKNESS
- LNAPL 0.41 TO 0.60 FEET IN THICKNESS
- LOCATION OF LAND TREATMENT UNIT (LTU) CLOSED
- LOCATION OF NON-WASTE AREA IN LTU

NOTE: FIGURE REPRODUCED USING ENVIRO CLEAN SERVICES, LLC DATA COLLECTED DURING APRIL 2018 SEMI-ANNUAL EVENT.

HOLLYFRONTIER

375 0 375 750
SCALE FEET

N

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DOCUMENT TITLE
TULSA WEST REFINERY
PERMIT NO. 05878775-PC

FIGURE TITLE
CORRECTED LNAPL THICKNESS APRIL 2018, BAILDOWN METHOD

CLIENT HOLLYFRONTIER TULSA REFINING LLC
TULSA, OKLAHOMA

LOCATION HFTR-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DESIGNED BY	CNA		
APPROVED BY	CNA\BEM	SCALE	1"=750'
DRAWN BY	SKG	DATE	11/28/2018

PROJECT NUMBER	FIGURE NUMBER
HFTRWEST:H18009	8-3

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E	ND
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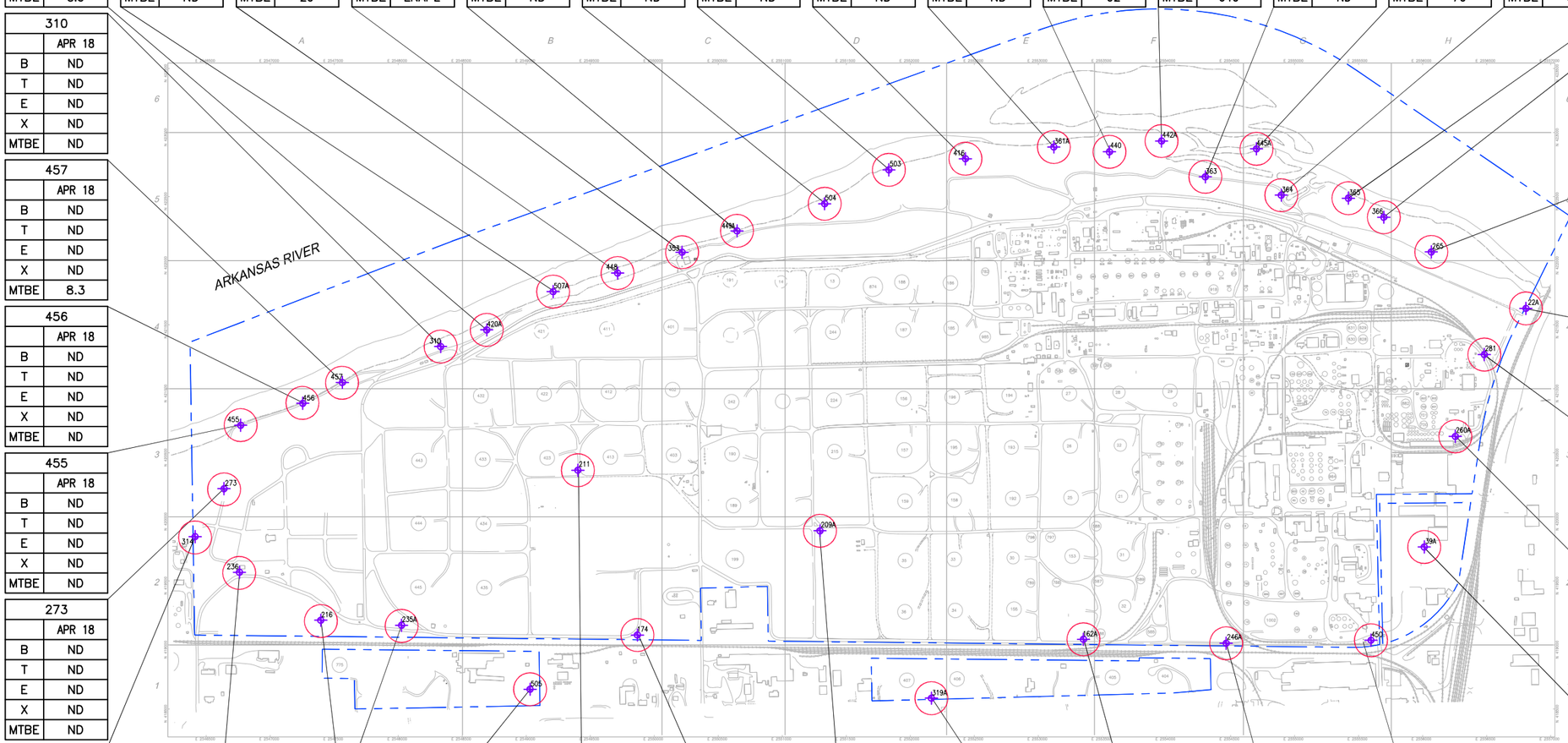

LEGEND

LOCATION OF POINT OF COMPLIANCE (POC) WELL

ND = Not Detected above the practical quantification limit

NS = Well not sampled for this parameter during sampling event

LNAPL = LNAPL encountered. Groundwater sample unable to be collected.

HOLLYFRONTIER

NOTE: FIGURE REPRODUCED USING ENVIRO CLEAN SERVICES, LLC DATA COLLECTED DURING APRIL 2018 SEMI-ANNUAL EVENT.

500 0 500 1,000
SCALE FEET

N

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DOCUMENT TITLE
TULSA WEST REFINERY
PERMIT NO. 05878775-PC

FIGURE TITLE
BTEX AND MTBE CONCENTRATIONS IN GROUNDWATER, APRIL 2018

CLIENT HOLLYFRONTIER TULSA REFINING LLC
TULSA, OKLAHOMA

LOCATION HFTR-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DESIGNED BY	CNA		
APPROVED BY	CNA\BEM	SCALE	1"=750'
DRAWN BY	SKG	DATE	11/28/2018

PROJECT NUMBER	FIGURE NUMBER
HFTRWEST:H18009	**8-4**

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Appendices

8.1. Sampling and Analysis Plan and Quality Assurance Project Plan

APPENDIX 8.1 – SAMPLING ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

HOLLYFRONTIER TULSA REFINING LLC
TULSA WEST REFINERY

APPENDIX 8.1
SAMPLING AND ANALYSIS PLAN AND QUALITY ASSURANCE PROJECT PLAN

TABLE OF CONTENTS

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LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICIES

LIST OF ACRONYMS

CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COC	Chemical(s) of Concern
CPE	Corrected Potentiometric Elevation
CSM	Conceptual Site Model
DO	Dissolved Oxygen
DOT	Department of Transportation
DQO	Data Quality Objectives
FID	Flame Ionization Detector
FOC	Field Operations Coordinator
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/ Mass Spectrometer
GD	Groundwater depth
GFAA	Graphite Furnace Atomic Absorption
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HFC	HollyFrontier Corporation
HFTR	HollyFrontier Tulsa Refining LLC
HFTR-W	HollyFrontier Tulsa Refining LLC, Tulsa West Refinery
Holly	Holly Refining and Marketing
ICP	Inductively Coupled Plasma
ICPMS	Inductively Coupled Plasma Mass Spectrometry
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management System
LNAPL	Light non-aqueous phase liquids
LT	LNAPL Thickness
LTU	Land Treatment Unit
MS/MSD	Matrix Spike/ Matrix Spike Duplicate
ODEQ	Oklahoma Department of Environmental Quality
OK	Oklahoma
OSHA	Occupational Safety and Health Administration
PARCC	Precision, Accuracy, Representativeness, Comparability, Completeness
PD	Product depth
PID	Photoionization Detector
PM	Project Manager
POC	Point of Compliance
QA	Quality Assurance
QAM	Quality Assurance Manual
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QC	Quality Control
QCI	Quality Control Indicators
RCRA	Resource Conservation and Recovery Act
RPD	Relative Percent Difference
RSD	Relative Standard Deviations

SIN	Sample Identification Number
SAP	Sampling and Analysis Plan
SAP-QAPP	Sampling and Analysis Plan and Quality Assurance Project Plan
SG	Specific gravity
SMR	Semi-annual Monitoring Report
SOP	Standard Operating Procedure
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
WWTP	Waste Water Treatment Plant

1 PROJECT MANAGEMENT

1.1 Project Organization and Responsibilities

This Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) has been prepared to identify the scope, procedures and Quality Assurance/Quality Control (QA/QC) protocols for the collection of supporting data for the semi-annual groundwater sampling and monitoring program occurring at the HollyFrontier Tulsa Refining LLC (HFTR), Tulsa West (HFTR-W) Refinery (the Refinery), in Tulsa, Oklahoma (OK). The semi-annual sampling activities include collection of groundwater samples from a select list of point of compliance (POC) wells and the collection of groundwater and light non-aqueous phase liquid (LNAPL) levels from the gauging monitoring well network. The scope of the monitoring program is presented in the Resource Conservation and Recovery Act (RCRA) Corrective Action and Post-Closure Care permit application, Section 8 *Groundwater Monitoring and LNAPL Management Plan* (December 2018).

HFTR's environmental consultant will be responsible for performing, or providing oversight of subcontractors completing the field investigations, preparing required reports, and performing any subsequent work required to complete the semi-annual groundwater sampling. The Oklahoma Department of Environmental Quality (ODEQ) is responsible for review and approval of this combined SAP and QAPP (hereafter referenced as SAP-QAPP). The various quality assurance and management responsibilities of key project personnel are defined below.

1.1.1 Management Responsibilities

RCRA Permit & Project Manager, Oklahoma Department of Environmental Quality

The ODEQ appointed RCRA Permit and Project Manager(s)(PM) is/are responsible for oversight of RCRA permitting and compliance pertaining to the Refinery. The ODEQ will provide review and approval of HFTR-W RCRA permit-related reports and other relevant documents.

Arsin Sahba, PG, HollyFrontier Corporation (HFC) Environmental Specialist – Remediation

Mr. Sahba (or a designated representative), has final responsibility for environmental related issues at the Refinery. Mr. Sahba provides overall direction for this project to the Refinery environmental remediation staff. Mr. Sahba serves as one of the primary communication links between the ODEQ and HFTR for this project.

Environmental Consultant Project Manager

The Consultant PM (or equivalent staff) will be involved in the planning and implementation of the semi-annual sampling events, and the evaluation of the resultant data. The Consultant PM is responsible for meeting technical, financial, and scheduling objectives for the project and is the primary communication link between HFTR, any subcontractors, and the laboratory. The Consultant PM will be involved in planning meetings and project update meetings and will provide senior

technical quality control and project oversight. Duties and responsibilities of the Consultant PM include the following:

1. Administrate and supervise all phases of the project;
2. Ensure project objectives are met within financial and time constraints;
3. Provide technical support to project team;
4. Work with the Consultant quality assurance officer (QAO) and field personnel to plan and conduct project operations, progress meetings, etc.;
5. Review reports and other work products prior to their issuance; and
6. Participate in project meetings held with HFTR and the ODEQ.

1.1.2 Quality Assurance Responsibilities

Environmental Consultant Quality Assurance Officer

The Consultant QAO will be responsible for enforcing the provisions of the SAP-QAPP and will remain independent of direct job involvement and day-to-day operations. Specific functions and duties will be to:

1. Establish QA/QC procedures for the project;
2. Evaluate data quality and maintain QC records;
3. Provide the final quality control review of analytical data;
4. Provide a communication link between project personnel and the laboratory; and
5. Revise work practices or identified procedural deviations to align work with approved SAP-QAPP procedures and guidelines.

1.1.3 Field Responsibilities

Environmental Consultant Field Operations Coordinator

The Consultant Field Operations Coordinator (FOC) will be responsible for overseeing the day-to-day conduct of project activities. Duties and responsibilities of the FOC will be to:

1. Ensure the sampling activities are conducted in a manner that follows the procedures outlined in this plan and the health and safety plan;
2. Coordinate the sampling activities with the Consultant QAO and field personnel;
3. Oversee the use, maintenance and operation of sampling equipment; and
4. Report daily activities, problems, etc. to the Consultant QAO.

The FOC will be in daily communication with field support personnel and may conduct field audits over the duration of the project.

Field personnel from the Environmental Consultant and/or subcontracted services and labor will be used to complete the semi-annual groundwater sampling events.

1.1.4 Laboratory Responsibilities

The laboratory will have its own project organization with responsibilities similar to that of the field operations personnel. A HFTR-contracted laboratory will be used to support the semi-annual groundwater sampling and analysis work.

Copies of applicable laboratory standard operating procedures (SOPs) for laboratory analyses will be supplied by the contracted laboratory selected to perform the work.

Laboratory Director

The Laboratory Director will be primarily responsible for the overall operation of the laboratory including all samples analyzed and data reported. The Laboratory Director will provide final review of all data packages before reporting results and will be responsible for initiating corrective action measures when analytical data do not meet the requirements of this plan or the laboratory's Quality Assurance Manual (QAM).

Laboratory Project Manager

The Laboratory PM will be the primary communications link between the laboratory and the Environmental Consultant's QAO/PM. The Laboratory PM will be responsible for relating any special needs of the field operations personnel to the laboratory. The Laboratory PM will also provide the final review of all data deliverables, ensuring they meet the requirements of this SAP-QAPP, before reporting results.

Laboratory Quality Assurance Officer

The Laboratory QAO will be primarily responsible for implementing the laboratory's QAM within the laboratory, and monitoring compliance with the laboratory's QAM. The Laboratory QAO's duties will also include: conducting laboratory audits, reviewing all QC data, and reporting problems to the Laboratory Director for corrective action.

1.1.5 Special Training Requirements / Certifications

All project personnel must be qualified and trained in the project tasks for which they are responsible.

1.1.5.1 Field Personnel

It is not anticipated that the completion of this project will require any uniquely trained personnel. However, all field personnel must complete the mandatory site-specific safety classes required by HFTR. If specialized training is required for any portions of the project, training will be provided by a qualified trainer and the date and type of training will be documented. The site-specific Health and Safety Plan (HASP) specifies the training necessary for compliance with the

Occupational Safety and Health Administration (OSHA) requirements. All field personnel will have completed OSHA 40-hour and annual 8-hour refresher Hazardous Waste Operations and Emergency Response (HAZWOPER) standard training, as required for personnel potentially exposed to hazardous substances, as specified by Title 29 Part 1910.120 of the Code of Federal Regulations (29 CFR 1910.120). If hazardous materials are moved off-site, compliance with the Department of Transportation (DOT) training requirements for shipping hazardous materials may be required.

1.1.5.2 Laboratory Personnel

Every employee has direct access to the QAM and training is provided in order to help each employee apply the QAM to his or her specific responsibilities. Records of relevant qualifications, training, skills and experience of the technical personnel are maintained by the laboratory.

Analysts that operate Graphite Furnace Atomic Absorption (GFAA), Inductively Coupled Plasma (ICP), Inductively Coupled Plasma Mass Spectrometry (ICPMS), Gas Chromatography (GC), or Gas Chromatography Mass Spectrometry (GC/MS) equipment must satisfactorily complete a short course offered by an equipment manufacturer, professional organization, university, or other qualified training facility (formal in-house training is acceptable). A minimum experience requirement for the operation of GFAA, ICP, ICPMS, GC, and GCMS equipment is one (1) year.

1.2 Refinery Background Information

The Refinery has been in operation since 1913 as a petroleum products refinery. The Refinery processes approximately 90,000 barrels a day of crude oil into fuels and more than 400 lubricant products, waxes, and aromatic oils. The Refinery occupies approximately 850 acres and includes petroleum products processing areas, raw and bulk products storage, historical and current waste treatment areas, and other operations and storage areas.

The Refinery has been owned and operated by a number of companies throughout its history. Through various acquisitions in the Refinery's first few decades of operation, the Refinery was eventually acquired by the Sunray DX Oil Company. In 1968, Sunray DX Oil Company merged with Sunoco, Inc. (Sunoco) and the Refinery became the Sunoco Tulsa Refinery. On June 1, 2009, Holly Refining and Marketing (Holly) purchased the Refinery from Sunoco. On January 1, 2016, Holly's legal name was changed to HollyFrontier Tulsa Refining LLC (HFTR), and HFTR is the current owner and operator of the Refinery.

An HFTR-W base map showing pertinent Refinery features including the land treatment units (LTUs), monitoring well gauging network, and POC wells are presented on Figure 8.A-1.

1.3 Project Description and Schedule

The *Groundwater Monitoring and LNAPL Management Plan* summarizes the monitoring requirements for HFTR-W. As part of the RCRA permit, HFTR is required to conduct groundwater and LNAPL fluid level gauging, groundwater sampling, and to submit Semi-annual Monitoring Reports (SMRs) summarizing the results obtained from monitoring. The semi-annual groundwater

sampling schedule is provided below. Task details, chemicals of concern (COC) lists, wells to be gauged and sampled, base maps showing the locations of monitoring wells, Refinery-wide gauging well network, LTUs, LNAPL recovery systems, and other pertinent site features are provided in the *Groundwater Monitoring and LNAPL Management Plan*.

HFTR-W Requirements

Task	Purpose	Frequency	Schedule	Compliance Deadline
Refinery-wide monitoring well gauging	Evaluate LNAPL apparent thickness, groundwater elevations and flow patterns	Semi-Annually	During April and October sampling events, each year	Well gauging data due 45 days from completion of the sampling event. SMRs due by February 15 and August 15, annually.
POC well sampling	Evaluate dissolved phase plume condition and stability; and identify potential off-site/upgradient sources impacting HFTR-W (or LTUs)	Semi-Annually	During April and October, each year (Upgradient POC wells only sampled once each year in April)	Analytical data due 45 days from completion of the sampling event. SMRs due by February 15 and August 15, annually.
LTU inspections and maintenance	Post-closure care, maintain integrity of closed LTUs to mitigate environmental impacts	Semi-Annually; after significant storm events; and as warranted by site conditions	In conjunction with April and October sampling events, each year	SMRs due by February 15 and August 15, annually.

Note: The semi-annual monitoring reports are due to the ODEQ on or before February 15 and August 15 of each calendar year.

1.4 Data Quality Objectives

1.4.1 Project Quality Objectives

The Data Quality Objectives (DQO) process is a mechanism to translate general project goals into specific tasks, which are conducted to produce data needed to support decision making for the project. The DQO process typically comprises a seven-step process. The first step is to develop a Conceptual Site Model (CSM) to provide an understanding of the Site based on available data, such as analytical results, historic use, exposure pathways, cleanup concerns, and future land use. The model is refined as additional data are added. With a well-defined CSM, the goals of the investigation are translated into qualitative and quantitative statements that define the type of data needed. These data needs include the number and type of samples to be collected, analytical detection limits, and certainty. Based on the outputs of the DQO process, a detailed work plan can be prepared.

The following provides the general DQO steps that will be involved for the collection of semi-annual monitoring data.

1.4.1.1 Stating the Problem

Routine groundwater sampling is required to monitor the conditions of the dissolved phase and LNAPL plumes in the subsurface, and the potential effects of such conditions on human health and the environment, as set forth in the applicable RCRA permit(s).

The purpose of this SAP-QAPP is to document groundwater sample collection methodologies, laboratory analytical methods, data evaluation methodologies and procedures, and resultant changes in sampling protocol for the semi-annual groundwater sampling events at HFTR-W. These data will be used to evaluate current conditions of groundwater and LNAPL in support of remedial strategy development, evaluation of remedial progress, and compliance with post-closure care and corrective action requirements set forth in the effective RCRA permit.

1.4.1.2 Identifying the Decision

Data collected during routine groundwater monitoring will be used to determine the following:

1. What is the current groundwater elevation, flow direction and estimated hydraulic gradient? Is this consistent with historical groundwater flow patterns?
2. Have the COC concentrations increased or decreased along the POC well network since the last monitoring period(s)?
3. Are COCs migrating?
4. Do the dissolved phase plumes and/or LNAPL plumes appear to be migrating, expanding or shrinking?
5. Are any new compounds exhibited in groundwater analytical results not generally detected in historic data?
6. What is the current estimated LNAPL footprint(s) and thickness(es)?
7. Do(es) the LNAPL plume(s) appear to be expanding, shrinking or stable compared to the previous reporting period(s)?
8. Do groundwater quality parameters suggest an environment conducive to natural attenuation of COCs?
9. Are changes to the POC monitoring network and/or the well gauging network warranted to fill data gaps or eliminate redundancies?
10. Are additional groundwater quality, chemical or geochemical parameters necessary to further evaluate plume effects, natural attenuation characteristics, and/or potential remedies?
11. Do the results of the groundwater sampling event validate the current CSM?
12. Is the Refinery in compliance with the effective RCRA Permit(s)?

13. Are additional investigations or actions warranted based on the findings to the above items 1 through 14?

1.4.1.3 Identifying Inputs to the Decision

Groundwater samples will be collected and analyzed, and wells will be gauged in order to support the decision and answer the questions posed in DQO step 2. The decision inputs include:

1. Spatial and temporal variation in groundwater COC data under current conditions;
2. Spatial and temporal variation of LNAPL;
3. Spatial and temporal variation in groundwater level data;
4. Spatial and temporal variation in groundwater gradients;
5. Spatial and temporal variation in water quality parameter data, including, at a minimum, pH, temperature, specific conductivity, turbidity, and DO.

1.4.1.4 Defining the Boundaries of the Study

The boundary of the study refers to both the spatial and temporal boundaries. The boundaries are defined to ensure that samples are representative of the area for which decisions will be made. Practical constraints on data collection need to be recognized. These constraints include meteorological conditions that would preclude sampling; inability to secure necessary access agreements; or the unavailability of personnel, time, or equipment.

The groundwater monitoring protocol includes wells located on HFTR property.

1.4.1.5 Developing a Decision Rule

A decision rule usually compares an output parameter to an action level, which then is used to determine course of action for the Site. A series of "*if…then*" statements has been developed to define the conditions that assist in choosing courses of action.

Based on analytical results obtained from previous groundwater samples, the following "*if…then*" statements will be applied to the data obtained during each groundwater sampling event:

- *If* analytical results demonstrate COC concentrations greater than applicable groundwater screening levels at POC wells, select wells may be re-sampled and/or additional investigation or remedial measures may be implemented.
- *If* analytical results demonstrate increasing COC concentrations in upgradient POC wells, additional investigations may be implemented to assess potential new release(s) from on- or off-site sources.
- *If* data gaps or redundancies are identified, additional monitoring wells may be installed and sampled, or select wells may be recommended to be eliminated from the monitoring or sampling plans.

- *If* evaluations of the dissolved phase and/or LNAPL plume(s) indicate plume expansion, mobility or migration, additional investigation or remedial measures or modifications to any existing corrective action may be implemented.

1.4.1.6 Specifying Limits on Decision Errors

The monitoring well spacing and placement have been developed, in part, from current groundwater COC concentrations and predominant groundwater flow directions. The number of POC and gauging program wells were also determined with respect to the ODEQ requirements.

Sampling may not capture all the variations in concentrations and analyses can only estimate the "true" value. Sampling "error" occurs when the sampling scheme does not adequately detect the variability in the amount of contaminant in the environmental matrix from point to point across the Site. The potential for these errors may be reduced by implementing the DQO process when outlining the monitoring plan.

Data may also be questionable due to measurement errors. Measurement errors can happen during sample collection, handling, preparation, analysis, data reduction, or data handling. There may be corrective steps that can be taken or additional qualifying information that can be collected that will allow for the full or limited use of the data. Corrective actions are discussed in Section 2.6.4 of this document.

1.4.1.7 Optimizing the Design

The purpose of this step is to identify the most resource-effective sampling design that generates data to satisfy the DQOs specified in the preceding steps. The sampling and analysis program designed for this project was developed by considering overall cost and ability to meet the previously defined DQOs.

1.5 Quality Assurance Objectives for Measurement Data

The overall QA objective for each project is to develop and implement procedures for field sampling, Chain-of-Custody, laboratory analysis, and reporting that will provide legally defensible results. Specific procedures for sampling, Chain-of-Custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this SAP-QAPP.

Data quality objectives for measurements collected during the semi-annual sampling events will be addressed in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. The collection of data used in this project will require that the sampling and testing be performed using standard methods, with properly operated and calibrated equipment, and conducted by trained personnel.

The following sections provide detailed discussion of PARCC elements.

1.5.1 PARCC Element – Precision

1.5.1.1 Definition

Precision is a measure of the mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. The overall precision of measurement data is a mixture of sampling and analytical factors. Precision is evaluated through field and laboratory duplicate samples. The precision of analytical data can be evaluated by calculating the relative percent difference (RPD) between duplicate samples. The RPD is calculated according to the following formula:

$$RPD = \frac{|C_1 - C_2|}{0.5 * (C_1 + C_2)} * 100$$

Where:
C_1 = the first sample value and
C_2 = the duplicate sample value

1.5.1.2 Field Precision Objectives

Field precision will be assessed through the collection and measurement of field duplicates for groundwater samples. Field duplicate samples will be collected at a rate of one duplicate per twenty (20) investigative samples. Field duplicate RPDs must be $\leq$ 30 percent for aqueous samples if one or both results are greater than five times the quantitation limit, otherwise results must be within +/- the absolute difference of the quantitation limit.

1.5.1.3 Laboratory Precision Objectives

Precision in the laboratory is assessed through calculation of the RPD for duplicate and spike duplicate samples, and by calculation of relative standard deviations (RSD) if three or more replicate samples are analyzed. Precision control limits for the subcontracted analytical laboratory will be provided in laboratory SOPs to be supplied by the contracted laboratory selected to perform the work.

1.5.2 PARCC Element - Accuracy

1.5.2.1 Definition

Accuracy is the degree of agreement between an observed value and an accepted reference or true value.

1.5.2.2 Field Accuracy Objectives

Accuracy in the field is assessed using field and trip blanks and through the adherence to all sample handling, preservation, and holding times. A trip blank will consist of a laboratory-prepared sample of deionized water. Trip blanks will accompany sample shipments which contain samples requiring volatile organic compound (VOC) analysis and will be subjected to the same procedures as the investigative samples. Trip blanks are only required when VOCs will be analyzed. Trip blanks

will be submitted for analysis at the rate of one trip blank per shipping container containing samples for VOC analyses.

Field blanks (equipment blanks) will be collected by pouring laboratory-prepared deionized water or distilled water over or through the sampling equipment and collecting the rinsate in the proper analytical containers. Field blanks are required at a rate of one per 20 investigative samples when non-dedicated equipment is used in sampling procedures.

1.5.2.3 Laboratory Accuracy Objectives

Laboratory accuracy shall be assessed by the preparation and analysis of method blank analyses for each analytical sequence. Laboratory accuracy is also assessed through the analysis of Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples, laboratory control samples (LCSs) and surrogate compounds, and the determination of percent recoveries. Enough sample containers will be provided to allow for the collection of one MS and MSD sample per 20 samples collected. Accuracy control limits will be provided in laboratory SOPs to be supplied by the contracted laboratory selected to perform the work.

In order to assure the accuracy of the analytical procedures, one environmental sample will be collected for every 20 primary samples, and designated as the MS/MSD sample. The increase in concentration of the analyte will be observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample to determine the percent recovery. Daily control charts will be plotted for each commonly analyzed compound and maintained on instrument-specific, matrix-specific, and analyte-specific bases.

Percent recovery for MS/MSD results is determined according to the following equation:

$$\%R = \frac{(\text{Spiked Sample Conc.} - \text{Sample Conc.})}{\text{Known Conc. Added}} \times 100$$

Percent recovery for LCS and surrogate compound results is determined according to the following equation:

$$\%R = \frac{\text{Experimental Conc.}}{\text{Known Amount Added}} \times 100$$

Additional information on laboratory accuracy will be provided in the method specific SOPs to be supplied by the contracted laboratory selected to perform the work.

1.5.3 PARCC Element - Completeness

1.5.3.1 Definition

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected under normal conditions.

1.5.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid measurements obtained from all the measurements taken during the project. Field completeness objective for this project will be greater than ninety percent.

1.5.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid measurements obtained from all the measurements taken during the project. Laboratory completeness for this project will be greater than ninety percent.

Completeness is the ratio of the number of valid sample results to the total number of samples analyzed with a specific matrix and/or analysis. Following completion of the analytical testing, the percent completeness will be calculated by the following equation:

$$\text{Completeness} = \frac{\text{Number of Valid Measurements}}{\text{Number of Measurements Planned}} \text{ x } 100$$

1.5.4 PARCC Element - Representativeness

1.5.4.1 Definition

Representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary.

1.5.4.2 Measures to Ensure Representativeness of Field Data

Representativeness will be achieved by insuring that sampling locations are properly selected and that a sufficient number of samples are collected. Representativeness is dependent upon the proper design of the sampling program and will be accomplished by ensuring that this SAP-QAPP and all relevant SOPs are followed. The QA goal will be to have samples and measurements representative of the media sampled. Field testing for pH, temperature, specific conductivity, DO and turbidity stabilization prior to groundwater sampling will help ensure that representative samples are collected.

1.5.4.3 Measures to Ensure Representativeness of Laboratory Data

Using the proper analytical procedures, appropriate methods, meeting sample holding times and analyzing and assessing field duplicate samples, ensures representativeness in the laboratory.

1.5.5 PARCC Element - Comparability

1.5.5.1 Definition

Comparability is an expression of the confidence with which one data set can be compared with another. Comparability is also dependent on similar QA objectives.

1.5.5.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that this SAP-QAPP is followed and that proper sampling techniques are used.

1.5.5.3 Measures to Ensure Comparability of Laboratory Data

Planned analytical data will be comparable when similar sampling and analytical methods are used and documented in the SAP-QAPP. Comparability is also dependent on similar QA objectives.

1.6 Documentation and Reporting

Data collected in support of on-going dissolved phase plume assessment and LNAPL containment evaluation will be submitted to the ODEQ semi-annually and will, at a minimum, include:

1. Text describing sampling and analysis activities (focusing on deviations from the GWMP and SAP-QAPP); regulated units; LNAPL recovery activities; and groundwater and LNAPL monitoring data;
2. Figures showing property location, property boundaries, sampling and gauging locations;
3. Tables or Figures summarizing groundwater and LNAPL gauging data;
4. Potentiometric surface maps based on the gauging event data;
5. Tables summarizing analytical results;
6. Parameter concentration maps;
7. Summary of hydrocarbon (LNAPL) recovery system performance;
8. A summary of findings and recommendations for future activities;
9. Complete laboratory data reports;
10. Other relevant materials required to support the DQO objectives; and
11. A bibliography of references and appendices of supporting documents.

HFTR may perform statistical analysis of groundwater data to determine compliance with the risk-based screening levels (RBSLs) (pending approval by ODEQ) as follows:

1. Direct comparison of the value of each constituent to its RBSL; or,
2. The Confidence Interval Procedure for the mean concentration based on a normal, log-normal, or non-parametric distribution. The 95 percent confidence coefficient of the t-distribution will be used in constructing the confidence interval (Chapter 21 of Statistical Analysis of Groundwater Data at RCRA Facilities-Unified Guidance, U.S. EPA, March 2009), and subsequent updates acceptable to the Executive Director. The confidence interval upper limit for each constituent shall be compared with the corresponding RBSL. To be considered in compliance, the confidence interval upper limit for a well in question

must not exceed the RBSLs. A confidence interval upper limit above the RBSLs shall be considered as evidence of statistically significant contamination; or,

3. An alternative statistical method proposed by the HFTR and approved by the ODEQ. Any proposed alternative method must be appropriate with respect to distributional assumptions and must provide reasonable control of both false positive and false negative error rates.

All records generated during these investigations will be kept on file by the Environmental Consultant. These records will be considered part of the Refinery remediation files and will at a minimum include: field logbooks; field data and data deliverables; photographs; drawings; soil boring logs; laboratory data deliverables; data validation reports; data assessment reports; progress reports, QA reports; project reports, etc.; and all custody documentation (tags, forms, airbills, etc.). Refinery remediation files are discussed in detail in Section 2.3.8.8 of this SAP-QAPP.

2 FIELD SAMPLING AND ANALYSIS PLAN

2.1 Sampling Process and Design

The purpose of this section is to describe the general sampling procedures that will be used during this project. The current Environmental Consultant's SOPs that are likely to be employed in the course of this project have been included in Appendix A. Additional SOPs will be included on an as needed basis. Sampling efforts will be uniform and follow the SAP-QAPP and SOPs to ensure the quality of the data collected.

The groundwater sampling plan for HFTR-W consists of the following tasks:

1. Semi-annual gauging of Refinery-wide monitoring well network and POC wells (collectively known as Program Wells);
2. Semi-annual sampling of downgradient POC boundary wells;
3. Annual sampling of POC upgradient wells;
4. SMRs summarizing groundwater monitoring results and LNAPL recovery system operations, including modifications to the SAP-QAPP or LNAPL system operations.

Primary COCs are listed on Table 8-1 of the *Groundwater Monitoring and LNAPL Management Plan*. QA/QC samples will be submitted in accordance with the protocols presented in the following sections of this QAPP. Requirements for QA/QC samples are identified in Sections 2.3 and 2.4.

2.2 Task 1 – Groundwater and LNAPL Gauging

The purpose of this section is to describe the methods and procedures that will be used during semi-annual groundwater and LNAPL gauging events. Groundwater and LNAPL levels and LNAPL thickness measurements will be collected as described in Section 2.2.1. The purpose of a semi-

annual gauging event is to assess current horizontal groundwater flow and LNAPL plume characteristics.

2.2.1 Groundwater Level and LNAPL Measurements

Groundwater and LNAPL level and LNAPL thickness measurements will be collected using manual methods.

2.2.1.1 Measurement Locations and Frequency

Groundwater and LNAPL level and LNAPL thickness measurements will be collected from the Refinery-wide gauging program wells on a semi-annual basis. The complete list of wells to be gauged during each semi-annual event is presented in Table 8-3 of the *Groundwater Monitoring and LNAPL Management Plan*.

2.2.1.2 Equipment and Procedures

In general, manual groundwater and LNAPL level and LNAPL thickness measurements will be collected using an electronic water level indicator and an oil-water interface probe. Each measurement shall be taken to the nearest hundredth of one foot from the reference point of each well. The reference point, unless otherwise marked, shall be the north side of the top of the well casing (i.e., riser). A detailed description of the procedures for water level measurements is included in SOP-009.

For wells in which LNAPL is detected, measured LNAPL thickness (LT) will be recorded via measurements of product depth (PD) and groundwater depth (GD); LT will then be calculated as:

$$LT\ (measured) = GD - PD$$

To correct groundwater elevations for wells in which LNAPL is detected, the following formula shall be used:

$$CPE = Well\ Datum - GD + (LT \times SG)$$

Where:

CPE = Corrected Potentiometric Elevation

GD = Groundwater Depth (measured)

LT = LNAPL Thickness (measured)

SG = Specific Gravity of the LNAPL

Historical LNAPL specific gravity measurements shall be used to best approximate the specific gravity of LNAPL in individual wells, as outlined in the *Groundwater Monitoring and LNAPL Management Plan*.

2.2.1.3 Documentation

Groundwater level and LNAPL level measurements will be recorded on the appropriate task-specific forms, where appropriate. These forms include site groundwater and LNAPL level measurement forms and groundwater sampling data sheets. Groundwater and LNAPL level data may also be recorded in the field notebooks.

2.2.1.4 Decontamination

The electronic water level indicator and oil-water interface probe will be decontaminated in accordance with SOP-001.

2.2.1.5 Investigative Derived Waste

All decontamination fluids will be processed through the on-site Waste Water Treatment Plant (WWTP) or disposed off-site in accordance with SOP-024.

2.3 Task 2 – Groundwater Sampling

2.3.1 General Sampling Requirements

The purpose of this section is to describe the general sampling procedures to be employed during semi-annual groundwater monitoring events. Contained in Appendix A are the current Environmental Consultant's SOPs relevant to the field activities described herein. The SOPs may be updated in the future without permit modification, to maintain most up-to-date sampling and field data collection methodologies. Sampling efforts will be uniform and follow the SAP-QAPP and SOPs to ensure the quality of the data collected. Routine groundwater monitoring includes laboratory analysis for site-specific COCs on Table 8-1 of the *Groundwater Monitoring and LNAPL Management Plan*, and field data acquisition of pH, temperature, specific conductivity, DO and turbidity.

2.3.2 Monitoring Wells Requiring Groundwater Sampling

During each semi-annual groundwater sampling event, all sampling program wells listed in Table 8-3 of the *Groundwater Monitoring and LNAPL Management Plan* will be gauged to evaluate groundwater and LNAPL elevations and apparent LNAPL thicknesses, as described in Section 2.2. Sampling program wells (POC wells) will then be sampled for target COCs listed on Table 8-1 of the *Groundwater Monitoring and LNAPL Management Plan*. Well location, designation and sampling frequency are listed on Table 8-2 of the *Groundwater Monitoring and LNAPL Management Plan*.

Low flow sampling techniques, as discussed in Section 2.3.5, will be used to collect the groundwater samples during each semi-annual sampling event. The groundwater sampling results will be used to evaluate current conditions of the dissolved phase plumes, maintain compliance with the RCRA permit and to evaluate the need for modifications to any corrective actions and/or sampling protocol.

Passive samplers may be evaluated for use in the future, pending comparability trials and ODEQ approval.

2.3.3 Laboratory Analysis

Environmental samples and QA/QC samples will be collected and submitted for laboratory analysis of the COCs listed in Table 8-1 of the *Groundwater Monitoring and LNAPL Management Plan.*

Table 1 provides a summary of practical quantitation limits (PQLs) and method detection limits (MDLs) for COCs. The laboratory SOPs, referenced on Table 1, are to be supplied by the contracted laboratory selected to perform the work. Information regarding the project target compounds and quantitation limits is provided in Table 1 and will be in accordance with the SW-846 Analytical Method. Sample QA/QC requirements are listed in Table 2.

Samples will be analyzed on standard turn-around times.

2.3.4 Sampling Equipment Preparation and Decontamination

Sampling equipment that is to be reused (e.g., submersible pumps) will be thoroughly decontaminated between sampling locations and at the beginning and end of each day. Decontamination will consist of washing equipment with mild, non-phosphate soap such as *Liquinox*, and thoroughly rinsing with distilled water. If complete cleaning of any piece of sampling equipment is not possible, then it will be discarded, and a clean article substituted. For non-dedicated electronic well purging equipment, non-phosphate soapy water will be run through the pump and hose (if reused) followed by a thorough rinsing with distilled water. For a more detailed explanation of decontamination procedures see SOP-001 (Appendix A).

2.3.5 Groundwater Sampling Methodology

Groundwater samples obtained during the semi-annual sampling events will be collected using low-flow sampling techniques in accordance with SOP-028 (Appendix A).

If passive samplers are proposed in the future, a comparability trial will be conducted, and the ODEQ approval sought prior to incorporation in this SAP-QAPP and the GWMP.

2.3.6 Sample Containers and Preservatives

Sample containers for environmental analysis will consist of certified laboratory supplied glass and plastic bottles. Table 3 lists the sample containers, preservatives, and holding times for COCs for the semi-annual sampling events. The subcontracted analytical laboratory will supply unpreserved and pre-preserved sample containers and VOC trip blanks as needed to complete the scope.

2.3.7 Sample Storage and Transportation

Field samples will be packaged and shipped according to SOP-019 (Appendix A). Coolers are the most common package or containment device used to ship samples. Coolers are also used during sampling efforts to store and transport samples prior to shipping. Samples will be placed in

an iced cooler immediately after collection. Any samples not placed on ice immediately upon collection will be discarded and a new sample will be collected.

2.3.8 Sample Handling and Custody Requirements

Custody is one of several factors that are necessary for the admissibility of environmental data as evidence in a court of law. Custody procedures help to satisfy the two major requirements for admissibility: relevance and authenticity. Sample custody is addressed in three parts: field sample collection, laboratory analysis, and final files. Refinery remediation files, including originals of all laboratory reports and purge files, are maintained under document control in a secure area.

A sample or file is under your custody if:

1. The item is in actual possession of a person;
2. The item is in view of the person after being in actual possession of the person;
3. The item was in actual physical possession but is locked up to prevent tampering; and/or,
4. The item is in a designated and identified secure area.

2.3.8.1 Chain-of-Custody Procedures

The Chain-of-Custody document records the history of the samples custody from acquisition to ultimate disposal. Samples collected may be used as legal evidence. As such, the hand-to-hand custody from the point of collection to delivery at the laboratory must be clearly documented. For more detailed information regarding Chain-of-Custody procedures refer to SOP-022 (Appendix A).

2.3.8.2 Field Custody Procedures

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the Chain-of-Custody intact. The protocol for specific sample numbering and other sample designations are included in Section 2.3.8.5 of this SAP-QAPP.

1. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. Field procedures have been designed to limit the handling of the samples to as few people as possible.
2. All bottles will be identified using sample labels with unique sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented in Section 2.3.8.5 of this SAP-QAPP.
3. Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the ballpoint pen may not function appropriately under certain freezing weather.
4. A properly completed Chain-of-Custody form will accompany all samples. The sample numbers will be listed on the Chain-of-Custody form. When transferring the possession

of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

5. Samples will be properly packaged and shipped according to procedures found in SOP-019 (Appendix A).

2.3.8.3 Sample Collection

Samples will be collected following SOP-028 provided in Appendix A of this SAP-QAPP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected (if applicable), and volume and number of containers.

2.3.8.4 Sample Labeling

All sample containers will be labeled at the time of sampling. Each label will be completed with the required information and then secured to the container to prevent accidental loss or damage from water or mishandling. Required information on the sample label includes: sample identification number, date, time, and requested analyses. Additionally, any preservatives or special handling instructions will be clearly displayed on the label and the Chain-of-Custody.

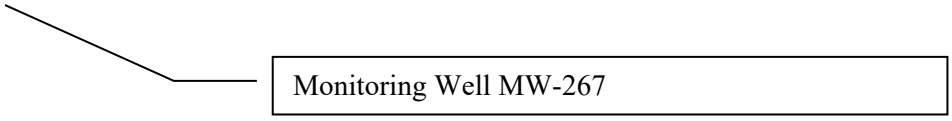
2.3.8.5 Sample Identification Numbers

A unique sample identification number (SIN) will identify each sample collected for chemical analyses. These SINs include several key pieces of information such as the well name, and the sampled depth interval (if applicable) or date sampled.

Groundwater Samples

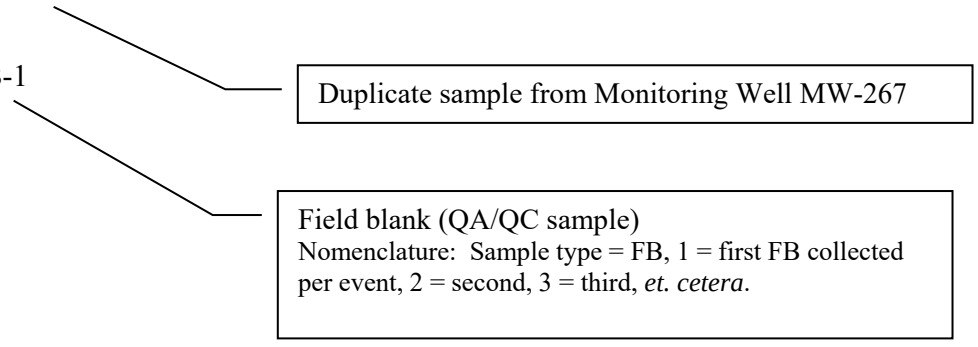
Some examples of nomenclature for water samples follow:

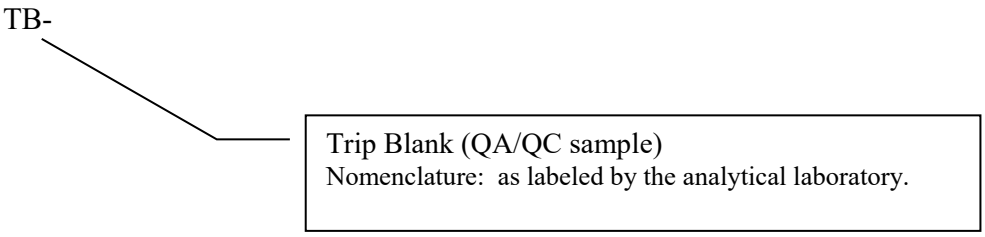
MW-267



MW-267 Duplicate

FB-1





2.3.8.6 Field Sampling Notes

All field notes will be recorded in the appropriate field notebooks and will be completed for each sampling location. The following tasks/data shall be recorded in the field notebook, per SOP-002:

1. Daily field report will be completed for each day summarizing that day's activities and observations;
2. Groundwater and LNAPL level measurement data will be recorded for each well gauged; and
3. Groundwater sampling field data will be recorded for each monitoring well sampled.

A copy of all field notebook pages with data entries, daily reports, and field notes will be given to the PM after returning from the property, while the originals will be maintained in the field/project notebook for that property. No one shall, at any time, remove information from job files, QA files, or the project notebook for field use or other use. If copies of previous work are required, then arrangements will be made with the Consultant PM or Consultant QAO to copy a portion of the file.

Field notebooks, and/or daily field reports will not be obscured, destroyed, or discarded, even if they contain errors or are illegible. Entries will be described in as much detail as possible so that persons going to the Refinery could reconstruct a particular situation without reliance on memory. All entries will be made in permanent ink, signed, and dated and no erasures will be made. Corrections will be made by drawing a single line through the error and writing in correct information. The use of white-out, obliterating, or writing directly over the erroneous entry will be prohibited. All corrections will be dated and initialed by the person making the correction. Field notebooks, field data sheets, or daily field reports will follow requirements and procedures listed in SOP-002.

2.3.8.7 Laboratory Documentation

Workbooks, bench sheets, instrument logbooks, and instrument printouts are used to trace the history of samples through the analytical process and to document and relate important aspects of the work, including the associated quality controls. All logbooks, bench sheets, instrument logs, and instrument printouts are part of the permanent record of the laboratory. Laboratory supervisors will periodically review laboratory notebooks for accuracy, completeness, and compliance with internal

QA/QC procedures. Completed workbooks and instrument logbooks will be submitted to the Laboratory QAO (or designee) for storage.

In general, good laboratory practices require that the following (or equivalent) procedures be used. Each page, or as required, each entry, will be dated and initialed by the analyst when the record is made. Errors in entry will be crossed out in indelible ink with a single stroke. The use of white-out, obliterating, or writing directly over the erroneous entry will be prohibited. The individual making the correction will initial all corrections.

2.3.8.8 Refinery Remediation Files

The Refinery remediation file(s) will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described in this SAP-QAPP. The Refinery and the Environmental Consultant is the custodian of the remediation file(s) and maintains the contents of files for the investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports and data reviews in a secured, limited access area.

The Refinery remediation file(s) may include hard copies or electronic copies of:

1. Field logbooks;
2. Field data and data deliverables;
3. Photographs;
4. Drawings;
5. Soil boring logs/well construction logs;
6. Laboratory data deliverables;
7. Data validation reports;
8. Data assessment reports;
9. Progress reports, QA reports, project reports, etc.; and
10. All custody documentation (tags, forms, airbills, etc.).

2.3.9 Investigative Derived Waste

Purged water will be collected and processed through the Refinery WWTP or disposed off-site in accordance with SOP-024.

2.4 Quality Control Requirements

2.4.1 Level of Quality Control Effort

Field blanks (if applicable), trip blanks, method blanks, field duplicates, laboratory duplicates, laboratory control, and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs.

Field (equipment rinsate) and trip blanks consisting of distilled water will be submitted to the analytical laboratories to help assess the quality of the data resulting from the field sampling program. Field blanks are analyzed to check for procedural decontamination at the Site that may cause sample contamination and will be collected if non-dedicated equipment is used for sampling. If required, field blank samples will be collected at a frequency of one per every twenty samples or one per each day of sampling, whichever is more frequent. Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage. Trip blanks pertain to samples with volatile organic analyses only. Trip blanks are prepared prior to the sampling event in the actual sample containers and are kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other samples and sent for analysis. There should be one trip blank included in each sample shipping container that contains bottles for VOC analysis. At no time after their preparation will the sample containers be opened before they reach the laboratory.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Duplicate samples are analyzed to check for sampling and analytical reproducibility. Laboratory control samples provide information on analytical system biases. Matrix spikes provide information about the effect of the sample matrix on the digestion, extraction, and/or measurement methodology. All matrix spikes will be performed in duplicate and are referred to as MS/MSD samples. Sample containers will be filled to allow for the collection of one MS and MSD sample per 20 samples collected.

All samples will be sent to the designated approved laboratory for analysis. All analyses will be completed in accordance with the specified methods. The level of laboratory QC effort for this project and the quantitation limits will be in accordance with the laboratory's SOPs, to be supplied by the contracted laboratory selected to perform the work.

2.4.2 Internal Quality Control

The purpose of internal quality control measures is to document the validity of analytical data generated by the laboratory. Laboratory internal quality control may include, but is not limited to, the analysis of blanks, reference standards, analytical spikes, and surrogate spikes. Every analytical series will include some of these controls depending on the analytical methods used. The internal quality controls used by the laboratory will be combined so they are completely representative of every aspect of the analytical task from sample preparation to sample analysis.

The following sections present a summary of, and suggested frequencies for, various quality control measures that may be used dependent upon the analytical method(s) selected.

2.4.2.1 Blank Samples

Blanks are used to assess contamination introduced in transit, storage, or in the laboratory. The types and frequencies of laboratory blank samples are specified by the United States Environmental Protection Agency (USEPA) methods used for analysis.

Method Blanks

Method blanks identify sources of contamination throughout the analytical process, whether a contribution of specific analytes or a source of interference, which will need to be identified, isolated, and corrected. To accomplish this, the method blank must be initiated at the beginning of the analytical process and include all aspects of the analytical work. This includes glassware, reagents, and instrumentation, as well as any other possible source of contamination. Method blanks will meet the criteria specified in the subcontracted laboratory's SOPs or the Analytical Method.

Instrument Blanks

Instrument blanks are analyzed after a sample or dilution has run which contains a target compound at a concentration greater than 25 ug/l, a non-target compound at a concentration greater than 100 ug/l or saturated ions from a compound (excluding compound peaks in the solvent front). The results of the instrument blank analysis indicate whether there is residual contamination in the instrument from a previous sample.

2.4.2.2 Analytical Spikes

The purpose of an analytical spike is to assess the efficiency and proficiency of an analytical series. This includes quantitation standards, sample preparation, instrument set-up, and the premises inherent in quantitation. This control reflects the competency of sample analysis within an analytical series. Matrix and surrogate spikes may also indicate influence of sample matrix interferences that are not within the control of the analyst. The types and frequencies of analytical spikes are specified by the USEPA methods used for analysis.

Laboratory Control Spikes

The LCS is a matrix interference-free blank sample that is spiked with known and verified concentrations of the analytes being measured. The LCS is processed through the same preparation and analytical steps, and the recoveries of the spiked analytes obtained are used to assess the accuracy of the analytical system.

Matrix Spike

Within an analytical series, a representative sample portion is designated as a separate sample and spiked with known concentrations of the analytes under consideration. Advantages of spikes are that the spiked portion is handled and prepared in exactly the same way as the samples. Sample related interference affecting analysis would be reflected in the results from the spiked sample. Results of spikes exceeding tolerances specified by the methods need to be evaluated thoroughly in conjunction with other measures of control.

Surrogate Spike

Surrogates, which have properties similar to the analytes of interest, are compounds unlikely to be found in nature. The intent of a surrogate spike is to provide broader insight to the proficiency and efficiency of an analytical method on a sample specific basis. This control reflects analytical

conditions, which may not be attributable to the sample matrix. If results of a surrogate spike analysis exceed method-specified tolerances, then the analytical results need to be evaluated thoroughly in conjunction with other control measures. Re-analysis of the sample with additional controls, or different analytical methodologies, will be necessary.

2.4.2.3 Replicate Analysis

Replicate analysis is a measure of analytical precision and can be limited in its scope. If used in conjunction with reference standards or analytical spikes, it can measure the reliability of the analytical systems. Replicate analyses can be significant in the interpretation of analytical results for samples with complex matrices.

2.4.2.4 Calibration Check Standards

The purpose of a calibration check standard is to assess an instrument's stability. A calibration check standard will be analyzed at the beginning and end of an analytical series or periodically throughout large series of samples. Calibration check standards will be run after every twelve hours. In analyses where internal standards are used, a calibration check standard need only be run at the beginning of an analytical series. If results of the calibration check standard exceed method specified tolerances, then samples analyzed since the last acceptable calibration check standard will be re-analyzed.

2.4.2.5 Internal Standards

Internal standards will be monitored when required by the analytical method. The internal standard is present in all samples to be analyzed with the exception of performance standards. The standard responses must meet the criteria stipulated in the analytical method. If internal standard areas in one or more samples exceed the specified tolerances, then the instrument will be re-calibrated, and all affected samples re-analyzed.

2.4.3 Sampling Quality Control

Several sampling quality control measures will be necessary to assess the integrity of samples collected and determine if the QA objectives discussed in this SAP-QAPP are being met. These measures include the use of field duplicate samples, field blanks (if applicable), and trip blanks to locate possible sources of sample contamination. Table 5 provides a summary of field quality control frequencies.

If using non-dedicated equipment for sampling, field blanks will be collected by running distilled water through or over the parts of the sampling devices that contact the samples. The rinsate will be transferred directly to the appropriate laboratory supplied analytical containers. Field blanks will be analyzed for the same parameters as the field samples. It is the sampler’s responsibility to collect the appropriate number of field blanks for each sampling activity.

Field duplicate samples will be collected at a minimum frequency of one per every twenty investigative samples.

2.5 Instrument Calibration and Maintenance Requirements

2.5.1 Field Instrument Calibration and Preventative Maintenance

The field equipment for this project may include such items as thermometers, pH meters, conductivity meters, Flame Ionization Detector (FID), or Photoionization Detector (PID), multi-parameter water quality meters and other monitoring equipment as needed. Specific preventative maintenance procedures to be followed for field equipment are those recommended by the manufacturer. Field instruments will be calibrated daily before use, following manufacturer's procedures, and checked as field conditions necessitate through the day. Initial calibration and calibration checks will be documented in the field notebook. The recommended maintenance schedule for field instruments is indicated in Table 4. Critical spare parts such as tape and batteries will be stored on-site to reduce downtime. Backup instruments and equipment will be available on-site or within one-day shipment to avoid delays in the field schedule.

The data quality objectives for field measurements are summarized in Table 5.

2.5.2 Laboratory Instrument Preventative Maintenance

As part of the QA Program Plan, a routine preventative maintenance program is conducted by the analytical subcontractor to minimize the occurrence of instrument failure and other system malfunctions. Designated laboratory employees regularly perform routine scheduled maintenance and repair of (or coordinate with the vendor for the repair of) all instruments. All maintenance that is performed is documented in the laboratory's operating record. All laboratory instruments are maintained in accordance with manufacturer's specifications and the requirements of the specific method employed. This maintenance is carried out on a regular, scheduled basis, and is documented in the laboratory instrument service logbook for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under a repair and maintenance contract with factory representatives. Table 6 provides an example of a preventive maintenance schedule for laboratory equipment. The laboratory will maintain an adequate supply of all necessary spare parts.

2.5.3 Laboratory Instrumentation Calibration Procedures

Calibration procedures for a specific laboratory instrument will consist of initial five-point calibration, initial calibration verification and continuing calibration verification. The selected analytical subcontractor will provide SOPs describing the calibration procedures for each specific laboratory instrument, including their frequency, acceptance criteria, and the conditions that will require recalibration. Laboratory instrumentation calibration procedures will meet the requirements of the appropriate Method.

2.5.4 Field and Laboratory Consumables

An adequate supply of all supplies and consumables will be available for field and laboratory work. All supplies used in the field and laboratory will be inspected prior to use to ensure that they are free from visible defects. Sampling equipment and analytical supplies will be subject to the

various QC measures (i.e., equipment blanks and method blanks) previously discussed. Any unacceptable supplies or consumables will be discarded and replaced with an acceptable item.

2.6 Data Management

2.6.1 Sample Documentation

All sample documents will always be legibly written in ink. Any corrections or revisions to sample documentation shall be made by drawing a single line through the error, writing in the correct information, and initialing any changes. The following sections are provided to outline sample documentation procedures that will be employed when conducting the semi-annual groundwater sampling activities.

2.6.2 Field Data Notes

General field notes will be recorded in the field notebook using indelible ink.

Additionally, a Daily Field Report or equivalent document may be completed at the end of the day summarizing the day's activities and observations. Copies of the documentation will be provided to the Consultant PM as necessary. If copies of previous work are required, arrangements will be made with the Consultant PM.

Field notebooks or daily field reports will not be obscured, destroyed, or discarded, even if it contains errors or is illegible. Corrections will be made by drawing a single line through the error, writing in the correct information, and initialing any changes. Corrections will be dated and initialed by the person making the correction.

2.6.3 Laboratory Data Reduction, Review and Reporting

2.6.3.1 Data Reduction

Analytical results will be reduced to the concentration units using the equations specified in the analytical procedure. Senior laboratory staff will check the calculations.

2.6.3.2 Data Review

Each laboratory section will provide extensive data review prior to reporting results. In general, there are three levels of data review.

The analyst will be responsible for primary review of data generated from sample analysis. If recoveries of the quality control samples are within the method-specified tolerances, then the data will be presented to data review groups for secondary review. If recoveries of any quality control samples exceed specified tolerances, affected samples will be re-analyzed as required by the method.

Data review groups will conduct secondary review to determine if the analytical results are acceptable. If recoveries of the quality control samples are within the method specified tolerances, then the data will be presented to the Laboratory PM for final review. If recoveries of quality control

samples exceed the specified tolerances, affected samples will be submitted for re-analysis as required by the method.

Final review of analytical results will consist of the Laboratory Director's determination that the analytical results of a sample(s) are consistent. If so, the data will be presented in a final report. If discrepancies or deficiencies exist in the analytical results, corrective action will be taken. Audits of final reports by the Laboratory QAO may be conducted to determine the precision, accuracy, completeness, and representativeness of sample analyses.

2.6.3.3 Data Reporting

Data reporting will be in accordance with the appropriate USEPA method used for analysis and will be prepared in a standard deliverable. Laboratory reports shall, at a minimum, include the following:

1. Narrative including statement of samples received, sample condition upon receipt, description and rationale for any deviations from approved methods/SOPs, summary of data quality, and documentation of any significant problems encountered during analysis;
2. Documentation of laboratory events including date/times of sample receipt, sample preparation or extraction, and sample analysis;
3. Analytical data including method reference, results, reporting limits, dilutions, etc.;
4. A summary of QA/QC results, control limits, and supporting documentation as requested; and
5. A copy of the signed Chain-of-Custody for samples submitted for analysis.

The Laboratory QAO and/or the Laboratory Director should sign the laboratory reports prior to issue. Reports will be issued to the Consultant PM and Consultant QAO. Any draft reports should be clearly identified.

2.6.4 Corrective Action

Corrective actions may be required for either analytical and equipment problems or non-compliance problems. Analytical and equipment problems may occur during sampling and sample handling, sample preparation, laboratory analysis, and data review. Non-compliance problems are often associated with non-conformance to this plan or the USEPA methods being used.

2.6.4.1 Laboratory Corrective Action

When deficiencies or "out-of-control" situations exist, the laboratory will provide a means of detecting and correcting these situations. An "out-of-control" situation is defined as data exceeding control limits. Samples analyzed during "out-of-control" situations will be re-analyzed prior to reporting results. The laboratory's corrective action procedures are documented in their QAM and method specific SOPs. In general, there are several levels of "out-of-control" situations that may occur in the laboratory during analysis.

2.6.4.2 Bench Level

Corrective action procedures will often be handled at the bench level. If an analyst finds a non-linear response during calibration of an instrument, then the instrument will be recalibrated before sample analysis. The problem may be corrected by a careful examination of the preparation or extraction procedure, spike and calibration mixes, or instrument sensitivity. If the problem persists, it will be brought to the management level.

2.6.4.3 Management Level

If resolution at the bench level was not achieved, or a deficiency is detected after the data has left the bench level, then corrective action becomes the responsibility of the Laboratory PM or Laboratory Director. Unacceptable laboratory control, matrix, or surrogate spike recoveries detected by data review will be reported to the Laboratory QAO. A decision to re-analyze the sample or report results will be made depending on the circumstance.

2.6.4.4 Receiving Level

If discrepancies exist in either the documentation of a sample or its container, a decision will be made after consulting with the appropriate management personnel. Decisions will be fully documented. Some examples of container discrepancies are broken samples, inappropriate containers, or improper preservation. In these cases, corrective action will involve the Laboratory PM contacting the Consultant PM and/or Consultant QAO.

2.6.4.5 Field Corrective Action

Corrective actions for field equipment problems will consist of reporting the problem to the Consultant PM and/or the Consultant QAO so that maintenance can be performed, or new equipment can be acquired. Non-compliance problems will be reported immediately to the Consultant QAO. The Consultant QAO will consult with the Consultant PM and corrective actions will be initiated. Corrective actions may include resampling when necessary to meet the data objectives. The nature, extent, and corrective action for all non-compliances will be documented.

2.6.5 Quality Assurance Reports to Management

2.6.5.1 Laboratory Internal Reporting

The Laboratory QAO will report the status of the laboratory QA/QC program to the laboratory management. Each report should include:

1. Periodic assessment of measurement data accuracy, precision, and completeness;
2. Results of audits;
3. Significant QA/QC problems and recommended solutions; and
4. Resolutions of previously stated problems.

The laboratory will determine the content and frequency of these reports in accordance with its QAM or SOPs. The laboratory will report to the Consultant QAO or Consultant PM if the laboratory's internal quality control issues have affected the results of the samples.

2.6.5.2 Additional Reporting

Laboratory analytical reports will include a summary of the quality assurance activities and quality control data for the project as related to sample analysis. The Laboratory PM will report suspected field QA/QC problems to the Consultant QAO. The Consultant QAO will report to the Consultant PM when appropriate. These reports may be either oral or written depending upon the nature and complexity of the issues in the report.

The Consultant QAO will report any known issues potentially affecting the quality of the analytical or field data to the Consultant PM. The Consultant PM is responsible for further dissemination of these reports.

2.6.6 Data Management

The raw data obtained during field activities will be recorded on the appropriate field forms or in dedicated field notebooks. This data will become part of the project files to be maintained as previously described in this SAP-QAPP. The analytical subcontractor will maintain all raw data for a minimum of ten (10) years. The analytical subcontractor will not destroy any data or records without the consent of the Environmental Consultant or HFTR. The procedures to be employed for data verification, reduction, validation, and reporting are provided in Section 4 of the SAP-QAPP.

3 ASSESSMENT AND OVERSIGHT

3.1 Performance and System Audits

Performance and system audits of both field and laboratory activities may be conducted to verify that sampling and analysis are performed within the constraints of this plan. These audits can either be conducted internally by field or laboratory staff or externally by HFTR or state or federal agencies. The laboratory will participate in any performance or system audit conducted or requested by HFTR or the ODEQ.

3.1.1 Performance Audits

Performance audits may be conducted periodically to determine the accuracy of the total measurement system(s) or components. In this program, blind performance evaluation samples, submitted by state agencies, are analyzed and evaluated throughout the year as part of an on-going participation in their certification programs. Any deficiencies in the results of these analyses are reported to the laboratory and corrective action is initiated.

In addition to blind sample analyses, the laboratory will also participate in any audits from state and federal agencies. These agencies submit a report noting any deficiencies and necessary corrective action. The laboratory will respond with evidence of compliance within a limited time.

The laboratory also maintains a schedule of internal audits whereby the Laboratory QAO audits each section of the laboratory. When the audit is completed, a formal report will be issued to the Laboratory Director. This report shall note any deficiencies and a follow-up date to confirm corrective action.

3.1.2 System Audits

A system audit is an evaluation of the various components of the measurement system to assess their proper selection and use. This includes a careful evaluation of all laboratory quality control measures. System audits will be conducted internally by the laboratory.

3.1.3 Field Audits

HFTR or the Environmental Consultant may conduct internal audits of field activities involving sampling and measurements. These audits may include a thorough examination of field sampling records, field instrument operating records, sample collection, shipping and handling, Chain-of-Custody, etc. These audits may occur at the discretion of HFTR or the Consultant PM, at the beginning of the project, or when new or modified sampling procedures are introduced to verify that the established procedures are followed. Follow-up audits will be conducted to correct deficiencies, and to verify the QA/QC procedures are being maintained throughout the project. Additionally, audits will occur periodically throughout the monitoring period, especially when changes to sampling teams or subcontractors are implemented. When an audit is completed a written report will be submitted to the Consultant PM and HFTR.

Consultant personnel will participate in any external audit requested by regulatory agencies. The results and recommendations or any external audit should be reported to the Consultant QAO and/or Consultant PM in a timely manner so that corrective actions may be initiated.

3.2 Reports

3.2.1 Internal Reporting

Written reports of field audits will be issued to the Consultant PM. The Consultant PM is responsible for further dissemination of these reports.

The Laboratory QAO (or designees) will report the status of the laboratory QA/QC program to the laboratory management. Each report should include:

1. Periodic assessment of measurement data accuracy, precision, and completeness;
2. Results of audits;
3. Significant QA/QC problems and recommended solutions; and
4. Resolutions of previously stated problems.

The laboratory will determine the content and frequency of these reports in accordance with its QAM and its SOPs. The laboratory will report to the Consultant QAO or Consultant PM if the laboratory's internal quality control issues have affected the results of the Consultant's samples.

3.2.2 Additional Reporting

Laboratory analytical reports will include a summary of the quality assurance activities and quality control data for the project as related to sample analysis. The Laboratory PM will report suspected field QA/QC problems to the Consultant QAO or Consultant PM.

4 DATA REDUCTION, VERIFICATION, VALIDATION, AND REPORTING

The quality of field and analytical data must be assessed to ensure that these data are being properly used. In order to support the conclusions of the assessment, all data must meet the DQOs identified in Section 1.4. All data generated through field activities or by the laboratory operation shall be reduced, verified, and validated prior to reporting. Data shall not be disseminated until it has been subjected to these procedures, which are summarized in subsections below.

4.1 Review of Field Data

Field data reduction procedures will be minimal in scope compared to those implemented in the laboratory setting. Only direct-read instrumentation will be employed in the field. All field data will be written into the field notebook(s) immediately after measurements are taken. If corrections are required, the error will be legibly crossed out with a single line and the correction will be made in a space adjacent to the original. All corrections will be initialed and dated by the individual making the correction. Later, when the results calculation forms required for the Semi-Annual sampling events are being filled out (i.e., corrected LNAPL thicknesses, groundwater elevations, etc.), the FOC will review the forms to determine whether any errors have been made by the field crew.

4.2 Data Validation

Data verification is the process of checking the completeness, correctness, and compliance of data with the field and analytical methods, SOPs, and this SAP-QAPP. Data validation is the process of assessing overall data quality with respect to the PARCC parameters. Data verification and validation procedures shall be performed for both field and laboratory operations as described below.

4.2.1 Procedures Used to Verify and Validate Field Data

The Consultant PM or designee will verify all data generated during field activities. Data verification will consist of reviewing all field data and documentation for transcription errors. Any data that is entered into project databases, spreadsheets, drawings, etc. will be checked against the original field measurements. Field custody records will be checked against the work plan to determine that the appropriate samples were collected. Similarly, the custody records will be checked against the analytical data generated by the laboratory to determine that all requested analyses were complete.

Field measurements will be validated under the direction of the Consultant QAO according to the PARCC parameters. Additionally, the analytical results of field QC samples will be evaluated to determine that the field investigation and sampling methods employed meet the PARCC requirements. Any identified non-compliant data will be evaluated to determine the potential effect on overall validity and usability of the data generated. If the data is determined not suitable for its intended purpose it will not be used and new data may be collected.

4.2.2 Procedures Used to Verify and Validate Laboratory Data

The analytical subcontractor generating the data will perform initial data verification and validation in accordance with individual methods and the laboratory's QA/QC program prior to reporting any analytical results. Data validation on the final analytical data reported by the analytical subcontractor will be performed in accordance with individual methods and national guidelines. Data validation on the final analytical data will be performed by either the Consultant QAO or designee (project- or senior-level scientist).

Data verification and validation is the process through which proper quantification, recording, transcription, and calculations are confirmed. It also confirms that the data is reasonable and complete. The process should be such that errors are minimized and that corrective action steps are taken when errors are detected. The laboratory's data verification and validation processes include three steps: primary, secondary, and final review. The independent data validation is conducted by the Consultant QAO or designee after the laboratory data review process is completed.

4.2.2.1 Primary Review

The analyst performs the initial review of the data. The analyst is responsible for verifying the correctness of the data entered into the Laboratory Information Management System (LIMS). This review includes, but is not limited to, verifying that the quality control indicators (QCI) meet protocol criteria, calibration criteria are met, appropriate detection limits were used, and data was reduced correctly and that any corrective action was documented properly. The primary reviewer is responsible for verifying any documentation associated with the data, completing review records associated with the process, and compiling QC Reports. The analyst must perform primary review on 100% of the data generated.

4.2.2.2 Secondary Review

The Laboratory QAO or designee can be responsible for a secondary review of the data. This step is intended as a validation of the primary review. Secondary review focuses on the calibration criteria, QCIs, compound identification, results expression, reporting limits, and level of documentation. Approximately 10% of the data are validated. If problems exist during this review, the data is returned, a 100% review is done, and corrective action is performed as appropriate.

4.2.2.3 Final Review

The Laboratory PM must perform final review of the completed project prior to releasing the final report. This review ensures that the client requirements have been met and that the final report

has been properly completed. The process includes, but is not limited to, verifying that chemical relationships are evaluated, Chain-of-Custody is completed, cover letters/ narratives are present, flags are appropriate, and project specific requirements are met.

4.2.2.4 Data Validation

The Consultant QAO or designee will review the analytical data package and will provide independent validation of the laboratory data according to method and/or regulatory protocols. The basis for validation will be the USEPA Contract Laboratory Program (CLP) *National Functional Guidelines for Data Review* (most current versions for both organic and inorganic data), modified to accommodate the criteria in the analytical methods reported. Final data qualifiers may be assigned to the original laboratory data reported as a result of the independent validation effort.

4.2.3 Laboratory Data Reporting

After the laboratory has verified and validated the analytical data it will be reported to the Consultant's QAO. The laboratory reports will consist of:

1. A summary page referencing the laboratories sample number, client sample number, date/time collected, and date/time received for each sample submitted.
2. Analytical results for each sample documenting the results, QC flags, units, chronology of analytical events, reporting limits, analyst, dilutions, and method references. Surrogate recoveries and other QC data (as appropriate) are also reported along with the appropriate control limits.
3. Definitions of quality control flags used in report.
4. Notes and comments of any identified QC problems or concerns that potentially affect the quality of the data generated.
5. Copy of the completed Chain-of-Custody record and sample receipt temperature and condition.

Data will also be received electronically from the laboratory in the approved format and uploaded to the project database. These data will be double checked against the hardcopy reports for accuracy and completeness. Final qualifiers assigned during the independent data validation process will also be checked. After being double checked, the data will be tabulated for subsequent presentation for reporting purposes. All finalized tables will be logged and entered into the Consultant's database, which only Consultant employees will have access to.

The original laboratory data received by the Consultant QAO will be maintained in the QA files after the review process is completed. The Consultant QAO will give a copy of all laboratory data to the Consultant PM after review. No one shall, at any time, remove information from job files, QA files, or the project notebook for field use or other use. If additional copies of laboratory data are required, then arrangements will be made with the Consultant's QAO to copy a portion of the file.

Job files, QA files, and project notebooks will be kept at the Consultant's office for a period of ten (10) years, after that they will be moved to a secure, fireproof storage facility.

4.3 Reconciliation with User Requirements

Data collected during the semi-annual sampling events will be used to evaluate the current conditions of the dissolved phase and LNAPL plumes beneath the Refinery. These data will be reconciled with the DQOs and PARCC parameters presented in Sections 1.4 and 1.5 of the SAP-QAPP. Specifically, these data will be qualitatively and quantitatively assessed to determine that appropriate sample collection and analytical procedures were used. These assessments will include:

1. Determination of adherence to applicable SOPs;
2. Determination that samples were collected from the proposed sample locations;
3. Evaluation of detection limits, matrix interferences, and other factors potentially biasing data;
4. Evaluation of the data verification results;
5. Evaluation of qualified data for environmental assessment purposes;
6. Determination that the DQO procedures followed and/or refined during the investigation; and
7. Determination if there are any data gaps identified that need further evaluation.

5 REFERENCES

A variety of technical manuals, administrative documents, and publications were referred to in preparing this document. Some of the references consulted are presented below. Referenced documents and publications may or may not have been reviewed in their entirety.

HollyFrontier Tulsa Refining LLC. RCRA Permit Application, Groundwater Monitoring and LNAPL Management Plan. December 2018.

USEPA. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846, 3rd Edition. Updates II and III, 1998.

USEPA. Chapter 21 of Statistical Analysis of Groundwater Data at RCRA Facilities-Unified Guidance, March 2009.

USEPA. Contract Laboratory Program, National Guidelines for Data Review. January 2017.

TABLES

HollyFrontier Tulsa Refining LLC
Tulsa West Refinery
SAP-QAPP

Table 1

Summary of Analytes, Method Detection Limits and Practical Quantitation Limits for Groundwater Samples[a]

Inorganics U.S. EPA Method 6010B		Water		
Analyte	**CAS**	**MDL**	**PQL**	**Units**
Arsenic	7440-38-2	4.85	10	ug/L
Barium	7440-39-3	1.88	10	ug/L
Lead	7439-92-1	1.97	5.0	ug/L
Zinc	7440-66-6	1.97	50	ug/L

VOCs U.S. EPA Method 8260B		Water		
Analyte	**CAS**	**MDL**	**PQL**	**Units**
Benzene	71-43-2	0.055	1.0	ug/L
Ethylbenzene	100-41-4	0.056	1.0	ug/L
Methyl-tert-butyl ether	1634-04-4	0.063	1.0	ug/L
Toluene	108-88-3	0.066	1.0	ug/L
Xylene (Total)	1330-20-7	0.120	3.0	ug/L

a. Please refer to laboratory SOPs for additional information.
b. Groundwater samples collected from wells with high concentrations of target COCs will have elevated reporting limits due to sample dilution. The reporting limits for samples requiring dilutions will be dependent upon analyte concentrations within the samples.

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Table 2

Field and Laboratory Quality Control Frequencies

QUALITY CONTROL SAMPLES	FREQUENCY OF SAMPLES
Field Samples	
Field Sample Duplicate	Typically one duplicate sample for every 20 or fewer investigative samples.
Matrix Spike/Matrix Spike Duplicate	Typically sample volume for one MS/MSD is collected in the field for every 20 or fewer groundwater samples.
Field (Equipment Rinsate) Blank	Typically one field blank for every 20 or fewer investigative samples. Field blanks will only be collected when non-dedicated equipment is used.
Trip Blanks	One blank per sample shipment of VOC sample vials (i.e., one blank per cooler).
Laboratory Samples	
Initial Calibration	Sample analysis cannot proceed without a valid initial calibration.
Continued Calibration Checks	Every 12 hours or 20 samples, which ever is sooner. Recalibrate as required by the method.
Laboratory Control Samples including Method Blanks and Blank Spikes	Every 12 hours or 20 samples, which ever is sooner. Recalibrate as required by the method.
Tune Standard	One per batch.
Laboratory Control Spikes/Spike Duplicates	Every 20 samples.
Surrogates	A minimum of three surrogates at retention times across the GC run.
Internal Standards	A minimum of three standards at retention times across the GC run.

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Table 3

Summary of Sample Containers, Preservation Methods and Holding Times[1]

Parameter	Analytical Method	Bottle Type	Preservation	Holding Time[2]
WATER				
Volatile Organics (VOCs)	U.S. EPA Method 8260B	(3) 40 ml glass vials	HCL to pH<2 Cool to 4°C	14 days
Metals[3]	U.S. EPA Method 6010B	(1) 500 ml plastic bottle	HNO_3 to pH<2 Cool to 4°C	180 days[4]

Notes:
1. These are typical containers; containers may vary, and containers may be combined during the sampling process.
2. All holding times are measured from date of collection.
3. Metals for POC wells include: arsenic, barium, lead, zinc.
4. VOCs for POC wells include: benzene, toluene, ethylbenzene, total xylenes (BTEX), methyl-tert-butyl ether (MTBE).

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Table 4

Preventative Maintenance for Field Instruments

INSTRUMENTS		MAINTENANCE PROCEDURES/SCHEDULE		SPARE PARTS IN STOCK
MiniRae 2000 Photoionization Detector (or similar)		1. Calibrate beginning and end of each day and as necessary during use. 2. Check battery, and recharge when low. 3. Clean lamp window every 24 hours of operation. 4. Replace water traps if they become wet.		1. Battery charger 2. Spare filter cartridges 3. Calibration Gas
Thermo Environmental Model 580B Photoionization Detector (or similar)		1. Calibrate beginning and end of each day, and as necessary during use. 2. Check battery, and recharge when low. 3. Clean lamp and dust filter as needed. 4. Replace water traps if they become wet.		1. Battery Charger 2. Spare dust filters. 3. Calibration Gas
Vrae or MSA 4 gas monitors (or similar)		1. Calibrate beginning and end of each day, and as necessary during use. 2. Check battery, and recharge when low. 3. Clean lamp and dust filter as needed. 4. Replace water traps if they become wet.		1. Battery Charger 2. Spare Batteries 3. Spare moisture filters.
YSI 6-Seires Sonde with flow through cell (or similar)		1. Calibrate beginning and end of each day, and as necessary during use. 2. Check probes/membranes daily for wear or damage. 3. Replace probes/membranes as needed. 3. Replace batteries as needed.		1. Battery charger 2. Calibration Solutions 3. Clean flow through cell as needed.
LaMotte, Aquatic Hach Turbidimeters (or similar)		1. Calibrate beginning and end of each day, and as necessary during use. 2. Clean/wipe optics chamber with optical lens cleaning cloths		1. Spare Batteries 2. Calibration Standards 3. Spare Test Vial
Solinist or Heron Water Level Indicators and Interface Probes (or similar)		1. Check probe function before use. 2. Service as needed.		1. Spare Batteries. 2. Calibration Solutions

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Table 5

QA Objectives for Field Measurements

PARAMETER	INSTRUMENTS	PRECISION [a.]	ACCURACY [b.]	COMPLETENESS
Immiscible Layer Detection and Measurement	Heron or Solinist Oil-Water Interface Probe (or similar)	+/- 0.01 ft.	+/- 0.005 ft.	95%
Static Groundwater Levels	Heron or Solinist Water Level Indicator (or similar)	+/- 0.01 ft.	+/- 0.005 ft.	95%
Temperature	Multi-parameter water quality sonde such as YSI, In-situ or QED	+/- 0.5^{o} C.	+/- 0.15^{o} C.	95%
Conductivity	Multi-parameter water quality sonde such as YSI, In-situ or QED	+ 0.001 to 0.1 mS/cm (range dependent)	+ 0.5% of reading +0.0001 mS/cm	95%
pH	Multi-parameter water quality sonde such as YSI, In-situ or QED	+/- 0.2 pH units	+/- 0.2 pH units	95%
Dissolved Oxygen	Multi-parameter water quality sonde such as YSI, In-situ or QED	+/- 0.01 mg/L	+/- 2% of readings for 0.2 mg/L which ever is greater for 0-20 mg/L range +/- 6% of readings for 20-50 mg/L range.	95%

NOTES:
a. Expressed as the acceptable deviation from the Scale.
b. Expected based on equipment manufacturer specifications.

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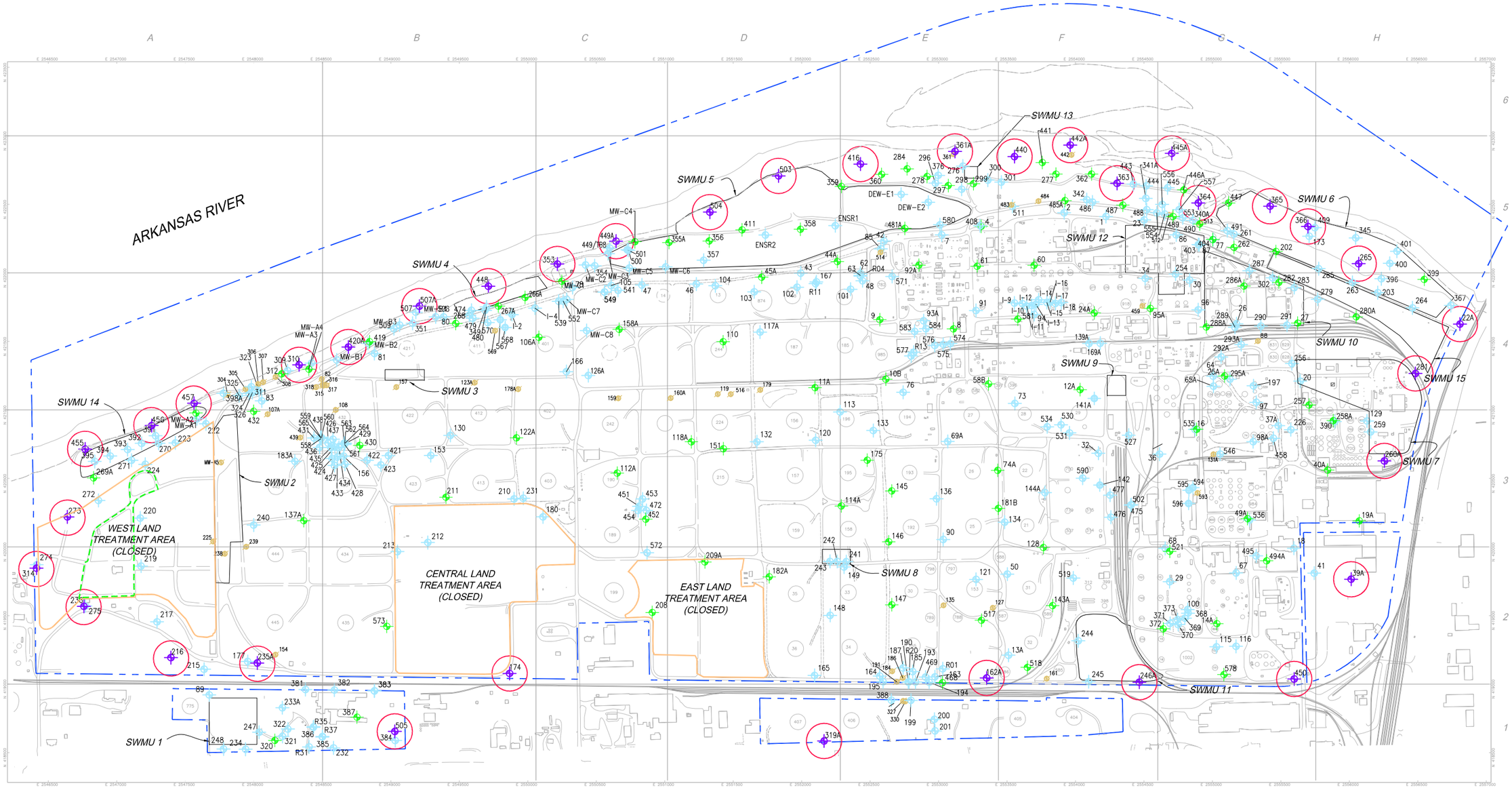
Table 6

Preventative Maintenance for Analytical Instruments

INSTRUMENT	ACTIVITY	FREQUENCY
Gas Chromatograph/ Mass Spectrometer	Replace pump oil	Monthly/as needed
	Change septa	As needed
	Change gas line dryers	When pressure reaches 100 psi
	Clean source	Semi-annually/as needed
	Replace electron multiplier	As needed/poor sensitivity
	Injector port cleaning	As needed/poor sensitivity
	Leak check septum	As needed/when leak suspected
	Check gas flow	As needed
	Clean VOA purge glassware	As needed
	Cut capillary column	As needed
	Replace liner	As needed/contamination suspected
Gas Chromatograph	Change septa	As needed
	Clean gas line dryers	As needed
	Change syringes on autosamplers	As needed
	Leak check	When installing columns
	Injection port cleaning	As needed
	Check inlet system for buildup	Periodically
Purge and Trap Sample Concentrator	Replace trap	As needed
	Decontaminate system	As required by blank analysis
	Check system for leaks	As needed
Graphite Furnace Atomic Adsorption Spectrometer	Change graphite contact rings	As needed
	Clean quartz windows	As needed
	Change tubes	As needed
Inductively Coupled Plasma Spectrometer	Change sample rinse lines	As needed
	Clean nebulizer components	As needed
	Clean torch assembly	As needed
	Clean filters	As needed
	Clean Mirrors	As needed
Inductively Coupled Mass Spectrometer	Change pump tubing	As needed
	Clean nebulizer components	As needed
	Clean torch assembly	As needed
	Clean sampler and skimmer cones	As needed
	Change roughing pump oil	As needed
pH/Conductivity Meter	Clean electrodes	As needed
	Fill electrodes	As needed

FIGURES



LEGEND

- LOCATION OF NON-PROGRAM MONITORING WELL
- LOCATION OF GAUGING PROGRAM MONITORING WELL
- LOCATION OF POINT OF COMPLIANCE (POC) WELL
- LOCATION OF PLUGGED MONITORING WELL
- LOCATION OF LAND TREATMENT UNIT (LTU) CLOSED
- LOCATION OF NON-WASTE AREA IN LTU

HOLLYFRONTIER

375 0 375 750
SCALE FEET

N

EQUUS Environmental, LLC
1323 East 71st Street, Suite 200
Tulsa, Oklahoma 74136-5065
918.921.5331
www.EQUUSENV.com

DOCUMENT TITLE
TULSA WEST REFINERY
PERMIT NO. 058078775-PC

FIGURE TITLE
FACILITY BASE MAP

CLIENT HOLLYFRONTIER TULSA REFINING LLC
TULSA, OKLAHOMA

LOCATION HFTR-TULSA WEST REFINERY
1700 SOUTH UNION, TULSA COUNTY, OKLAHOMA

DESIGNED BY	CNA		
APPROVED BY	CNA\BEM	SCALE	1"=750'
DRAWN BY	SKG	DATE	11/28/2018

PROJECT NUMBER	FIGURE NUMBER
HFTRWEST:H18009	**8.A-1**

\\eqserver.equus.local\Main\Projects\HollyFrontier\HFTRWest\H18003-2018 SMR\04_CAD\20180716_GWrpt_BaseMap.dwg on Nov 28, 2018 - 3:26pm

APPENDIX A

Consultant Standard Operating Procedures

SOP INDEX

STANDARD OPERATING PROCEDURE
GROUNDWATER SAMPLING
EQUIPMENT DECONTAMINATION
(SOP-001)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
GROUNDWATER SAMPLING EQUIPMENT DECONTAMINATION
(SOP-001)

1.0 SCOPE AND APPLICABILITY

It is estimated that over 50 percent of all errors in environmental analysis result from incorrect sampling. There are five (5) objectives to any groundwater sampling event. These objectives are:

- The safety of the person performing the sampling
- Obtaining a representative sampling of the material being tested
- Preventing contamination of the sample
- Providing legal documentation of the sampling event
- Protecting the sample from chemical, physical or biological change prior to analysis

During sampling activities that involve potentially hazardous substances, personnel may have their personal protective gear contaminated by those substances through the course of the work effort; and, in addition, sampling equipment may become contaminated. Since contamination of this sort is not always easily discernible, it is necessary to assume that all personnel and equipment have been contaminated.

Effective decontamination procedures minimize the potential for cross contamination, offsite contaminant migration (the transfer of contaminants to areas outside the exclusion zone, usually by improperly decontaminated equipment), or personnel exposure from improperly decontaminated protective gear.

1.1 PURPOSE OF PROCEDURE

The purpose of this Standard Operating Procedure (SOP) is to describe decontamination procedures for groundwater sampling equipment. Groundwater sampling equipment can be defined as any equipment that is placed "downhole" in order to obtain measurements or collect groundwater samples.

1.2 SCOPE COVERED BY SOP-001

This procedure describes general decontamination requirements for groundwater sampling equipment, required site facilities and supplies, disposal procedures, and typical decontamination solutions.

1.3 APPLICABILITY

Groundwater equipment decontamination procedures as described herein are applicable for groundwater sampling events and shall be conducted as specified in the Work Plan, Field Sampling Plan (FSP), or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent that they are different.

1.4 DEFINITIONS

1.4.1 Contamination

Contamination during groundwater sampling is defined as the introduction of substances not found at the sampling location or the increase of known constituents at the sampling location due to the failure to remove such substances or constituents. These substances or constituents are commonly called contaminants. Uncleaned or improperly cleaned equipment is often called "dirty" or contaminated.

1.4.2 Decontamination

Decontamination is the process of neutralization through washing, rinsing, and removing of contaminants from exposed surfaces of groundwater sampling equipment so that the potential for contamination migration is minimized. Properly decontaminated sampling equipment is often called "clean".

1.4.3 Cross Contamination

When applied to groundwater sampling activities, cross contamination is the transfer of contaminants, usually from one sample to another, by improperly decontaminated sampling equipment, containers, or measurement devices.

1.4.4 Health and Safety Considerations

The decontamination process may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, field personnel should follow the precautions and procedures and use the appropriate personal protective equipment as described in the approved Health and Safety Plan (HASP).

Decontamination solutions may also present an exposure hazard. Detergents such as Liquinox® can cause skin irritation with prolonged contact. Organic solvents can cause

central nervous system effects as well as eye and skin irritation. Acid solutions may be corrosive to skin, eyes, and the upper respiratory tract.

At a minimum, water-resistant gloves and safety glasses shall be worn when performing equipment decontamination using a detergent solution. Solvex® gloves and safety glasses must be worn when performing equipment decontamination using organic solvents. Equipment decontamination using organic solvents shall be performed in a well-ventilated area. The decontamination basin and exhaust fan shall be utilized when this operation is performed in the warehouse or other enclosed space. Organic solvent shall not be allowed to enter the basin drain. The Field Services Technician shall be notified within 24 hours after use of any solvent other than acetone. This notification is necessary because quantities must be monitored, and a permit may be required if the type of solvent and quantity meet or exceed federal and/or state criteria.

Neoprene gloves, rubber apron, safety glasses, face shield, and a half-face respirator equipped with acid gas cartridges shall be worn by personnel preparing acid solutions. This operation shall be performed in a well-ventilated area.

Personnel performing equipment decontamination using a 10% acid solution shall wear Solvex® gloves and safety glasses. A face shield and a rubber apron shall be worn where there is a high potential for splashing.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing decontamination procedures shall be properly trained in field sampling and decontamination techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in the decontamination techniques. All personnel performing groundwater sampling activities shall be proficient in each of the decontamination methods described in this SOP. Occasional on-site field audits conducted by the Environmental Department will ensure that field personnel continue to perform decontamination procedures correctly.

3.0 EQUIPMENT AND MATERIALS

Since the expected types and levels of contaminants at a site and the methods used to investigate them will vary from site to site, a decontamination plan should be customized and of sufficient detail to address the conditions and contaminants at the site.

3.1 GENERAL CONSIDERATIONS

The level of effort needed for decontamination should be determined prior to beginning the field work and shall be commensurate with the level of contamination anticipated . Procedures for personal decontamination of field personnel shall be specifically addressed in the site-specific HASP. These HASP procedures shall be followed and will be incorporated with the groundwater sampling equipment decontamination procedures contained in this SOP to limit personnel exposure and cross-contamination potential. Decontamination activities shall be documented to verify that proper procedures are followed. Quality assurance samples, such as rinsate samples and equipment blanks, should be collected as required by the Quality Assurance Project Plan (QAPP).

Decontamination procedures may be subject to federal, state, or local regulations along with any client requirements. All such requirements must be satisfied, but the procedures adopted should be no less stringent than those presented in this SOP.

Climatic conditions anticipated during the decontamination activities may play a significant factor in the procedures selected. Special facilities may be necessary to compensate for weather conditions such as high heat, extreme cold or wind-blown dust.

3.2 SITE FACILITIES AND SUPPLIES

3.2.1 Site Selection

The equipment decontamination site should be in an area where contaminants can be controlled and at the boundary of a "clean" zone. The location should also be selected to prevent equipment from being exposed to additional or other types of contamination including airborne contaminants. For large projects, a formal "Contamination Reduction Zone" may be established in which all decontamination activities will be conducted. Personnel not involved with the decontamination process should not enter this area.

The decontamination area should have sufficient storage facilities for unused drums, used drums containing spent decontamination fluids and waste, and trash containers.

3.2.2 Water Supply

Large volumes of water (potable, distilled, and/or deionized) may be required for decontamination procedures. Municipal water supplies are generally considered adequate for use as potable water for initial sampling equipment decontamination. Distilled water is purified potable water that typically has a specific conductance of 60 µmhos/centimeter or less. Deionized water is ultra-purified water that has a specific conductance of less than 10 µmhos/centimeter. The lower the specific conductance, the more pure or "clean" the water is. Distilled or deionized water is often used as a final rinse during small equipment decontamination. To ensure that the water supplies are clean, analysis of the water at its source and after it has been stored in a tank may be performed prior to use of the water at the site.

3.2.3 Special Organic or Metals Rinse Solutions

Solvents, such as acetone, hexane, or methanol, may be utilized to decontaminate sampling equipment in cases where a detergent wash solution will not remove all organic residues from sampling equipment. When solvents must be utilized, only pesticide grade or purer solvent is acceptable.

When the analytes of interest include metals, a dilute nitric acid or a dilute hydrochloric acid rinse may be used to assure that sampling equipment is free from metal contaminants. Whenever it is necessary to utilize an acid rinse, only trace- metals-free concentrated acid should be used to prepare the rinse solution. Do not use a nitric acid rinse to clean stainless steel sampling equipment. Nitric acid can remove metals from the stainless steel. At extremely critical work sites, both a dilute nitric acid and a dilute hydrochloric acid rinse may be desired; otherwise, for most work sites only one (1) acid rinse solution is necessary and either nitric acid or hydrochloric acid is acceptable.

3.3 CLEANING EQUIPMENT AND SUPPLIES

Decontamination of groundwater sampling equipment may require tubs or buckets to contain the wash and rinse solutions. Garden sprayers may also be utilized for final rinsing or as part of the initial cleaning. Typically, these sprayers are for use with small hand tools or sampling equipment. Sprayers tend to break down and malfunction and, therefore, should not be relied upon as the sole method of decontamination.

Decontamination solutions, other than potable, distilled, or deionized water, may be required to adequately clean the equipment or neutralize some contaminants. These solutions can vary from

low sudsing detergent and water, to various organic solvents, to dilute solutions of acids. Occasionally, even more specialized decontamination solutions will be necessary. As these specialized solutions would be very site-specific and would be defined in a specific FSP, no further discussion of these solutions is included in this SOP. Any necessary concentrated materials or liquids must be stored in a protected environment. Storage areas must be secure, and flammable chemicals should be located away from buildings and high traffic areas. Federal, state, or local laws may dictate the storage methods of these solutions. A list of general purpose compounds/solutions used for decontamination, their mixing ratios and typical uses is provided in **Table 001-T01**.

Miscellaneous items required for decontamination procedures may include some of the following:

- Brushes - to remove mud, dust, etc. or to scrub sampling equipment
- Plastic sheeting or bags - to wrap decontaminated equipment after cleaning or to contain spent fluids
- Paper towels - to dry equipment
- Plastic or stainless steel tubs or buckets - to contain decontamination solutions and rinse water
- Plastic squeeze bottles, garden sprayers, stainless steel trays to contain additional decontamination solutions (such as solvents or dilute acid solutions)

Attachment 001-A01 to this SOP presents a checklist of decontamination equipment typically utilized for hazardous waste investigations. Supplies other than those shown on this checklist may also be needed.

3.4 GENERAL SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

All sampling equipment that may contribute to the potential contamination of a sample must be thoroughly decontaminated prior to each use. All sampling equipment shall be assumed to be contaminated unless specific documentation exists that the sampling equipment has been properly decontaminated. Examples of specific documentation include vendor certified pre-cleaned sample containers, or sampling equipment that is sealed in plastic (bailers, etc.). Vendor certification paperwork shall be retained in corporate files to verify that equipment was certified to

meet the cleaning standard(s) specified. Any equipment that does not appear to meet specified standards shall be decontaminated prior to use.

Most sampling equipment can be cleaned by hand. The following procedure is given as a typical sequence. This sequence should be modified to be consistent with on-site conditions:

- Using a brush, scrub with potable water to remove mud and residue
- Using a brush, scrub with a detergent-potable water solution or other decontamination solution
- Rinse with clean potable water using tubs or sprayer
- Triple rinse with distilled and/or deionized water
- Dry equipment with paper towels
- Pack and seal equipment in plastic bags or other appropriate containers to prevent recontamination unless equipment is to be used immediately

The wash solution and the rinse solutions must be changed whenever they are visibly dirty (i.e., visible dirt, oily residue, etc.).

Retention of used decontamination fluids will vary from site to site. Unless otherwise specified in the project Work Plan, FSP, or QAPP, all decontamination fluids will be contained in properly labeled containers and held for appropriate disposal.

3.5 SPECIFIC SAMPLING EQUIPMENT DECONTAMINATION

Standard decontamination procedures for various pieces of groundwater sampling equipment are discussed below.

3.5.1 Water Level Indicator

Unwind cable from the water level indicator (WLI) reel and place in the wash bucket or tray filled with a solution of potable water and Liquinox®. Use a soft-bristle brush to remove gross contamination from the probe end taking care not to damage the sensor. Using a soft-bristle brush, clean substantially more cable than will be placed down hole. Transfer the cleaned cable and sensor to a rinse bucket/tray (or series of rinse buckets/trays) and rinse with potable water. Transfer the clean, rinsed cable and sensor to a final distilled/deionized water rinse bucket/tray and rinse at least two times with distilled/deionized water. The WLI reel should be placed on a clean sheet of heavy plastic

so that any loose cable does not come in contact with the ground surface. Rewind the cable onto the WLI reel. Clean paper towels can be used to dry the cable as it is replaced onto the reel. Clean the sensor holder prior to replacing the WLI sensor in the holder. A decontaminated WLI can be placed in a large, clean plastic bag to help keep it clean between sampling locations.

3.5.2 Interface Probes

Cleaning interface probes is similar to cleaning WLIs. The sensor storage compartment should be cleaned in addition to the sensor and cable. Solvent rinses may be necessary if the Liquinox® wash does not remove all traces of organic contaminants. Follow the same basic protocol presented in Section 3.5.1. for cleaning the interface probe. Field personnel should not place a contaminated sensor in the storage compartment prior to decontaminating the sensor. As with WLIs, the interface probe can be placed in a large, clean plastic bag immediately following decontamination to keep it clean between sampling locations. Do not use acetone to clean the interface probe.

3.5.3 Total Depth Tapes

Regardless of the nature of any real or suspected well impact, special care should always be taken to ensure that all parts of a total depth (TD) tape including the actual stainless steel tape, weight and reel are clean prior to use. In addition, TD tapes present an additional decontamination challenge when they are used to measure total depth in wells with free-phase hydrocarbon present. Special brushes, tubs or trays, and/or solvents may be necessary to properly clean the TD tape between wells. It is also necessary to unreel more tape than was placed downhole into a tub and scrub with a brush in order to remove any traces of free-phase hydrocarbon that might have migrated from the outer portions of the stainless-steel tape to the inner portion of the tape. A decontaminated TD tape can also be placed in a large, clean plastic bag to help keep it clean between sampling locations.

3.5.4 Bailers

Disposable bailers are frequently used to obtain groundwater samples. These bailers are purchased pre-cleaned from the manufacturer and are individually wrapped in plastic. As long as these bailers are not allowed to come in contact with potentially contaminated surfaces (i.e., the ground surface), no additional cleaning is necessary.

Re-useable bailers are cleaned at a stationary location and are also wrapped in plastic. Cleaning bailers at the job site is not normally recommended. Special brushes and stainless steel trays must be transported to the job site to use for bailer decontamination. Unless otherwise specified, the general cleaning protocol is followed and special solvent rinses may or may not be used depending upon the analytes of interest for the site. Bailers should be taken apart for cleaning. Scrub the check valves and the male and female threads of each connection well. Re-assemble the bailer after the final rinse has been performed. Clean bailers should be placed in plastic sleeves to keep them clean until use.

3.5.5 Flexible Plastic Tubing

Flexible plastic tubing, often called poly pipe, is used in conjunction with submersible pumps to purge wells of stagnant groundwater. The standard cleaning protocol for poly pipe is to decontaminate the outside of the pipe and rely on the stagnant groundwater that moves through the pipe to flush out any contaminants from the inside of the poly pipe. The poly pipe comes in large, bulky coils, and it is very difficult for one (1) individual to adequately clean the pipe. Whenever large tubs are not available for decontaminating pipe, clean, heavy plastic sheeting must be placed underneath the coil of pipe to aid in keeping the pipe from coming in contact with the ground. Scrub brushes and Liquinox® wash solution are used to remove contaminants from the outside of the pipe. The various rinse solutions needed can be poured directly over the pipe or can be sprayed onto the pipe. The pipe should be rinsed well with a final distilled/deionized rinse. Cleaned poly pipe can be placed on another clean sheet of heavy plastic or in a clean, large plastic tub. To help assure that the poly pipe is thoroughly decontaminated, use clean paper towels to dry the poly pipe as the pipe is threaded down into the well.

Another type of flexible plastic tubing is used with low flow peristaltic and bladder pumps for purging and sampling monitor wells. This tubing is purchased on reels that should be placed in plastic bags upon receipt from the vendor. Normal decontamination of this tubing is to wipe any tubing that will be placed downhole with paper towels moistened with distilled/deionized water. If the tubing reel is not stored in a plastic bag, then a detergent solution wash followed by the appropriate series of rinse solutions shall be used. As with the larger poly pipe, the purging activities are usually relied upon to flush any contaminants from the inside of the tubing.

All plastic tubing or pipe shall be discarded in an appropriate manner immediately following initial use unless otherwise specified in the FSP. Used plastic tubing or pipe will not be decontaminated and reused at another project site.

3.5.6 Submersible Grundfos Pumps

Submersible pumps are cleaned by placing the pump into a bucket or deep tub of potable water and Liquinox® solution (The electrical cable and the safety cable can be cleaned using the protocol for the WLI, which is described in Section 3.5.1.). The pump controller is turned on and the solution is circulated through the pump. It may be necessary to remove the intake screen on the pump in order to clean it properly. The manufacturer's instructions should be consulted to see if components need to be removed in order to adequately clean the pump. After the wash solution has been circulated through the pump, the pump should be placed into the different water rinse solutions. Neither organic solvents, such as acetone or hexane, nor dilute acid solutions shall be circulated through the pump. The controller should be turned on and each rinse solution circulated through the pump. The final rinse consists of circulating distilled/deionized water through the pump. Following the final rinse, any components that were removed for cleaning should be re-assembled. A clean pair of gloves shall be used to perform any necessary re-assembly. A decontaminated pump can be wrapped in plastic until it is ready for use.

3.5.7 Low-Flow Bladder Pumps

These pumps are decontaminated by disassembling the pump body, disposing of the pump bladder, and scrubbing the internal ports using the supplied brushes. As always, follow the Liquinox® and water wash with three separate rinses of deionized/distilled water.

Reassemble pump, installing new bladder. A clean pair of gloves shall be worn during reassembly of the pump. The flexible tubing used with these pumps is single use only and should be disposed of as described in Section 3.5.5.

3.5.8 Downhole Sensing Instruments

Downhole sensing instruments include dissolved oxygen probes, conductivity probes, Hermit transducers, and any other sensing probe or instrumentation that is placed into a well. The typical cleaning protocol is the same as the protocol presented in Section 3.5.1. Take extreme care not to damage the sensors. The manufacturer's instructions should be consulted for all pieces of specialized equipment in order to determine whether solvents

can or cannot be used on the equipment and whether brushing or rubbing the sensors can damage them. The cleaning protocol should be modified accordingly so that equipment is not damaged but is decontaminated to the greatest extent possible.

4.0 QUALITY CONTROL AND QUALITY ASSURANCE

In order to verify that the equipment cleaning protocol is acceptable, many sampling events will include the submittal of at least one (1) equipment or rinsate blank sample for laboratory analysis for the analytes of interest for a particular project. While results for this type of sample will also include any bias inherent to the procedure and to the laboratory, the results are used to determine that the equipment decontamination protocol has been effective in removing any target analytes that might be present on the sampling equipment and whether the source water is truly "clean".

An equipment blank is prepared by pouring laboratory-supplied reagent-grade water over a piece of sampling equipment that has been cleaned using the specified decontamination protocol. The equipment should be cleaned using the exact same protocol used for all other equipment. An equipment blank that is prepared from inadequately cleaned equipment (cleaned using a different protocol than the protocol used during the actual sampling event being conducted) or that is not prepared from true downhole equipment has no value because it does not assess the true cleaning protocol or conditions that the groundwater samples are subject to .

5.0 REFERENCES

EPA SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC (May 1996).

OSWER-9950.1, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. Environmental Protection Agency, Washington, DC (September 1986).

PBS-181557, A Compendium of Superfund Field Operations Methods, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC (December 1987)

Smith, Dr. R.K., Handbook of Environmental Analysis, Genium Publishing Corporation, Schenectady, NY (1993).

TABLES

Table 001-T01: General Purpose Decontamination Solutions

Chemical	Solution	Uses/Remarks
Clean, Potable Water	None	Used to remove mud, dirt, or other residues as an initial rinse or to prepare designated solutions.
Distilled/Deionized Water	None	Use as intermediary rinses and as the final rinse for general purpose decontamination. Deionized water is more highly purified than distilled water and may be necessary for some sites.
Low-Sudsing Detergent	Liquinox – Use approximately 1 teaspoon per gallon of potable water; for other detergents-follow manufacturer's directions.	Generally used as a wash solution on most sites; best choice on sites where contaminant is unknown or a wide range of contaminants exists.

Attachment 001-A01
Checklist of Decontamination Equipment

- ☐ Potable Water Supply
- ☐ Distilled/Deionized Water Supply
- ☐ Decontamination Solution(s)
- ☐ Detergent ☐ Liquinox ☐ Other
- ☐ Solvent:_____
- ☐ Other:_____
- ☐ Cleaning Accessories
  - ☐ Soft-bristle Brushes
  - ☐ Buckets
  - ☐ Trays
  - ☐ Garden Sprayers
  - ☐ Squeeze Bottles
  - ☐ Long handle Brushes (for cleaning bailers)
  - ☐ Plastic Sheeting/Bags
  - ☐ Paper Towels

Notes: _____

STANDARD OPERATING PROCEDURE
FIELD ACTIVITY DOCUMENTATION - FIELD BOOKS
(SOP-002)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
FOR FIELD ACTIVITY DOCUMENTATION - FIELD BOOKS
(SOP-002)

1.0 SCOPE AND APPLICABILITY

The purpose of Standard Operating Procedure 002 (SOP-002) is to describe the procedures for acquiring and using a Field Book (FB) for recording data and observations during field activities as required by Work Plans or other project-specific documents such as Sampling and Analysis Plan (SAP), or Quality Assurance Project Plan (QAPP).

1.1 SCOPE OF SOP-002

This Standard Operating Procedure (SOP) describes the procedures for obtaining a project FB, listing the essential elements that shall be recorded in the FB, and describes document control system for FBs.

1.2 APPLICABILITY

All field activities at a site should be recorded in original form at the time they are conducted in a bound FB. Documentation to be recorded shall include:

- Notation that a site briefing on the task to complete and health and safety took place before field work was conducted
- Weather conditions
- Names of all personnel at the Site
- All sampling activities (planned and revised)
- Field testing and analysis results
- Labeling and chain-of-custody information
- Information regarding decontamination of personnel and equipment
- Sample packaging and shipping information
- Instrumentation calibration and maintenance information, as required per the field instrument

The types of field activities which require the above record keeping include, but are not limited to:

- Drilling, well installation, grouting, and well development activities
- Hydrogeologic testing and sampling
- Air monitoring
- Field audits
- Phase I Site Assessments
- Environmental investigation (general)
- Remediation/construction oversight
- Other field activities as required

Field documentation as described herein shall be conducted for all activities as specified in the Work Plan (WP) or other project-specific documents. In the event there is a conflict in specifications presented herein with those presented in the WP referencing this SOP, then the specifications in the WP will supersede the SOP specifications. FB documentation is not required for site visits where field activities as described above are not conducted.

1.3 STANDARD TERMS

Attachment 002-A01 to SOP-002 contains definitions for standard terms that are acceptable for use as entries into FBs. Use of standardized terms ensures that all personnel have the same understanding when using these defined terms.

2.0 PERSONNEL QUALIFICATIONS

All personnel that perform field activities shall be familiar with the requirements of SOP-002 prior to beginning the field activities requiring documentation. Additionally, training on the use of equipment and materials is required.

3.0 EQUIPMENT AND MATERIALS

3.1 FIELD BOOK

Each FB shall consist of a bound book, preferably with waterproof paper and pre-numbered pages. The individual recording observations or field data in any FB that is not pre-numbered shall number the pages of the book with sequential numbers located in the upper right-hand corner of each page.

Personnel shall utilize an assigned project FB for documenting field activities for a specific project. All field personnel should have at least one (1) spare FB with them at any time they are required to go to a project site.

3.2 WRITING UTENSILS

All entries recorded in a project FB will be made using either blue or black indelible ink or waterproof marker. Use of a pencil is not acceptable. Field personnel should carry an ample supply of spare writing utensils.

4.0 DOCUMENT CONTROL SYSTEM FOR FIELD BOOKS

4.1 FIELD BOOK INITIATION

Each FB shall be initiated when it is determined that field activities will commence. The following information, at a minimum, shall be recorded on the front of each FB:

- Client and/or project name and/or location,
- Project number, and
- FB number.

A FB number, which consists of a three-digit number that will be sequential, will also be assigned in the event that multiple FBs are needed for a project. The sequence number will begin with the number 001, then 002, 003, etc.

Whenever practical (determined by the size of the FB), the client and/or project name and project number shall also be recorded on the spine of the FB. Upon initiation of a FB the initiation information will be entered into the FB Tracking Form. This will document the start, status, and end of FB use.

4.1.1 Initiation of a Spare Field Book

Under some circumstances, personnel may find it necessary to initiate a FB while at a project field site. For example, this could occur because the assigned project FB has become full. The steps below shall be followed whenever a FB is initiated at a field site.

- Contact the QA/QC team as soon as possible with the pertinent information regarding the initiation of the new FB (project name, project number, sequence number, date initiated, and name of the individual retaining custody of the FB). The QA/QC team will record the information in the FB Tracking Log (**Attachment A002-A02**).
- Use a black waterproof marker to record the information discussed in Section 4.1 on the front and, if appropriate, the spine of the FB.
- The first entry in the new FB shall be a notation that the book has been initiated and is checked out by the individual initiating the book. Record the date the entry

is made. Make a notation in the FB that the QA/QC team has been notified of the new FB, unless the QA/QC team initiated the field book.

4.2 FIELD BOOK ORGANIZATION

The first two (2) pages in each field book are reserved for specific information described in Section 4.2.1 and Section 4.2.2 below. The remaining pages in the FB are for field activity documentation.

4.2.1 Field Book Initiation Documentation

A notation of the date the FB is initiated will be made on the first page. The individual initiating the FB shall include their name in the initiation notation. For example:

- Book initiated on April 8, 2013 by Jane Smith

4.2.2 Signatures

Following the FB initiation documentation, the printed name, written name, and initials of each person that makes entries into the FB will be recorded. An example is show in **Attachment 002-A04** This will help to determine which entries were made by various personnel using the FB.

4.2.3 Ownership

All FBs are the property of the client for which the project is being performed and the consultant. Only pertinent project information shall be recorded in the project FB.

4.3 RETURNING A FIELD BOOK TO CENTRAL FILES

All FBs shall be retained by the field team member(s) and provided to the QA/QC team upon completion of the field activities to determine all pertinent information has been recorded. Original field books, after closure of a project, will be maintained in the central files by the QA/QC team.

4.4 OBTAINING AN ESTABLISHED FIELD BOOK

Once a FB has been initiated it will be available for use. Each FB shall be retained in the QA/QC team files until the FB is checked out for use. The QA/QC team shall obtain the appropriate FB from their files to provide it to a member of the field team for upcoming project field work.

5.0 DOCUMENTATION GUIDELINES

The purpose of the FB is to fully document a field activity. Individuals making entries into the FB should ask themselves whether the field activity that is being documented can be re-created by another individual who is unfamiliar with the site by using only a site map and the FB notes. If not, then the level of detail of the field notes is insufficient and more details are necessary. In the case of a legal proceeding, notes, if referred to, can be subjected to cross-examination and are admissible as evidence. Both FBs and personnel (including other personnel in addition to the original note taker) are subject to subpoena. All FB entries should be factual, detailed, objective, and unbiased. At no time should a personal opinion be recorded in a FB.

The type of information that shall be recorded in the field notes is listed in Section 5.1 below. In addition, an example of typical FB entries is included in **Attachment 002-A04**. Even though specific information is required for FB entries, the format of information entry is left to the discretion of the individual making the entry. Individuals may use a tabular format where possible for conciseness and ease of use. This type of information may be duplicated on a form or may be transcribed to a form; however, the bound logbook record will take official precedence over transcribed or duplicated form records when the same data (whether conflicting or agreeing) is contained in both.

In some cases it may become necessary to augment existing FB entries. Any such entry shall be noted as such making it clear that the new information was not made at the time the original work was performed. Reference the “Error Codes” presented in **Table 002-T01**.

5.1 REQUIRED INFORMATION

The following list includes information that shall be included in FB documentation:

- Date and signature of person who checked out the FB
- Date and time of arrival at the field site
- Purpose of the site visit
- Documentation of site safety briefing per the site-specific HASP and review of field activities to be performed
- Signatures of all persons making current entries into the FB

- Weather conditions (daily, or as weather conditions change)
- Names of all personnel present at the site (daily)
- Field equipment unit numbers or other identification number (i.e., serial number)
- Calibration readings of all daily-required field instruments including initial calibration, continuing calibration, and any appropriate notes
- Record lot number and expiration dates for all calibration standards.
- Method of sample collection and any factors that may affect sample quality.
- Equipment and/or personnel decontamination procedures utilized
- Actual field measurements, including, at a minimum, actual measurement results and units of measurement.
- Any health and safety monitoring measurements as indicated by the Health and Safety Plan.
- Documentation of any relevant conversations (such as discussion with a client representative)
- Documentation of any problems encountered (i.e., well lock broken, well pad cracked, etc.) (daily).
- Photograph details
    - Approval to take photographs
    - Time, date, description of photograph
    - Name of photographer
- Initials of each person making entries at the bottom of each page.
- A diagonal line on blank space of any incompletely filled page (see **Attachment 002-A04** for examples) with the signature or initials of the last one to use the field book.

- Date, signature, and notation by person who returns the FB to the QA/QC team when either the FB is completed or the project is completed.

5.2 CORRECTION OF ERRORS

All errors in the FB shall be corrected by drawing only one (1) line through the entry. The initials of the person making the correction, along with the date of the correction shall be entered near the error. Additionally, appropriate error correction can also be found in the example of typical FB entries in **Attachment 002-A04**.

Wherever possible, error codes shall be utilized to explain why it was necessary to change a FB entry. The error code should be written near the correction and should be circled to make it clear that the entry is an error code. Proper error codes are listed in **Table 002-T01**.

6.0 REFERENCES

EPA SW-846, Test Methods for Evaluating Solid Waste Physical/Chemical Methods, U.S. Environmental Protection Agency, Office of Solid Waste, Washington, DC (June 1997).

EPA 330/9-78-001-R, NEIC Policies and Procedures, U.S. Environmental Protection Agency, Office of Enforcement, Denver, Colorado (August 1991).

OSWER-9950.1, RCRA Ground-Water Monitoring Technical Enforcement Guidance Document, U.S. Environmental Protection Agency, Washington, DC (September 1986).

PBS-181557, A Compendium of Superfund Field Operations Methods, U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, Washington, DC (December 1987).

TABLE 002-T01
ERROR CODES

Error Code	Description
CE	Calculation error correction
CL	Changed for better clarity
DC	Original sample description changed after further evaluation
NI	Not initialed and dated at the time of entry
OB	Not recorded at the time of initial observation
RE	Recording error
TE	Transcription error
SE	Spelling error
WO	Write over

ATTACHMENT 002-A01
STANDARD TERMS AND ABBREVIATIONS

Soil

SB	Soil Boring (SB-1)
BH	Bore Hole (BH-2)
HA	Hand Auger Boring (HA-1)
BGL	Below Ground Level
SS	Surface Soil Sample, usually for 0.0 – 0.5 feet
GS	Ground Surface
S	Sediment Sample (S-3)
SP	Soil Probe (SP-6)

When collecting soil samples, always record the depth interval that was sampled. BH-1 (2.0 – 3.0 feet BGL)

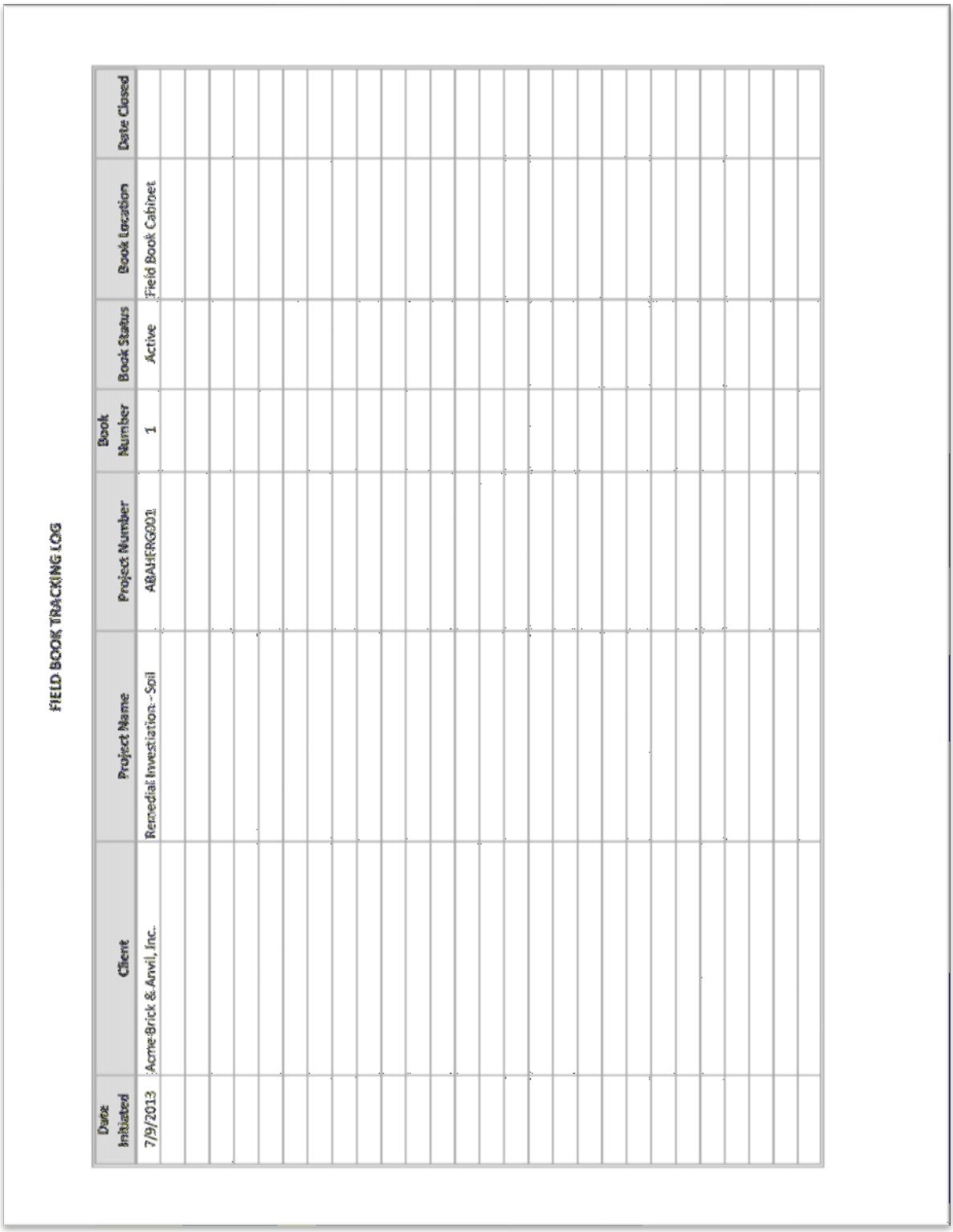
Water

WL	Water Level
SW	Surface Water sample (SW-3)
TD	Total Well Depth
TOC	Top of Casing
DTW	Depth to water
MW	Monitoring Well (MW-4)
DTP	Depth to Product

General

VOA/VOC	Volatile Organic Analysis/Volatile Organic Compounds
SVOA/SVOC	Semi-Volatile Organic Analysis/Semi-Volatile Organic Compounds

ATTACHMENT 002-A02
FIELD BOOK TRACKING LOG



FIELD BOOK TRACKING LOG

Date Initiated	Client	Project Name	Project Number	Book Number	Book Status	Book Location	Date Closed
7/9/2013	Acme Brick & Anvil, Inc.	Remedial Investiation--Soil	ABAHERG001	1	Active	Field Book Cabinet	

ATTACHMENT 002-A03
FIELD BOOK LOG

ATTACHMENT 002-A04
FIELD BOOK ENTRIES

STANDARD OPERATING PROCEDURE
MONITORING WELL DEVELOPMENT
(SOP-008)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE-
MONITORING WELL DEVELOPMENT
(SOP-008)

1.0 SCOPE AND APPLICABILITY

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-008 (SOP-008) describes the minimum acceptable requirements for developing monitoring wells or piezometers as described in the Work Plan, Sampling and Analysis Plan, or as otherwise specified for the purpose of characterizing subsurface groundwater conditions at the site.

In the event there is a conflict in specifications presented herein with those presented in the parent document which may reference this SOP, then the specifications in the parent document will be followed to the extent which they are different.

1.2 SCOPE COVERED BY SOP-008

This procedure describes general requirements and considerations for groundwater monitoring well or piezometer development, well purging and evacuation equipment, and general procedures for well development.

1.3 APPLICABILITY

Monitoring well development as described herein shall be conducted for all wells or piezometers as specified in the Work Plan or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent which they are different. The procedures presented herein are required for all environmental personnel.

1.4 DEFINITIONS

None.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing well development shall be properly trained in Health and Safety, field sampling and well development techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in the well development techniques. All personnel performing groundwater sampling activities shall be proficient in the well development methods described in this SOP or be under direct supervision of a qualified person.

3.0 HEALTH AND SAFETY

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Well development is the first exposure to a monitoring well, and related groundwater impacts, following the installation activities. Accordingly, field personnel should follow the precautions, procedures, and use the appropriate personal protective equipment (PPE) described in the approved Health and Safety Plan (HASP).

At a minimum, appropriate chemical-resistant gloves, safety glasses and steel toed boots shall be worn when performing well development activities. Review the Site specific HASP prior to preparation for well development activities to be aware of the specific PPE requirements.

4.0 EQUIPMENT AND MATERIALS

Equipment required is dependent on the method used for development of the well and partially on the potential groundwater impacts. All equipment to be placed into the well will be clean, either new, unused, or previously decontaminated.

- Gather together monitoring well installation information, Work Plan, or equivalent, Site map, and HASP

- Assemble well development equipment and supplies from approved vendors, including but not limited to

    - PPE
    - Liquid level meter
    - Organic vapor meter (OVM), if volatile organic compounds (VOCs) are potential impact
    - Pump, bailer or air compressor to purge well
    - Surge block
    - Drums for purge water containment
    - Labels
    - Water quality parameter meter(s)
    - Field book
    - Decontamination equipment and supplies
    - Tools

5.0 PROCEDURE

5.1 GENERAL REQUIREMENTS AND CONSIDERATIONS

Well development shall be conducted for all monitoring wells and piezometers and is required for the following reasons:

- To restore the natural permeability of the formation adjacent to the borehole.
- To remove clay, silt and other fines from the filter pack and well screen so that subsequent water samples will not be abnormally turbid or contain undue suspended matter.
- To remove foreign materials such as remnant drilling fluids from the well, filter pack, and aquifer that were introduced during the time of drilling and well installation.
- To remove pH changed/affected groundwater that may have occurred during the well grouting operation.

All well development and groundwater sampling equipment (including pumps, hoses, containers, and bailers) will be decontaminated prior to introduction into wells or piezometers to be developed. Decontamination procedures in SOP-001 should be followed.

5.2 DEVELOPMENT METHODS AND PROCEDURES

Following completion of the monitoring well installations, all wells should be thoroughly developed. The purpose of monitoring well development is to remove any fluids lost to the formation during drilling (if fluids were used in the drilling process) and ensure proper development of the sand pack and formation surrounding the screen. To ensure proper curing of the cement-bentonite grout seals, no development will occur for at least 24 hours following well completion. Monitoring wells should not be sampled within 48 hours of well development.

Prior to development, the water levels within the well and the total well depth will be measured and recorded in accordance with SOP-009. These measurements will be used to calculate the fluid volume in the wells and sand pack prior to development. Water levels should be taken and recorded before, during and after well development. In the event volatile organics are a potential groundwater impact an OVM should be used to monitor the air quality at the top of casing (TOC) of the well and in the operator breathing zone (OBZ).

Development will consist of the removal of sufficient volumes of groundwater until the discharged water is relatively free from suspended sediment and the pH, specific conductance, and temperature of the groundwater has stabilized. In addition, any fluids lost during drilling will be recovered and, if practicable, this quantity plus at least three times the casing and sand pack volume (assume 30% porosity) will be

removed. Field conditions, such as well yield and quality of filter pack may have bearing on expected development quality. All development water will be captured and managed in accordance with SOP-024. Measurements of the discharge volume, pH, temperature, and specific conductivity.

The basic procedure for well development is to remove any drilling fluids, silt, clay fines and sands from the well, well screen and surrounding gravel pack. Provided that the formation recharge rate is high enough, groundwater will flow from the formation, through the gravel pack and screen, and into the well. The groundwater flowing from the formation and sand pack will carry loose particles into the well to be removed.

The typical well development methods used are surging, over-pumping, and bailing. Obtaining the highest possible yield is not usually an objective in well development and vigorous development is not always necessary. The choice of an appropriate method to develop a well is based on site conditions and project objectives as outlined in a Work Plan, Sampling and Analysis Plan (SAP), Field Sampling Plan (FSP), or Quality Assurance Project Plan (QAPP). To ensure proper curing of the cement-bentonite grout seals, no development will occur for at least 24 hours following well completion.

- Surging involves raising and lowering a surge block or surge plunger inside the well. This forces water through the well screen and into the sand pack and formation and loosens sediment pulled from the formation into the well. Sediments accumulated in the well will need to be removed with a bailer or pump.
- Surging may also be accomplished through the use of compressed air. The air is used as an air lift to evacuate the well and to agitate the water column and well screen. The agitation and evacuation process are repeated until the well is sufficiently free of sediment.
- Over-pumping involves pumping at a rate rapid enough to draw the water level in the well as low as possible and then allowing the well to recharge to the original level. The process is repeated until sufficiently sediment free water is produced.
- Bailing involves the use of a bailer to remove water from the well. The process is repeated until sufficiently sediment-free water is produced. In some cases, potable water may be added to assist in developing a poor-yielding well. In this instance, the volume of water used must be added to the standard quantity removed from a well for development.

5.2.1 Well Casing Evacuation

Using the depth to water, well depth, and filter pack interval (assume a porosity of 30%), calculate the minimum volume of groundwater to remove from each well. The following equations should be used to calculate the volume of groundwater:

(1) Casing water volume is $V_c = \pi r_c^2 h_c \times 7.48$; where:

V_c = The volume of water in casing, gallons

r_c = Radius of casing, feet

h_c = Height of water column in casing, (TD – DTW) feet

7.48 = Conversion factor from cubic feet to gallons

(2) Annular water volume is $V_s = (\pi r_s^2 h_s - \pi r_c^2 h_{cs}) \times 7.48 \times 0.30$; where:

V_s = The volume of water in the saturated sand pack interval, gallons

r_s = Radius of drilled borehole, feet

h_s = Height of saturated sand pack interval, feet

r_c = Radius of casing, feet

h_{cs} =Length of casing/screen in sand pack interval, feet

0.30 = Estimated porosity of sand pack

7.48 = Conversion factor from cubic feet to gallons

The minimum amount of water that should be removed from the well for well development equals three casing volumes (V_c) plus the three sand pore volumes (V_s).

(3) The volume to be removed is $V = 3(V_c + V_s)$

If a well is incapable of yielding three well volumes, then the well will be surged and evacuated to dryness, multiple times if possible) and allowed to recover. If necessary, potable water may be added to the well to assist in developing. All purged groundwater will be collected and stored for proper disposal.

Purged water shall be tested periodically for pH, temperature, and specific conductance. Readings shall be compared to ensure that water quality in the well has stabilized. Stabilization is indicated when the above parameters vary less than 10 percent for at least three consecutive readings. In some instances turbidity of the purge water can be monitored to evaluate the progress of the well development.

6.0 DOCUMENTATION

Prior to development, the water levels within the well and the well depth will be measured and recorded in accordance with SOP-009. These measurements will be used to calculate the fluid volume in the wells and sand pack prior to development. Measurements of the discharge volume, pH, temperature, and specific conductivity along with observations of water clarity will be recorded on field forms or in the field logbook. Water levels may be taken and recorded before, during and after well development.

7.0 REFERENCES

Practical Guide to Ground Water Sampling, United States EPA, EPA/600/2-85/104, September 1985.

RCRA Ground-Water Monitoring: Draft Technical Guidance, United States EPA Office of Solid Waste, November 1992.

RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), OSWER- 9950.1, September 1986.

United States EPA Environmental Response Team SOP 2044 rev 0.1, November 23, 2001.

STANDARD OPERATING PROCEDURE
GROUNDWATER LEVEL MEASUREMENTS
(SOP-009)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE FOR GROUNDWATER LEVEL MEASUREMENTS (SOP-009)

1.0 SCOPE AND APPLICIBILITY

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-009 (SOP-009) describes the minimum acceptable requirements for obtaining groundwater levels in monitoring wells and piezometers.

1.2 SCOPE COVERED BY SOP-009

This procedure describes the minimum requirements for conducting water level measurements of groundwater, discrete water level measurements, and continuous water level measurements.

1.3 APPLICABILITY

Water level measurements as described herein are applicable for groundwater sampling events and shall be conducted as specified in the Work Plan, Sampling and Analysis Plan (SAP), or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.4 DEFINITIONS

1.4.1 Water Table Elevation

Water table elevation is the elevation of the groundwater surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric.

1.4.2 Total Hydraulic Head

Total hydraulic head is the sum of the elevation head, the pressure head, and the velocity head at a given point in an aquifer.

1.5 HEALTH AND SAFETY CONSIDERATIONS

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures, and use the appropriate personal protective equipment described in the approved Health and Safety Plan. Care shall be exercised to avoid direct skin contact with the water or well contaminants on equipment during and after measuring.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing groundwater level measurements shall be properly trained in field sampling and water level measurement techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in the water level measurement techniques. All personnel performing groundwater sampling activities shall be proficient in methods described in this SOP. Occasional on-site field audits conducted by the Environmental Department will ensure that field personnel continue to perform water level measurements correctly.

3.0 EQUIPMENT AND MATERIALS

3.1 GENERAL REQUIREMENTS

Water level measurements shall be obtained at wells and piezometers designated in the Work Plan or SAP. Water levels should be referenced to a common elevation datum for the entire site, preferably to a USGS benchmark. Water depths within wells and piezometers shall be referenced to the top of the casing, which is, in turn, referenced to a permanent benchmark. Water level measurement devices shall be decontaminated as per SOP-001.

3.2 DISCRETE WATER LEVEL MEASUREMENTS

3.2.1 Wells/Piezometers with Screens, Fully Open to Water Table

Water levels shall typically be required from a series of wells when data for preparing groundwater contour maps are needed. Water levels may also be required when monitoring the changes in water level during aquifer testing if aquifer response is sufficiently slow.

Water level measurements shall be made by determining the depth to the water surface below the reference point. The fixed reference point is typically established by scribing the point on the northern, outer edge (lip) of the well casing. A line should be scribed or notched so that filings do not fall into the wall.

Attachment 009-A01 describes the method to be used making water level measurements with electronic water level indicators. Electronic water level indicators are conduction probes which activate an alarm and light when they intersect the water. The depth to water level is determined by reading the measured and marked increments on the lowering cord.

3.3 INTERFACE METERS

If light non-aqueous phase liquids (LNAPL) are suspected to be present or if dense non-aqueous phase liquids (DNAPL) are suspected, then a meter equipped with an electronic interface probe that is capable of distinguishing between water and LNAPL/DNAPL should be utilized. If LNAPL or DNAPL are suspected, then the interface meter should be used to check the surface of the fluid column and also the base of the fluid column. Manufacturer's instructions for use shall be reviewed prior to using an interface meter. All readings will be recorded in the field log book.

Attachment 009-A02 describes the method to be used making water level measurements with an interface meter. Interface meters typically use an infrared beam and detector which activate an alarm and light when they intersect the water and non-aqueous liquids. The depth to water level is determined by reading the measured and marked increments on the lowering cord.

3.4 CONTINUOUS WATER LEVEL MEASUREMENTS

Continuous water level measurements are made by determining the height of the water column above a pressure transducer and electronically recording fluctuations in this height with a data logger. The continuous record is used for aquifer testing where rapid changes in water level are anticipated.

4.0 REFERENCES

Driscolt Fletcher, G., Groundwater and Wells, Second Edition, Minnesota, 1986.

Practical Guide for Ground-Water Sampling, U.S. EPA, EPA/600/2-85/104, September 1985.

RCRA Groundwater Monitoring: Draft Technical Guidance, EPA Office of Solid Waste, November 1992.

RCRA Ground-Water Monitoring Technical Enforcement Guidance Document (TEGD), OSWER- 9950.1, September 1986.

ATTACHMENT 009-A01

WATER LEVEL MEASUREMENT WITH ELECTRICAL WATER LEVEL INDICATORS

Description

Electrical water level indicators use the water in the well to close an electrical circuit. Contact with water is indicated by a small lamp or amp meter. Power is supplied by small flashlight batteries. Typical electrical water level indicators use either a single wire or a two-wire configuration. Single wire (electrode) indicators are grounded to the steel well casing. The wire is then lowered to contact the water, and the circuit is closed. Both the positive and negative electrodes are lowered into contact with the water in a two-wire configuration. In both water level indicator types, the wire or cable is marked in 0.01-foot intervals to indicate depth. Depth is referenced to the surveyor's mark. All water level indicators are equipped with weights to maintain line tension for accurate readings.

Application

Electrical water level indicators are useful for all water level measurement needs. Electrical water level indicators can also be used to obtain accurate readings in pumping wells where water turbulence makes steel tape readings difficult. Electrical water level indicators may be left in a well for long periods of time, if required.

Limitations

The most serious drawback to the use of electrical water level indicators in monitoring is the insulating effect of oil contaminants (if present), particularly where there is a significant amount of floating oil. In such cases, an electrical water level indicator made to detect floating oil and water (interface meter) should be used.

Procedure

Check the interval markers with a surveyor's tape to verify length of water level indicator wire or cable. Inspect the surveyor's reference mark inside the casing to be sure of legibility.

Lower the water level indicator probe until it just makes contact with the water in the well. Record the position of the probe relative to the reference point. Record the actual water level reading to the nearest 0.01-foot. Repeat to confirm depth.

Withdraw the water level indicator from the well. Decontaminate the water level indicator wire or cable and probe in accordance with SOP-001.

ATTACHMENT 009-A02

WATER LEVEL MEASUREMENT WITH INTERFACE METERS

Description

Electrical water level indicators use the water in the well to close an electrical circuit. However, if LNAPL or DNAPL is suspected to be present, then a meter equipped with an electronic interface probe should be utilized that is capable of distinguishing between water and LNAPL/DNAPL based on non-completion of the conductivity circuit. All water level indicators are equipped with weights to maintain line tension for accurate readings.

Application

Interface meters measure the thickness of floating or sinking products in monitoring wells or storage tanks. To detect liquids, interface meters typically use an infra-red beam and detector. When the probe enters a liquid, the beam is refracted away from the detector, which activates an audible tone and light. If the liquid is a non-conductive oil/product, the signals are steady. If the liquid is water, the conductivity of the water completes a conductivity circuit. This overrides the infrared circuit, and the tone and light are intermittent.

Procedure

Turn main switch to the “on” position. Also twist probe to the “on” position. A flashing light on the faceplate indicates that the probe is in the “on” position, but the main switch is not “on.” A continuous buzz indicates that the main switch is “on”, but the probe is “off.”

Lower probe slowly until lights and audible tone are on. Raise and lower the probe gently to determine the exact upper level of the nonconductive floating product (LNAPL). Note level from marked tape. If no floating product exists, one single light will come on. Continue to lower the probe until only one light is on. Shake the probe slightly at this point to clear any residual product from the conductivity sensor. Raise the probe slowly until both lights and the audible tone are on to determine the LNAPL/water interface. Read level directly from the tape to the nearest 0.01ft. Repeat to confirm readings. Record depth and thickness and continue logging to determine if DNAPL is present by lowering the probe to the bottom of the well. Allow the probe to each the bottom and lift up on the tape until some tension is felt. Record the total depth of the well. If DNAPL is detected, record the top and bottom elevations of that layer.

Withdraw the water level indicator from the well. Decontaminate the water interface meter and probe in accordance with SOP-001.

STANDARD OPERATING PROCEDURE
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES
(SOP-018)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES
(SOP-018)

1.0 SCOPE AND APPLICABILITY

Standard Operating Procedure-018 (SOP-018) describes the requirements for preparation of sample containers, preservation of samples, and sample holding times to ensure that accurate and valid chemical analyses may be performed.

1.1 SCOPE COVERED BY SOP-018

This procedure describes the general requirements, types of containers, cleaning procedures for sample containers, preservation procedures for samples, and holding times for samples.

1.2 APPLICABILITY

Procedures for sample containers, preservation of samples, and sample holding times as described herein shall be conducted as specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different. Further, if an analytical method change occurs (e.g., EPA SW 846 or equivalent), the new procedures will supersede the protocols presented herein.

1.3 DEFINITIONS

Holding time – the maximum time that samples may be held before the start of preparation and/or analysis where the resulting analytical data are considered valid. Holding time will be determined by the laboratory based on the date and time provided on the sample containers/chain-of custody forms.

1.4 HEALTH AND SAFETY CONSIDERATIONS

These procedures may involve exposure to impacted sample waters or soils via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures, and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

1.5 PERSONNEL QUALIFICATIONS

Personnel collecting samples for chemical analyses shall be properly trained in field sampling techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in using the equipment needed to conduct sampling techniques.

2.0 MATERIALS AND METHODS

2.1 GENERAL REQUIREMENTS AND CONSIDERATIONS

Sample containers and preservation methods should be selected and used such that accurate and valid chemical and physical analyses may be performed. Materials or procedures that might cause overt disturbance, contamination, oxidation or other chemical decomposition or reaction of the sample should be avoided. This SOP only addresses containers and preservation of chemical analytical samples. Use of containers and preservation procedures should be consistent with analytical procedures to be used by the analytical laboratory. Preservation is generally limited to pH control, addition of chemicals, and refrigeration. These techniques are intended to retard biological action, retard hydrolysis of chemical compounds, keep metals in solution, and reduce volatility of constituents.

Refrigeration to maintain the sample temperature near 4°C is the minimum amount of preservation that should be performed for most environmental samples. Samples should not be frozen and dry ice should not be used as the cooling agent (due to shipping restrictions). Chemical preservatives may be added to sample bottles in advance, generally by the testing laboratory or by field personnel.

The sample volumes required for analysis vary widely depending on laboratory capabilities. The volumes prescribed herein are conservative numbers; however, the actual analytical laboratory that will be performing the required analyses should be consulted as to the quantity required.

2.2 CONTAINER TYPES

Sample containers are generally be supplied by the laboratory which is contracted to perform the analyses. Laboratories shall provide appropriate, pre-cleaned containers for the types of analyses specified. Each container should be clearly labeled as to the type of test and chemical preservative (if required).

2.2.1 Documentation of Containers and Preservatives Used

A list of containers and preservatives used to collect aqueous or solid samples shall be recorded in the field log book.

2.3 CONTAINER AND PRESERVATION REQUIREMENTS FOR ENVIRONMENTAL SAMPLES

Containers, preservatives, and holding times specific to an individual project should be provided in the site-specific Work Plan or SAP. The selected analytical laboratory can supply specifics on the required preservation and holding times for the specified analytical methods.

2.3.1 Water Samples

2.3.1.1 Organics

Water samples for organics shall be collected in glass bottles equipped with teflon- lined screw caps. Water supply and other samples suspected of also containing residual chlorine shall have 0.008 percent NA2S203 (sodium thiosulfate) added. These water samples should be preserved by cooling with ice to 4°C.

Regulatory or other considerations may require that duplicate samples be collected for purgeable organics (volatile organics). Samples for purgeable organics should be collected in 40-ml glass vials (purge vials) equipped with teflon-backed silicon septum screw caps, filled with minimal aeration to the sample, and vials shall be filled completely with no headspace. The sampler shall take care that any chemical preservative in the vial is not washed out while filling the vial.

Samples for extractable organics should be collected in two one-liter, amber glass bottles with teflon-lined caps.

2.3.1.2 Metals

Water samples for metals analyses should be collected in high-density polyethylene bottles with solid polyethylene or polyethylene-lined caps. Containers should be filled to within ¼ inch of the top of the bottle. The samples should be preserved with nitric acid to below pH 2. Nitric acid concentration should not exceed 0.15 percent if the sample is to be shipped via air cargo.

2.3.1.3 General Chemistry

Water samples collected for general chemistry parameters will include a variety of containers and preservatives depending on the analyses to be performed. Containers should be filled to within ¼ inch of the top of each bottle.

2.3.2 Soil or Sediment Samples

Soil or sediment samples should be collected in wide-mouth glass jars equipped with teflon-lined screw caps. Samples should be preserved by cooling with ice or refrigeration at 4°C.

For samples being collected for volatile analyses by SW-846 Method 5035, samples shall be collected with appropriate coring devices. The cores shall be placed directly into appropriate, tared sample vials. Depending on the analytical method, the vials may or may not contain preservatives or teflon stir bars. The sampler shall write only on the supplied label and shall take extra care to remove any excess sample from the vial threads before replacing the vial lid. A separate wide-

mouth glass jar should also be filled with sample and submitted to the analytical laboratory. This jar is used for moisture determination so that sample results can be reported on a dry-weight basis.

3.0 REFERENCES

U.S. EPA, "Methods for Evaluation of Water and Wastes," EPA-600/4-79-020.

U.S. EPA, "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document," September,1986.

U.S. EPA, "Test Methods for Evaluating Solid Waste," publication SW-846, 1986 (Third Edition).

STANDARD OPERATING PROCEDURE
SAMPLE CLASSIFICATION, STORAGE, PACKAGING AND SHIPMENT
(SOP-019)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
SAMPLE CLASSIFICATION, STORAGE, PACKING AND SHIPMENT
(SOP-019)

1.0 SCOPE AND APPLICIBILITY

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-019 (SOP-019) describes the requirements for sample classification, storage, packaging, and shipment for the purpose of ensuring proper handling of samples.

1.2 SCOPE COVERED BY SOP-019

This procedure describes the general requirements, sample classification categories, sample storage requirements, sample packaging procedures, and sample shipping requirements for environmental samples being transported to analytical laboratories for analyses.

1.3 APPLICABILITY

Procedures for classification, storage, packaging, and shipment of samples as described herein shall be conducted as specified in the Work Plan, Sampling and Analysis Plan (SAP), or other document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.4 DEFINITIONS

None.

1.5 HEALTH AND SAFETY CONSIDERATIONS

These procedures may involve exposure to impacted sample waters or soils via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures and use the appropriate personal protective equipment described in the approved Site Health and Safety Plan.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing sample packaging and shipment procedures shall be trained in field sampling techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in sample packaging and shipment techniques described in this SOP.

3.0 MATERIALS AND METHODS

3.1 GENERAL REQUIREMENTS AND CONSIDERATIONS

Classification of samples shall be made on the basis of the suspected level of contaminant concentration which determines subsequent packaging and labeling requirements, shipping procedures and laboratory handling of samples.

Contamination concentrations must be assessed early in the planning stage of an investigation because of their effect upon field operations. Sample classification must be considered in the development of the Health and Safety Plan and Field Sampling Plan. The procedures and materials used for sample packaging must adequately protect the sample container from accidental breakage and should be sufficient to prevent any leaks or spills. Sample labels for proper sample identification are discussed in SOP-022. Samples classified as hazardous shall be shipped only by means specified in the appropriate Department of Transportation (DOT) regulations.

3.2 SAMPLE CLASSIFICATION

3.2.1 Environmental Samples

On-site samples may be classed as "environmental" by the Project Manager based on knowledge of the site and the nature of the sample. Samples collected off-site are considered "environmental" unless information to the contrary exists.

Initially, concentrations of constituents are estimated based on knowledge of contaminant sources and the contaminant transport mechanisms and their effects on contaminant concentrations. It is necessary to be conservative in the estimate of contaminant concentration. Sample classification can be downgraded for subsequent samples if data exists to support that decision.

3.2.2 Hazardous Samples

"Hazardous Samples" include soil or water samples that may be highly contaminated, sludge or waste pile samples of concentrated wastes, or any sample from an unlabeled drum or container.

3.3 SAMPLE STORAGE

Samples shall be stored in a manner consistent with the requirements for sample preservation so as to maintain the quality of the sample. Samples preserved by cooling shall be stored in such a way as to maintain the acceptable range of temperature for the duration of the holding time. The cooling process must be initiated immediately after sample collection in the field. Samples shall not be stored on-site for extended periods of time and should be protected from environmental extremes. Shipment to the laboratory should be completed as soon as possible and well within any holding time limits specified for particular analyses.

If temporary storage is necessary, samples shall remain in an area that has been designated as the "sample storage area" which must be locked and secured to maintain sample integrity and chain-of-custody requirements. Samples subjected to temporary storage shall be checked periodically to confirm that the appropriate holding temperature is being maintained. If temporary storage is necessary, holding temperature shall be confirmed with an NIST-certified thermometer or other device that has been calibrated to a NIST-certified thermometer. The sampler shall record the holding temperature and any periodic temperature measurements in the field logbook.

Samples shall not be stored in refrigerators or other areas where food or drink may also be stored and vice versa.

3.4 ENVIRONMENTAL SAMPLE PACKAGING

3.4.1 Regulatory Considerations

Current DOT regulations shall be reviewed prior to a sampling event to ensure that samples are shipped appropriate depending upon matrix and expected concentration of constituents of concern.

3.4.2 Shipping Containers

All sample containers should be placed inside a strong shipping container capable of withstanding a 4-foot drop on solid concrete in the position most likely to cause damage. A metal or plastic picnic cooler (ice chest) with a hard plastic liner withstands this test. The drainage hole at the bottom of the cooler must be taped shut so that the contents from broken containers or water from ice cannot escape. The shipping container should be taped shut to form an adequate seal around the lid to prevent any leakage in the event that the cooler is turned over.

Two plastic liners shall be placed inside the shipping container and all samples and ice shall be placed inside these liners.

3.4.3 Ice

Samples shall be packed in loose wet ice. The amount of ice used will depend on the available space in the cooler but 10 pounds per 20 quarts of cooler volume should be the minimum amount to ensure sufficient cooling. Dry ice (CO_2) generally should not be used.

3.4.4 Glass Sample Bottles

The lid of the glass sample bottle shall be tightened to ensure an adequate seal and to prevent loosening during transit. Glass containers should be wrapped and cushioned in an inert packing material such as Styrofoam, closed-cell foam packing material, or bubble wrap.

3.4.5 Plastic Containers

Plastic containers do not require individual cushioning material, but shall be packed to prevent movement during transport. Caps should be adequately tightened to prevent loosening during transit.

3.5 HAZARDOUS SAMPLE PACKAGING

3.5.1 Regulatory Considerations

If a sample is known to contain a material identified in the DOT Hazardous Materials Table, packaging, labeling and shipment must conform to the specific requirements for that substance. Current DOT and shipping firm requirements shall be followed for these types of shipments.

3.6 SHIPPING OF SAMPLES

3.6.1 Environmental Samples

Environmental samples may be shipped by commercial common-carrier, bus, by rental vehicle or air-cargo service to the testing laboratory. Samples should be received by the laboratory within 1 day after sampling or sooner, if necessary, to allow initiation of analyses within prescribed holding times.

3.6.2 Hazardous Samples

Hazardous samples shall comply with current DOT and shipping form requirements and regulations regarding shipment.

4.0 REFERENCES

Code of Federal Regulations, Title 49 {Transportation}, Hazardous Materials Tables and Hazardous Materials Communications Regulations: 49 CFR, Part 172, Office of the Federal Register, Material Archives and Records Service, General Services Administration.

Code of Federal Regulations, Title 49 (Transportation), Shippers - General Requirements for Shipments and Packages: 49 CFR, Part 173, Office of the Federal Register, National Archives and Records Service, General Services Administration.

U.S. EPA, "EPA Technical Methods for Investigating Sites Containing Hazardous Substances," Technical Monograph No. 22, Draft, dated June, 1981.

U.S. EPA, "RCRA Ground-Water Technical Enforcement Guidance Document," September 1986.

STANDARD OPERATING PROCEDURE
SAMPLE CONTROL AND CUSTODY PROCEDURES
(SOP-022)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
SAMPLE CONTROL AND CUSTODY PROCEDURES
(SOP-022)

1.0 SCOPE AND APPLICABILITY

To assure the integrity of data and the quality of the data generated from samples collected during environmental investigations, all samples are presumed to be collected as legal evidence and must be handled using strict custody control procedures described herein. Chain of Custody (COC) begins at the time of sample collection and ends at the final disposal of any remaining sample after laboratory analysis/storage.

This procedure is to be used by all personnel collecting samples for any variety of sample matrix.

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-022 (SOP-022) describes the procedures for controlling sample custody to maintain the quality and integrity of samples during collection, transportation, and storage for analysis.

1.2 SCOPE OF SOP-022

This procedure describes requirements for sample identification labels, transfer of sample custody and shipment, use of COC forms, and use of custody seals.

1.3 APPLICABILITY

Sample control and custody procedures described in this SOP are applicable for all sampling activities. In the event there is a conflict in the specifications presented herein with those requested by a Client or a Regulatory Agency, then those specifications will supersede the SOP's specifications.

1.4 DEFINITIONS

1.4.1 Chain-of-Custody Forms

Because samples collected during a field investigation could be used as evidence in litigation, possession of the samples must be traceable from the time each sample is collected until disposal procedures are implemented by the analytical laboratory after analysis has been completed and the samples are released for disposal. To document sample possessions, COC forms are used and COC procedures are followed.

1.4.2 Custody Seal

A custody seal is an adhesive-backed strip that is placed on a sample or shipping container in such a manner that a broken seal would provide evidence that the container was opened during transit, thereby potentially affecting the integrity of the sample(s).

1.4.3 Sample Nomenclature

Standard terms for sample nomenclature are discussed in SOP-002 Attachment 002-A01 and will be utilized when identifying samples in field book documentation, on sample labels, and on COC forms.

1.4.4 Custody Control

A sample is under custody control if one or more of the following criteria are met:

- The sample is in the sampler's possession
- The sample is in plain view of the sampler
- The sample was in the sampler's possession and then was locked up to protect the integrity of the sample
- The sample is in a secured area

2.0 PERSONNEL QUALIFICATIONS

All personnel that may perform field activities shall be familiar with the requirements of SOP- 022 prior to beginning a field investigation.

3.0 EQUIPMENT AND MATERIALS

3.1 COC FORM

A 2-part COC form is utilized to document sample custody. **Attachment 022-A01** contains an example of a COC form. Alternatives to this form may be acceptable. Each person accepting or relinquishing custody of samples shall sign and date the COC form. The top copy is shipped with sample containers to the analytical laboratory and the bottom copy is returned to the originating project manager. Additionally, a copy of the COC shall be provided to the QA/QC team as soon as practicable.

3.2 SAMPLE IDENTIFICATION LABEL

An adhesive-backed label is used to record the pertinent sample information and is affixed to the sample container. The label must not be easily removable from the container. **Attachment 022-A02** contains an example of a sample identification label.

3.3 CUSTODY SEAL

The custody seal is an adhesive-backed strip with space for the signature of the shipper and the shipping date. An example of a custody seal is proved as **Attachment 022-A02**. Custody seals are affixed to the shipping container or sample containers to ensure sample integrity and quality. A broken seal would suggest that the shipping containers and/or sample bottles were opened during transit.

3.4 WRITING UTENSILS

All entries recorded on COC forms, sample identification labels, or custody seals will be made using either blue or black indelible ink or waterproof marker. Use of a pencil is not acceptable. Field personnel shall carry an ample supply of spare writing utensils.

4.0 PROCEDURES

Sample control and custody shall be followed, without exception, by all persons involved in sampling and documentation activities during a field investigation.

Documentation of sample identification include, but are not limited to, COC forms, field books, custody seals, and sample labels.

4.1 SAMPLE IDENTIFICATION LABELS

Sample labels shall be provided by the analytical laboratory or the QA/QC team. Labels may be preprinted with spaces for the appropriate sample identification and information requirements. The label shall be of the type of material that indelible ink will write, but not be so overly absorbent that the ink will run. Labels will have an adhesive backing for securing on the sample containers.

The following sample information will be contained on each sample label and will be recorded in the field book:

- Site identification
- Sample identification number
- Date and time of the sample collection
- Preservative(s) used
- Printed name and signature of sampler

4.1.1 Labeling Procedure

After collection of a sample and placing it into the appropriate container, wipe off any excess sample matrix from the container surface. Fill out label information as prescribed above using indelible ink. Remove paper backing and affix adhesive label to the container. If a mistake is made, neatly mark through the mistake with a single line and write in the appropriate correction. All corrections must be initialed, dated, and an appropriate error code assigned to it.

If a label is too smudged or damaged to correct it neatly, affix a new label onto the container, completely covering the damaged label. **Attachment 022-A02** contains an example of a label.

Labels supplied by some analytical laboratories may be attached to the sample containers prior to shipment to the project site. The described procedure will be followed with the necessary modifications.

4.2 CHAIN OF CUSTODY RECORD

Because samples collected during an investigation could be used as evidence in litigation, possession of the samples must be traceable from the time each is collected, until disposal. To document sample possession, COC procedures and documentation are discussed below.

4.2.1 Chain of Custody Documentation and Forms

Chain of Custody documents are initiated by the sampling personnel in the field with the notation of sampling date, sample collection time, and sample identification. These data will also be noted in the field book, generally in a tabular format along with the description of the sample and sampling procedure, and include the following at a minimum:

- Sample identification information
- Date and time sample was taken
- Number and type of containers used
- Whether sample was grab or composite
- Preservation method used
- Notation of any samples that may be ‘hot” or contain light or dense non-aqueous phase liquids
- Analyses requested
- Name of sampling personnel (printed name and signature)
- QA/QC contact names, telephone numbers
- Shipping method and airbill tracking number

Each sample sent off-site will be recorded on a COC form by the sampler or a field sample custodian at the site. Any COC forms that are serialized with a unique COC identification number shall be documented in the field book for traceability. An example of a COC form is presented in **Attachment 022-A01**.

The COC form will be filled out by the sampler or the field sample custodian on behalf of the sampler. The COC form will be signed by the sampler upon relinquishing custody.

4.3 CUSTODY SEALS

When samples are shipped to the laboratory, they must be placed in containers sealed with custody seals. When samples are shipped, two or more seals are to be placed on each shipping container (such as a cooler), with at least one at the back, located in such a manner that a seal or seals would be broken if the container were opened during transit. Wide, clear tape will be placed over the seals to ensure that seals are not accidentally broken during shipment.

If samples are subject to interim storage before shipment, custody seals may be placed over the lid of the jar or across the opening of the storage box. Custody during storage will be the same as described above.

Attachment 022-A02 contains an example of a custody seal. **Attachment 022-A03** shows custody seal placement on a shipping container.

4.4 FIELD CUSTODY PROCEDURES

Only enough of the sample will be collected to provide representation of the matrix being sampled. To the extent possible, the quantity, types of samples, and the sample locations will be determined before the actual field work. As few people as possible will handle the samples.

Sample containers will be provided by the laboratory. In the event that emergency sampling is required, bottles (provided they are not expired or may have been compromised) that an office may have on-hand can be used. This is not preferable, but may sometimes be necessary and shall be noted in the field book and communicated to the QA/QC team.

Trained field samplers are personally responsible for the care and custody of the samples collected until the samples are transferred or properly dispatched. The criteria listed in Section 1.4.4 will be followed. A person may be designated to receive the samples from the field samplers after container decontamination; this person maintains custody until the samples are dispatched. The project manager or QA/QC team will determine whether proper custody procedures were followed during the field work and will decide if additional samples are required to make up for any deficiencies.

Samples shall be accompanied by a COC. When transferring samples, the individuals relinquishing and receiving them will sign, date and note the time of relinquishment or receipt on the form.

Samples shall be packaged properly for shipment and will be dispatched to the appropriate laboratory for analysis, with a separate COC record accompanying each shipping container. Shipping containers are sealed with custody seals for shipment to the laboratory. All shipments are accompanied by a COC record identifying their contents. The original form accompanies the shipment; the remaining copy is retained by the sampler and returned to the QA/QC team. The sampler must provide shipment tracking information to the QA/QC team as soon as practicable after shipment and must submit a copy of the COC to the QA/QC team upon completion of the field sampling activities.

All samples must be shipped in a manner that can be tracked. Samples that are classified as dangerous goods shall be handled and shipped in compliance with federal, state, and local regulations. Personnel must have successfully completed all mandated federal, state, and local training requirements prior to handling and shipping dangerous goods. Freight shipping labels will be retained as part of the permanent documentation of the COC records.

4.5 CORRECTIONS TO DOCUMENTATION

Unless restricted by weather conditions, all original data on sample identification labels, COC forms, and custody seals are written using indelible ink.

If an error is made on an accountable document assigned to one person, that individual may make corrections simply by crossing out the error with a single line striking the erroneous information and entering the correct information. Any error discovered on an accountable document will be corrected by the person who made the entry. All corrections must be initialed and dated, and if applicable, using generally used error codes.

5.0 REFERENCES

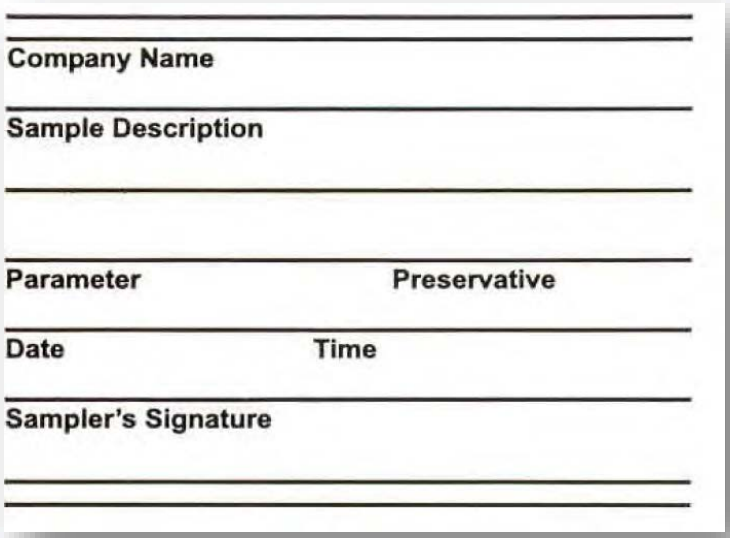
U.S. EPA, A Compendium of Superfund Field Operations Methods, publication EPA/540/P-87/001, December, 1987.

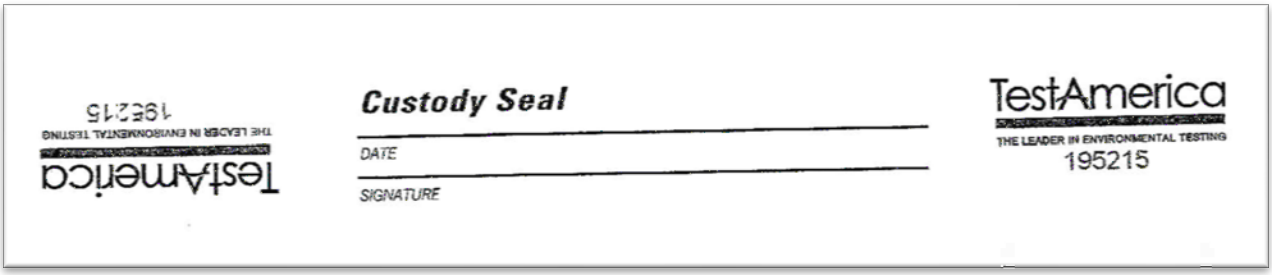
U.S. EPA, RCRA Ground-Water Technical Enforcement Guidance Document, September 1986.

Wisconsin Department of Natural Resources, Bureau of Drinking Water and Groundwater, "Groundwater Sampling Desk Reference", publication PUBL-DG-037 96, September 1996.

ATTACHMENT 022-A01
CHAIN OF CUSTODY RECORD

ATTACHMENT 022-A02
SAMPLE IDENTIFICATION LABEL AND CUSTODY SEAL





ATTACHMENT 022-A03
CUSTODY SEAL PLACEMENT

STANDARD OPERATING PROCEDURE
HANDLING OF INVESTIGATION DERIVED WASTE
(SOP-024)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE
HANDLING OF INVESTIGATION DERIVED WASTE
(SOP-024)

1.0 SCOPE AND APPLICABILITY

A by-product of most field investigations includes materials of various types that can become waste, which are generated during the course of the investigation. These materials can include, but are not limited to, soil cuttings, equipment decontamination fluids, excess field-testing fluids or solids, well purging fluids, and used personal protection equipment (PPE). The procedures presented herein are required for all environmental personnel.

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-024 (SOP-024) describes the procedures for handling investigation-derived waste (IDW). SOP-024 has been structured so that it can be used to manage different wastes that will be generated during the performance of various field investigations at a site. These procedures were developed to preserve flexibility in the choice of waste handling options as well as being acceptable to the State or Federal agencies involved.

1.2 SCOPE COVERED BY SOP-024

- Identifies a Waste Coordinator
- Identifies activities that will result in the generation of waste and provides a means to estimate the types and quantities of waste to be generated
- Identifies the waste management activities to be conducted, including containerization, handling, waste accumulation areas, and ultimate disposition
- Describes the measures to be taken to ensure the proper management of wastes
- Provides a Spill Control Plan for appropriate response actions to spills
- Describes the measures to be taken to minimize the generation of wastes

1.3 WORK SPECIFICATIONS

All handling of investigation-generated materials as described herein shall be conducted at the locations specified in the Work Plan, Sampling and Analysis Plan (SAP), or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.4 HEALTH AND SAFETY CONSIDERATIONS

This procedure may involve exposure to various impacted media and materials via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the procedures and use the appropriate personal protective equipment described in the approved health and safety plan.

2.0 PERSONNEL QUALIFICATIONS

Personnel shall be properly trained in field sampling, decontamination, and waste handling procedures. Such training will be done by study of appropriate SOPs and by placing any new employee with an experienced employee until the new employee has become proficient in field procedures. Personnel shall also maintain current certification of OSHA HAZWOPER training. The Project Coordinator will be the designated Waste Coordinator unless otherwise specified by the Project Coordinator.

3.0 PROCEDURE

3.1 ASSUMPTIONS

SOP-024 is based on the field sampling and analysis requirements set forth in the SAP, the health and safety requirements set forth in the Health and Safety Plan (HSP), and the following assumptions:

- Disposable protective gear will be treated as potentially contaminated waste. Non- disposable protective clothing will be sent to a commercial laundry facility that has been approved by the Health and Safety Department for cleaning.

- All subsurface soil extracted during soil sampling activities and all soil and water brought to the surface during the installation of boreholes and monitoring wells will be treated as potentially contaminated waste until analyses prove otherwise.

- Drums, bags and other containers of generated waste (excluding non-contaminated trash) may be stored on-site.

- Uncontaminated ("clean") trash will be segregated from presumed contaminated waste. Clean trash will be disposed of in an appropriate manner.

- Aqueous wastes can be containerized and transferred for management and disposal at the onsite wastewater treatment plant (WWTP). Aqueous waste may also be containerized, sampled, tested and disposed of at the appropriate disposal facility.

- Containers of RCRA hazardous waste (if any) will be manifested and disposed of off- site by the Site Owner or client.

- The Site owner or operator is assumed to be the "generator" of IDW.

- Multiple containers of the same or nearly the same waste will be accumulated and sampled as the same lot, in order to reduce the frequency of the waste characterization effort. Known hazardous waste material will not be mixed with non-hazardous waste materials.

3.2 WASTE MINIMIZATION

A primary goal of the Waste Minimization Program (WMP) is to minimize, to the extent practical: the volume of waste that must be generated and stored; and the amount of material that must be removed from the site for disposal. In order to minimize the volume of wastes, the following general procedures are recommended:

- Plan work ahead, based upon the work procedure to be utilized.

- Take only the material (i.e., chemicals) needed to perform the work activity

- Additional material can be brought to the work location if it is found to be necessary. Materials can be stored in large containers, but the smallest container reasonable should be used to transport the material to the location where it is needed.

- Maintain cleaning supplies outside of any potentially contaminated area to keep them clean and to minimize additional waste generation.

- Maintain or construct prefabricated materials, barriers, support equipment, etc., outside potentially contaminated areas.

- Perform mixing of detergents or decontamination solutions outside potentially contaminated areas.

- Avoid placing media considered contaminated for different reasons together.

- Use drop cloths or other absorbent material to contain small spills or leaks.

- Avoid a bellows effect when bagging contaminated materials.

- Use containers to minimize the spread of contamination.

- Do not place contaminated materials with clean materials.

- Verify waste containers are solidly packed to minimize the number of containers.

- Utilize only the size of container to meet your needs e.g., do not use a garbage can when a small polyethylene bag will do.

- Less hazardous substances should be used whenever possible, e.g. substitution of one type of solvent rinse for another more hazardous solvent for decontamination procedures.

3.3 PROJECT MATERIALS HANDLING

This section describes the anticipated inventory of project specific materials to be used during the course of the investigation. Potentially hazardous materials are typically materials brought on site in order to perform the investigation. The materials are used for decontamination, to seal boreholes, and provide lubrication and fuel for machinery. These materials should also be reported to the Industrial Hygiene/Health & Safety Group so that Safety Data Sheets (SDSs) can be included in the Health and Safety Plan. Spills of project specific materials may result in an evaluation of a reportable quantity for spill reporting purposes or the preparation of SDS forms. The anticipated inventory of materials includes:

- Alconox® detergent for equipment decontamination

- Type I Portland Cement for well grout material

- Silica sand filter pack material
- Powdered Bentonite® for well grout material
- Bentonite® pellets for well annular sealant
- Gasoline for use in portable equipment
- Hydraulic fluid for use by drilling equipment
- Motor oil for use of drilling equipment
- Diesel fuel for use by drilling equipment
- Solvent for equipment decontamination of metals (may be an acid rinse solution)
- Solvent for equipment decontamination of organics (may be an organic rinse solution)
- Chemical preservatives for environmental samples

3.4 EXPECTED WASTE STREAMS

Expected waste streams associated with soil and water investigation sampling activities and the related decontamination and clean-up. The expected waste streams can be categorized as follows:

- Drilling Waste
- Well Development Water and Purged Groundwater Waste
- Soil and Rock Sampling Waste
- Equipment Waste
- Field Laboratory Waste
- Decontamination Wastes

The various sources of waste are described in the following sections. All sampling activities will have associated disposable PPE and sampling equipment.

3.4.1 Drilling Waste

Drilling wastes expected to be generated include the soil cuttings extracted during the installation of soil borings and groundwater monitoring wells and the fluid water used for well drilling, well

development, and well purging. All solid wastes generated during the drilling process will be containerized, sampled, tested and properly disposed. Aqueous wastes generated during well drilling, development and purging of groundwater can be containerized, and transferred for management and disposal at the onsite WWTP. Aqueous waste may also be containerized, sampled, tested and disposed of at the appropriate disposal facility.

3.4.2 Well Development Water and Purged Groundwater Waste

Aqueous wastes generated during well development and purging of groundwater can be containerized, and transferred for management and disposal at the onsite WWTP. Aqueous waste may also be containerized, sampled, tested and disposed of at the appropriate disposal facility.

3.4.3 Soil and Rock Sampling Waste

Soil and rock samples may be collected for physical and chemical testing during field investigations. All soil and rock samples sent to the contract laboratory and any wastes generated during analytical activities will become the laboratory's responsibility for disposal.

Soil and rock samples not sent to contract laboratories will be handled as follows:

- Samples retained for visual reference or laboratory analysis at a later date will be stored on site in a designated area. After storage, all samples will be containerized with the material from the identical sample location.

- Media not retained for initial laboratory samples will be containerized with the material from the identical sample location.

3.4.4 Equipment Waste

During the performance of investigative activities, it is expected that some drilling tools and equipment may break during the performance of investigative activities, wear-out, or become unserviceable. It will be the drilling contractor's responsibility to decontaminate unserviceable tools or equipment and to remove these items from the site.

Air rotary drilling requires the use of several types of air filters. The number of filters required during the course of an investigation will vary according to the number and depth of boreholes and depend directly on the amount of drilling performed. Knowledge of contaminants in the filters will be gained from the sample results generated and the size and weight of the filter. If there is a question as to possible presence of contaminants, a representative sample will be collected of the filter material and tested as per 40 CFR Part 261, Subpart C. If filters are used in background locations or areas that have previously been demonstrated to be nonhazardous, the filters will be managed as non-

hazardous industrial waste (NHIW). Cutting and/or manual compaction of these filters should be employed to minimize the waste volume.

3.4.5 Field Laboratory Waste

Ancillary field sampling activities are performed in the field laboratory. The field laboratory activities that can be expected can include the preparation of reagents, sample filtering, sample preservation, and conductance of actual on-site test procedures. These activities are accomplished in accordance with procedures as outlined in the Field Sampling Plan (FSP). The field laboratory activities are expected to generate limited amounts of waste, which will consist of:

- Empty laboratory chemical containers
- Sample handling gloves
- Sample containers
- Absorbent towels for general cleaning and small spills

3.4.6 Decontamination Wastes

Tools required for drilling, well installation and development, and collecting samples must be cleaned and decontaminated. To minimize the amount of waste generated and to facilitate the management and disposal of decontamination wastes, equipment should be cleaned and decontaminated in batches. This practice will allow for the containerization of smaller amounts of fluids in fewer containers until a characterization of the chemical quality is determined and the appropriate method of disposal is determined. The wastes that could be generated are:

- Waste decontamination wash water
- Organic solvents
- Metal solvents
- Used gloves
- Drop cloths, paper towels, plastic bags, etc.
- Disposable bailers and monofilament line

Most decontamination activities will be performed at designated areas dedicated to decontamination identified by the Project Coordinator. This does not preclude the performance of "spot" decontamination in the field, i.e., boring locations.

Each decontamination area will be designed and equipped to ensure minimization of hazards to the environment. Some decontamination areas may be plastic-lined and bermed to provide total containment for decontamination wastes. A "spill kit" may be placed at each central decontamination facility consisting of:

- Personal protective clothing (disposable polyethylene-coated Tyvek ®, rubber boot-covers)
- Solvex® latex gloves
- Black/yellow barricade tape
- Barricade posts
- Solvent
- 10 mil thick plastic
- Shovels
- Absorbent booms
- Absorbent material
- Over-pack drums
- Organic/acid gas respirator cartridges (or other appropriate material-specific cartridges)

The emergency spill procedure will be to contact the Health and Safety Representative (as identified in the Health and Safety Plan); identify the source of the spill along with potential hazards; and contain the spill by either stopping it at the source and/or by use of absorbent booms. The Health and Safety Representative will give guidance on appropriate clean-up methods to be used as well as personal protective equipment employed. It is expected that any spills occurring at a decontamination facility will either consist of used decontamination fluids or unused decontamination fluids. The characterization of the spilled material will be the same as for the decontamination fluids in general.

3.5 SPECIFIC WASTE STREAMS

This section describes the various waste management control measures planned for each waste stream. The waste management measures include the containment of contamination, packaging of waste, handling of waste containers, labeling of waste containers, logging of waste containers on a waste container inventory list, storage, characterization and ultimate disposition of waste.

The Project Coordinator or person assigned will be responsible for ensuring waste is properly characterized and managed in accordance with the applicable solid waste rules. IDW is expected to fall into the one of the following categories: Hazardous Waste, Radioactive Waste, or NHIW. Waste management procedures are discussed in the following sections.

3.5.1 Containment, Packaging and Handling

All containers will be labeled. The container sizes listed in the following sections are suggested, not to preclude the use of larger or smaller waste containers where appropriate.

3.5.1.1 Personal Protective Equipment (PPE)

All disposable PPE, laboratory equipment, and general rubbish (paper towels, etc.) will be doffed in accordance with the Health and Safety Plan (HSP) and placed in large polyethylene trash bags. A separate bag(s) will be used for each investigation borehole area and closed tightly at the end of the workday.

3.5.1.2 Drill Cuttings

All drill cuttings will immediately be containerized. Separate containers will be used for each sampling location. At the end of each workday, the containers will either remain adjacent to the sampling location or be placed at a designated container storage area (CSA). The containers will be transported to the CSA by use of drum caddy, dolly, hand truck, or forklift.

3.5.1.3 Well Development/Purge Water and Drilling Fluids

Drilling fluids and all water generated during developing and purging monitoring wells will be containerized in closed-head containers. It may become feasible to use a larger container if several wells are being installed in a short time frame. Appropriate engineering judgment shall be used to group the waste. The containers will be securely closed after each use. Aqueous wastes can be transferred for management and disposal at the onsite WWTP. Aqueous waste may also be containerized, sampled, tested and disposed of at the appropriate disposal facility.

3.5.1.4 Decontamination Fluids

All fluids generated during decontamination activities will be containerized in closed head containers. Alconox® (detergent) based fluids and fluids containing solvents will be segregated in different drums when containerized. The containers will be securely closed when full or at the end of each day. Aqueous wastes can be transferred for management and disposal at the onsite WWTP. Aqueous waste may also be containerized, sampled, tested and disposed of at the appropriate disposal facility.

3.5.2 Labeling and Logging

Environmental media collected during site activities that must be placed into drums or other containers for storage should be labeled with the contents of the containers, type of waste (borehole cuttings, decontamination water, etc.) and the location of waste source (e.g., MW-6, drill rig decontamination area, etc.). If the media is a known listed waste then the container must be labeled with the words "Hazardous Waste", and the accumulation start date must also be placed on the container. If the waste is being sampled to determine if it is a RCRA hazardous waste then the container shall be labeled with the words “Non-Hazardous Waste, pending analysis”, and the accumulation start date must also be placed on the container.

When the sample characterization results (see Section 3.6) are returned from the laboratory, the waste classification will be confirmed. The containers will then be labeled according to the following procedure.

Containers that have been characterized as containing hazardous waste as defined in 40 CFR Part 261 will retain the Hazardous Waste label. If the waste is nonhazardous, the “Non-hazardous waste, pending analysis” label should be removed and a Non-Hazardous label applied. Other labels may be necessary according to shipping procedures and constituents present in the waste.

3.5.3 Storage

Containers can be stored either on site adjacent to the waste generation location or at the appropriate CSA (Hazardous vs. Non-hazardous CSA). No container shall remain on site for more than 90 days. All wastes will be grouped based on characterization data (Hazardous vs. Non-hazardous) and stored in separate CSAs.

3.6 CHARACTERIZATION AND DISPOSITION

Environmental media are the property of the Client or Landowner. All wastes generated during investigation activities will be characterized according to the requirements of the SAP or a Site-Specific Disposal Plan. The waste will be sampled and tested for hazardous characteristics, and the results of the testing will be provided to the Project Coordinator.

Procedures for solid waste management in Oklahoma are well documented in the Chapter 520 rules. In many instances, for example, when wastes qualify as de minimus, waste characterization should be done to meet the requirements of the disposal facility. Refer to OAC 252:520 Generator Requirements for Oklahoma wastes. Refer to the appropriate state rules for wastes generated in other locations.

Unless modified by input from the applicable state agency, the following is the anticipated characterization and disposal process. Aqueous waste must be tested prior to disposition with EPA Methods 1311 (TCLP), 1110 (Corrosivity-field pH may be used in place of this test), ignitability (1010, 1020A) and EPA Chapter 7 methods for reactive cyanide and sulfide. Solids will be tested according to these methods with the exception of corrosivity, which is not applicable to solids. Soil samples may also be tested for EPA Region 5 Skinner list volatiles, semi-volatiles and metals in order to document concentrations for approval to reuse on site. In the event the soil cannot be reused on site, additional soil samples will be tested for TCLP volatiles, TCLP semi-volatiles and TCLP metals to determine the appropriate characterization for disposal.

All above referenced sample results will be available from the analytical laboratory at least 60 days from first date of storage and will be maintained at the site for at least three years. The data will also be forwarded to the Project Coordinator. The 60 day time period allows an additional 30 days to manifest and dispose, if hazardous, and still not exceed the 90-day storage time limit for hazardous waste.

After a container has been characterized, the Project Coordinator or designee will coordinate the disposal of the waste with the Client or Landowner. Preparation for transport of containers shall include, but is not limited to, closure of container, sealing of closures (i.e., tightening of bungs or bolting of lock rings), palletizing of drums, and removing any contamination on the outside of the container. All manifests must be signed by the waste generator, and transportation must be done by a licensed hazardous waste transporter. Waste shipment and disposal will be tracked by the client representative.

All wastes will be disposed of in accordance with state and federal regulations.

4.0 DATA AND RECORDS MANAGEMENT

Documentation of the day-to-day handling of investigation-generated materials will be the responsibility of the Project Coordinator or designee.

STANDARD OPERATING PROCEDURE
LOW-FLOW PURGING AND SAMPLING
(SOP-028)

Reviewed By:_____ Date:_____

Approved By:_____ Date:_____

Approved By:_____ Date:_____

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STANDARD OPERATING PROCEDURE FOR LOW FLOW PURGING AND SAMPLING (SOP-028)

1.0 SCOPE AND APPLICABILITY

1.1 PURPOSE OF PROCEDURE

Standard Operating Procedure-028 (SOP-028) describes purging wells and collection of groundwater samples using EPA approved low-flow techniques.

1.2 SCOPE COVERED BY SOP-028

This procedure describes requirements for low-flow purging, water quality field parameters, sampling, and documentation. This SOP applies only to sampling at the wellhead and does not address sampling light or dense non-aqueous-phase liquids (LNAPL or DNAPL). The method does not require the removal of large volumes of water from the well.

1.3 APPLICABILITY

Low-flow purging and sampling as described herein shall be conducted at the locations specified in the Work Plan, Sampling and Analysis Plan, or other parent document referencing this SOP. In the event there is a conflict in specifications presented herein with those presented in the parent document referencing this SOP, then the specifications in the parent document will be followed to the extent they are different.

1.4 DEFINITIONS

1.4.1 Drawdown (low-flow purging and sampling)

The water level in a well is lowered by pumping the well.

1.4.2 Low-Flow

Low-flow refers to the velocity of formation pore water adjacent to the well screen that is imparted during the well pumping. It does not necessarily refer to the flow rate of water discharged by a pump at the surface.

1.5 HEALTH & SAFETY CONSIDERATIONS

This procedure may involve exposure to impacted groundwater via routes of dermal contact and inhalation. Accordingly, sampling personnel should follow the precautions, procedures, and use the appropriate personal protective equipment described in the approved Health and Safety Plan.

2.0 PERSONNEL QUALIFICATIONS

Personnel performing low-flow purging and sampling procedures shall be trained in field sampling techniques. Such training will be done by placing any new employee with an experienced employee until the new employee has become proficient in groundwater sampling techniques described in this SOP. Occasional on-site field audits conducted by the Environmental Department will ensure that field personnel continue to perform low-flow purging and sampling procedures correctly.

3.0 EQUIPMENT AND MATERIALS

3.1 GENERAL REQUIREMENTS

Low-flow purging involves pumping a well at rates less than the natural recovery rate at a continuous drawdown from a specific zone of the formation in the well screened interval. Field parameters rather than specific water volumes are used to determine groundwater stability prior to sample collection.

The objective of using low-flow purging is to pump the well in a manner that minimizes the stress and disturbance to the groundwater flow system. The low pump rate purges water at a rate that does not exceed the well yield and isolates the column of stagnant water above the pump intake; therefore it does not have to be removed prior to collection. Using low-flow techniques can eliminate or greatly reduce the need for sample filtration. Low-flow purging and sampling is generally not suitable for very low yield wells.

Special care will be exercised to prevent contamination of the groundwater and samples collected during sampling activities. Two primary ways in which such contamination can occur are:

- improperly cleaned equipment
- insufficient cleaning of equipment between wells

Therefore, all portions of non-dedicated sampling and test equipment that will potentially contact the interior well casing shall be thoroughly cleaned before use and between uses at different sampling locations. This includes water-level tapes or probes, pumps, tubing, lifting line, test equipment for on-site use, and other equipment or portions thereof. Specific procedures for equipment cleaning are found in SOP-001. Disposable equipment that has been cleaned and certified by the vendor should be utilized whenever possible to avoid the cleaning process and to minimize potential cross-contamination issues.

In addition to the use of properly cleaned equipment, further precautions shall be followed:

- A clean pair of new, disposable nitrile (or similar) gloves shall be worn each time a different well is sampled; and
- Sample collection activities, in general, should proceed progressively from wells which are least affected by constituents of concern progressively to wells most affected by constituents of concern.
- Groundwater sampling should not commence within 48 of monitoring well development.

3.2 PURGING AND GROUNDWATER SAMPLING PROCEDURES

3.2.1 Groundwater Level and Well Depth Measurements

Prior to the water level and well depth measurements, each well shall be inspected thoroughly for signs of damage. Any damage or repairs needed on the well must be noted in the field logbook.

Prior to installing a portable pump or prior to pumping wells with permanent pumps, an initial water level measurement shall be obtained.

Low-flow purging requires periodic water level measurements. Any water level equipment that does not disturb the water column may be used, as long as it meets the accuracy required by the SAP.

Using a pre-cleaned water level meter, the groundwater surface will be measured in accordance with SOP-009. These measurements shall be recorded in the field logbook. The date and time of water level measurements must also be recorded.

During well pumping, water level measurements should be taken every one to two flow cell volumes until sample collection. Drawdown should not exceed ten percent of the static water column height or extend below the top of the well screen.

3.2.2 Pumps

The pump that is used must be capable of pumping at low flow rates. Because the purging and sampling processes are one continuous operation, the pump selected should be appropriate for both.

Lower turbidity and lower purge volumes can achieve stabilized field parameters quicker if dedicated pumps are utilized. If portable pumps are used, care must be taken to minimize disturbance of the well and time (typically 30 to 60 minutes) is allowed prior to pump operations to allow any sediment to settle out before the purging process is started.

Examples of pumps include:

- Continuous Discharge Pumps
- Cyclic Discharge Pumps
- Peristaltic Pumps

Effort should be made to closely match the length of the tubing with the depth that the pump will be set. The pump intake should be positioned at or near the mid-point of the well screen or the middle of the water column if the height of the water column is less than the screened interval. The depth of the pump intake should be recorded in field book. If constituents of interest are known to concentrate at the top or bottom of the screened zone it may be desirable to position the pump intake to target the zone.

Portable pumps shall be carefully installed and lowered slowly into the screened interval to minimize water column disturbance. Some mixing of the water column above the well screen and the release of suspended material will require longer periods of time to achieve the required field parameter stabilization. The pump intake should be at least two feet from the top and bottom of the well screen.

The pumping rate shall be determined on a well-specific basis. The initial pumping rate should be approximately 100 milliliters per minute (mL/min) or less. If this is not possible with the pump being used, start with the lowest flow rate possible. Typical flow rates average from 0.1 L/min to 0.5 L/min.

Acceptable drawdown shall be no more than 10 percent of the water column. The maximum pump rate shall be equal or less than the well recharge rate. For low-flow purging and sampling the maximum pump rate is approximately 100 mL/min for most wells.

3.2.3 Grab sampling devices

No grab sampling devices are allowed when using the low-flow purging technique. These devices cause disturbance to the well column. Grab sampling devices include:

- Bailers
- Kemmerer samplers
- Inertial-lift devices

3.2.4 Volume Measuring Device

A volume measuring device (for example, graduated cylinder) and a time piece capable of measuring in seconds are necessary for calculating the flow rate from the pump discharge tube.

Once the correct pumping rate has been established for a well, use a large graduated cylinder and a stop watch or a watch with a second hand to determine how much groundwater is being removed

over a one-minute time interval. It may be necessary to repeat this procedure every 1-2 flow cell volumes to verify the pumping rate has not changed. Record the pumping rate in the field notes in units of milliliters per minute (mL/min).

3.2.5 Field Parameters

Low-flow purging requires measurement of field parameters to determine when purging is complete and sampling can commence. At a minimum, pH, specific conductance, temperature, dissolved oxygen, and turbidity are monitored until at least three sets of readings vary less than 10%. Field parameters should be collected every 1-2 flow cell volumes. Continuous monitoring using a properly sized, closed flow-through cell is most consistent and reliable.

Record all readings including periodic depth to groundwater measurements and the time of readings in the field book.

4.0 SAMPLE EXTRACTION

When project specific stability criteria have been met, actual sample collection will begin. When samples are collected using bladder or peristaltic pumps, the end of the pump discharge tubing shall be removed so that the water stream is discharging from a clean section of tubing. If a flow cell has been utilized for measuring field parameters, the tubing shall be cut off before the flow cell. If volatile organic compound vials are to be filled, the sample stream shall be slowed, if necessary, to minimize aeration of the sample stream while filling the vials. The discharge tubing shall not be allowed to come in contact with the sample containers.

Any excess water taken during well purging and sampling shall be placed in a container for proper disposal as described in SOP-024.

5.0 REFERENCES

ASTM, "Standard Practice for Low-Flow Purging and Sampling for Wells and Devices Used for Groundwater Quality Investigations," Designation D 6771- 02, 2002

9 SOLID WASTE MANAGEMENT UNITS

Eighteen (18) Solid Waste Management Units (SWMUs) and two Areas of Concern (AOC) have been identified at the HollyFrontier Tulsa Refining LLC (HFTR) Tulsa West Refinery (the Refinery) through the Resource Conservation and Recovery Act (RCRA) corrective action process. As such, HFTR is including the information required under Title 40 Part 270.14(d) of the Code of Federal Regulations (40 CFR 270.14(d)) in this RCRA Part B Permit Renewal Application (Renewal Application).

9.1 Solid Waste Management Units and Areas of Concern

Historically, there were or have been a total of eighteen (18) SWMUs identified in various locations across the Refinery, including landfills, land treatment units (LTUs), storage areas, and impoundments. The locations of the SWMUs are provided on Figure 9-1. A description of each SWMU is provided in Table 9-1, and a summary of the SWMU corrective action status is provided in Table 9-2.

Over time, seven (7) of the eighteen (18) SWMUs (2, 3, 9, 11, 15, 17 and 18) were granted No Further Action (NFA) status and were deleted from the Refinery's Resource Conservation and Recovery Act (RCRA) Post-Closure and Corrective Action Permit (Permit No. 058078775-PC, issued June 1, 2009). Some of the SWMUs were closed with waste in-place, while others were "clean-closed" with the wastes removed. Some of the landfill SWMUs required remedial actions for the wastes they contained, including Refinery-wide groundwater monitoring. In addition, portions of the groundwater beneath the Refinery were impacted with petroleum hydrocarbons, including light non-aqueous phase liquids (LNAPL). With the exception of SWMU 10, the wastewater treatment system (WWTS), none of the eleven (11) SWMUs remaining in the Permit are active at the time of this Renewal Application submittal.

The Refinery property includes approximately 1.8 miles of shoreline along the Arkansas River and groundwater generally moves from the interior of the Refinery north toward the Arkansas River. Five SWMUs are located adjacent to the river (SWMUs 4, 5, 6, 13 and 14).

AOC 1 (the Arkansas Riverbank Area) was historically designated by the Oklahoma Department of Environmental Quality (ODEQ) at the Refinery. The Riverbank Area is located along the south bank of the Arkansas River and is shown on Figure 9-1. The Riverbank Area was later subdivided into smaller, discrete areas designated as Areas A – H, which can be seen on Figure 9-1. An LNAPL containment system was installed in December 2007 to prevent LNAPL releases from the riverbank in Areas E, F, and G, and this area was designated as AOC 2 (Areas E, F, and G Riverbank Containment System). Areas A – D and Area H continue to comprise AOC 1.

AOC 1 includes the area of the Refinery lying to the north of the crest of the flood control levee constructed by the United States Army Corps of Engineers (USACE), extending to the riverbank, and extending from the eastern end of SWMU 14, eastward to the easternmost Refinery property boundary. AOC 1 does not include SWMUs 4, 5, and 6. AOC 2 encompasses Areas E, F, and G and is the area of the Refinery immediately adjacent to the USACE flood control levee, and extends from the eastern end of SWMU 5, eastward to the western boundary of SWMU 6. AOC 2 does not include AOC 1 or SWMUs 5 and 6.

The Refinery performs routine inspections along the Riverbank Area to monitor for hydrocarbon sheening in the River. Inspection procedures and schedules are included in Section 3 (Inspection Plan) of this Renewal Application.

9.2 Chronology of Corrective Actions

The Refinery performed a RCRA Facility Assessment (RFA) on July 21, 1986, and the identified SWMUs were included in the Refinery's original RCRA Part B Permit issued on November 1, 1988[1]. The Refinery subsequently performed remedial actions at SWMU 14 (Allison Property Landfill) during the RFA. On March of 1991, the Refinery submitted a RCRA Facility Investigation (RFI) for SWMUs 4 and 6. An RFI was not conducted on SWMUs with a recommendation of NFA status from the RFA. A discussion paper from Sun Oil, a previous owner of the Refinery, dated November 26, 2001, stated that SWMUs 1, 2, 3, 7, 8, 9, 11, 12, and 13 were not actively contributing to groundwater contamination, were relatively stable, and needed no further remedial actions at the Refinery.

In a letter dated September 19, 2016, ODEQ requested additional groundwater monitoring for SWMU 2, following on a railroad spur expansion project conducted by HFTR. HFTR responded in a letter dated October 28, 2016 requesting that the ODEQ withdraw the request on the basis that the waste in SWMU 2 was non-hazardous and LNAPL is already being addressed in the area. ODEQ accepted this request on January 27, 2017 and the NFA status remains for SWMU 2.

Under authorization from Consent Order #02-190 (agreed upon on July 5, 2002, and later terminated by ODEQ on June 1, 2009), SWMUs 4, 5, and 6 were further investigated during corrective action activities.

A summary of SWMU 4, 5, 6 and 14 corrective action investigation and remediation information is provided below and in Table 9-2.

[1] Note that SWMU 5 was identified in the 1986 RFA, but the ODEQ and USEPA did not include this SWMU in the 1988 RCRA Part B Permit. SWMU 5 was subsequently investigated in 2005.

SWMU 4 (Asphalt Sludge Landfill)

In a discussion paper describing SWMU 4 from Sun Oil, dated November 26, 2001, it was noted that small amounts of seepage (approximately a droplet every few seconds) was noted to occur from the base of the fill below the Asphalt Sludge Landfill, usually following rainfall. Four (4) seepage areas were identified along the Arkansas River. The seepage along the River was analyzed for benzene, toluene, ethylbenzene, and xylene (BTEX) in 1994, with none of these constituents detected. Surface run-off was evaluated, and results were below the United States Environmental Protection Agency's (USEPA's) National Pollutant Discharge Elimination System (NPDES) effluent limitations. In addition, gauging data was collected from monitoring wells immediately upgradient of the SWMU. In 2003, an interim remedial measure was implemented to place a collection and drainage trench on the downgradient end of the landfill and to install a cap over the former landfill. The area around the SWMU was also contoured for proper drainage and erosion control. The closure of this SWMU was accepted by ODEQ in March of 2004. The SWMU is currently subject to additional assessment, primarily along the riverbank, for maintenance and to identify potential effects of the approved remedy.

SWMU 5 (North Petroleum Sludge [Area D] Landfill)

There was some waste exposure at the river's edge at this unit. In a discussion paper from Sun Oil, dated November 26, 2001, it was noted that areas of the fill extended to or below the normal river elevation. In 2005, interim measures were implemented that involved re-grading the SWMU 5 area, implementing erosion control measures, stabilizing of the riverbank, limited removal and conditioning of exposed surface waste, limited removal and conditioning of waste material from the riverbank and the adjacent riverbed, and surface conditioning of the overall SWMU. The interim remedial measure was accepted by the ODEQ in February 2007.

SWMU 6 (Northeast Landfill)

In a discussion paper describing SWMU 6 from Sun Oil, dated November 26, 2001, it was noted that the surface of the unit was generally well-vegetated, but little or no vegetation was seen in areas where oily or tarry wastes were exposed. Interim measures were implemented because wastes were exposed in several locations. The primary objective was to remove and cover exposed historical waste material and mitigate erosion of the Riverbank Area. Surface run-off water was evaluated, and the results were below the USEPA NPDES effluent limitations. Groundwater monitoring results were collected from six (6) upgradient wells. Data indicated that BTEX concentrations beneath the unit were greater than within the unit itself; thereby indicating that the landfill was not the source of BTEX contamination. These interim measures involved re-grading the SWMU area, implementing erosion control measures, stabilizing the riverbank and adjacent riverbed, limited removal and conditioning of exposed surface waste, limited removal of waste material from the riverbank and adjacent riverbed, and resurfacing the overall SWMU.

Remedial activities were completed in 2006, but the Refinery continues maintenance and monitoring of the SWMU.

Surface run-off water was later evaluated to determine if SWMU 6 was the cause of hydrocarbon sheening seen along the Riverbank Areas, located at areas B and H. Interim Measures were performed in Area B which included removing a small volume of Refinery waste that had sloughed off into the river and stabilizing a small area of the riverbank that had been eroded from surface water run-off (Hull & Associates, 2014).

Interim Measures remediation at Area H constituted a repair of the previously constructed Interim Measures at Area H, because four (4) consecutive hydrocarbon sheening events had been observed along the easternmost two-thirds of Area H, adjacent to SWMU 6, in 2010. The hydrocarbon sheening was attributed to waste materials and/or LNAPL leaking through the geotextile and riprap along the stabilized portions of the SWMU 6 Riverbank Area. The proposed Interim Measure repairs at SWMU 6 included the following:

- Removed existing riprap. If petroleum products were observed, the riprap was washed, rinsed, and re-deployed;
- Excavated the material adjacent to the riverbank to the depth of the riverbed, and field tested it for petroleum to determine the limits of excavation;
- Once excavation was complete, the area was backfilled with suitable clean and washed aggregate materials;
- Upland of the riverbank, the top 24 inches were filled with 18 inches of compacted clayey soils covered with 6 inches of topsoil to establish a vegetative cover;
- Reconstructed the riverbank by installing a geosynthetic clay liner along the tank to be covered by a minimum of 1.5 feet of compacted clayey soils;
- Woven geotextile was placed over the clay and any aggregate for protection from deterioration; and
- Completed a report documenting the post-construction activities and repairs made to the original Interim Measures.

An *Interim Measure Summary Report for Riverbank Areas B & H* was submitted in January 2014.

Additional interim measures are proposed in 2019 at Area H due to hydrocarbon sheening events reported to ODEQ in 2018.

SWMU 14 (Allison Property Landfill)

At the time of the RFI, SWMU 14 formed the south bank of the Arkansas River and had no cover over the waste fill. In 1993, interim measures were proposed, including placing a

membrane cap over the top of the fill to eliminate possible contamination of surface run-off, and placing rip-rap along the edge of the riverbank to reduce erosion. In addition, piezometers and monitoring wells were installed upgradient from the SWMU. The data from the piezometers and monitoring wells showed no current river impacts from the presence of the fill. These interim measures were completed in 1995 and approved by the USEPA.

9.3 Corrective Action in Groundwater

Portions of the groundwater beneath the Refinery have been contaminated with petroleum hydrocarbons, including light non-aqueous phase liquids (LNAPL). The Refinery's LNAPL recovery program can be found in Section 8 (Groundwater Monitoring and LNAPL Management Plan) of this Renewal Application. HFTR also implements a Refinery-wide groundwater monitoring program that satisfies regulatory requirements for groundwater monitoring for SWMUs. Details regarding the groundwater monitoring program are provided in Section 8 (Groundwater Monitoring and LNAPL Management Plan) of this Renewal Application. Additional corrective action and remediation information is provided in Table 9-2. HTFR is proposing to conduct a site-wide risk assessment to evaluate whether groundwater at the site presents a risk and whether additional work is warranted. A risk assessment work plan will be submitted for prior ODEQ approval.

9.4 Wastewater Treatment System

HFTR is requesting in this Renewal Application removal of the current Permit provisions of Section III.F.1 *(Specific Condition – Continued Requirements for Previously Identified SWMU and AOC, SWMU 10 – Wastewater Treatment System)* that require written notice to ODEQ prior to any excavations, repairs, expansions or other modifications of SWMU 10, and to provide a work plan for ODEQ approval prior to closure, replacement, or reconstruction of any in-ground or below-ground units within SWMU 10. The wastewater treatment system (SWMU 10) is an operating unit; concrete units within the WWTS will be inspected for cracks during routine maintenance/turnaround of the units and will be repaired as necessary. The Refinery will continue to follow current health and safety protocols to ensure worker protection, proper handling to prevent any release of hazardous constituents, and proper management of soil and other materials during any work in this area to protect human health and the environment. Therefore, HFTR does not feel the written notifications are necessary.

9.5 Land Treatment Units

The Refinery operated three RCRA-permitted LTUs – the Central LTU, the West LTU, and the East LTU. All three LTUs were closed and are currently in the post-closure care (PCC) period. The closed LTUs are also included in the Refinery's Corrective Action Program (CAP), collectively as SWMU 16. No additional corrective action investigations are required for the

LTUs. The Refinery is currently maintaining and monitoring the LTUs in accordance with the PCC plan, which is provided in Section 5 (Post-Closure Plan) of this Renewal Application.

9.6 Corrective Action in Soil

HTFR is proposing to conduct a site-wide risk assessment at SWMUs 4, 5, and 6 to evaluate whether the soils present risk and whether additional work is warranted. These are the three open SWMUs (excluding SWMU 10 that is currently active) as the remaining SWMUs have received NFA status or in the case of SWMU 16 are the LTUs that are in post-closure. A risk assessment work plan will be submitted for prior ODEQ approval.

9.7 References

The Source Group, Inc. and Atkins Benham, Inc. Environmental Division, 2002. Current Conditions Report and Comprehensive Site Conceptual Model. July 17, 2002.

The Benham Companies, LLC. AOC 1 Investigation Report. February 5, 2010.

Don Hensch, Sun Oil – Tulsa Refinery. Discussion Paper – SWMU #4. November 26, 2011.

Don Hensch, Sun Oil – Tulsa Refinery. Discussion Paper – Area D (aka SWMU 5). November 26, 2001.

Don Hensch, Sun Oil – Tulsa Refinery. Discussion Paper – SWMUs # 1, 2, 3, 6, 7, 8, 9, 11, 12, and 13. November 26, 2001.

Don Hensch, Sun Oil – Tulsa Refinery. Discussion Paper – SWMU #14 (Allison Property Landfill). November 26, 2001.

ODEQ 2009. Resource Conservation and Recovery Act Post-Closure and Corrective Action Permit for a Closed Hazardous Waste Management Facility No. 058078775-PC. Oklahoma Department of Environmental Quality. June 1, 2009.

ODEQ 2017. Response to DEQ September 19, 2016 correspondence regarding SWMU-2 Excavation and Rail Spur Construction. January 27, 2017.

Hull & Associates, Inc. Riverbank Areas B & H Interim Measure Summary Report. January 2014.

Tables

Table 9-1. Solid Waste Management Units

Unit Name	Operation Dates	Dimensions (acres)	Waste Received	Status
SWMU 1 – Midco Landfill	Early 1900s - 1982	2.5	Petroleum sludge	Waste was removed, and the area was covered. Closed and in no further [corrective] action (NFA) status.
SWMU 2 – West Landfarm	Mid to late-1970s - 1980	4.72		Deleted from the 2009 Permit.[1]
SWMU 3 – Tetraethyl Lead (TEL) Weathering Area	Unknown (unit has gone unused since before 1966)	0.3	Steel using in hydrofluoric acid and TEL services.	Deleted from the 2009 Permit.[1]
SWMU 4 – Asphalt Sludge Landfill	1949 – 1966	1.8	Asphaltic sludge	Closed and subject to continued monitoring and operation of a collection system.
SWMU 5 – North Petroleum Sludge (Area D) Landfill	Unknown – prior to 1971	5.5	Acid sludge, petroleum sludge, coke fines, spent filter clays, catalyst fines, and demolition wastes	Closed and subject to continued monitoring and maintenance.
SWMU 6 – Northeast Landfill	1949 (or earlier) – sometime between 1954 and 1961.	9	Demolition debris acidic sludges, refining residue from bum pits, and trash	Closed and subject to continued monitoring and maintenance.
SWMU 7 – East Landfill	1954 - 1961	6	Trash, filter clay, and petroleum sludge	Closed and NFA status.
SWMU 8 – Scrap Metal Landfill	1958 - 1980	0.3	Metals previously used in HF (and possibly) leaded gasoline service.	Closed and NFA status.
SWMU 9 – Concrete Sump	1973 - 1981	0.26	Petroleum sludge	Deleted from the 2009 Permit.[1]

Table 9-1. Solid Waste Management Units (cont.)

Unit Name	Operation Dates	Dimensions (acres)	Waste Received	Status
SWMU 10 – Wastewater Treatment System	Active	6.9	Wastewater discharge	Active operations unit.
SWMU 11 – Spray Pond	Unknown - 1960	4	Stormwater run-off collection	Deleted from the 2009 Permit.[1]
SWMU 12 – Cat Cracker Landfill	Unknown - 1948	3	Coke fines, cinders, railroad engines, rocks, scrap wood, scrap metal, and bricks.	Closed and NFA status.
SWMU 13 – Scrap Metal Landfill	Unknown	0.02	Scrap metal previously used in hydrofluoric and tetraethyl lead service.	Closed and NFA status.
SWMU 14 – Allison Property Landfill	Unknown - 1942	3	Asphaltic sludges.	Closed and NFA status.
SWMU 15 – Storm Water Impoundments	1991 - 1994	5.5	Non-hazardous wastewater.	Deleted from the 2009 Permit.[1]
SWMU 16 – Land Treatment Units	Mid-1970s - 1994	74.5	Dissolved air flotation float (K048), slop oil emulsion solids (K049), API separator sludge (K050), leaded gasoline tank bottom sludge (K052), and oil/water/solids separation sludge (F037).	Closed and under post-closure care.
SWMU 17 – Oily Sludge Roads	Varies	Varies	Unknown	Deleted prior to the original November 1, 1988 Permit.
SWMU 18 – Tank Diked Areas	Varies	Varies	Unknown	Deleted prior to the original November 1, 1988 Permit.

[1] SWMUs were granted No Further Action (NFA) status prior to being deleted from the Refinery's RCRA Post-Closure and Corrective Action Permit (Permit No. 058078775-PC, issued June 1, 2009)

Table 9-2. Corrective Action History and Status

Unit Name	Activity Status
SWMU 1 – Midco Landfill	The landfill was closed in 1982 and was not a regulated unit under the Refinery's initial RCRA Permit of October 1988. An RFI was completed on the unit. As of June 1, 2009, the SWMU was granted no further [corrective] action (NFA) status.
SWMU 2 – West Landfarm	The 1988 RCRA Permit required an RFI for SWMU 2. The RFI was completed, and it was concluded that there were no hazardous constituents above background and requested a determination of NFA. ODEQ granted the SWMU NFA status and this SWMU was deleted from the permit.
SWMU 3 – Tetraethyl Lead (TEL) Weather Area	The unit was cleaned during the winter of 1981. The July 21, 1986 RFA Report included a recommendation for NFA due to prior waste removal. The 1988 RCRA Permit did not require a RFI for SWMU 3. This SWMU has been deleted from the permit.
SWMU 4 – Asphalt Sludge Landfill	Sunoco submitted a RFI Phase I Report for SWMU 4 dated March 4, 1991. In 2003, an interim remedial measure was implemented to place a collection and drainage trench on the downgradient edge of the landfill because seepage was noted from the base of the fill. The area was contoured for proper drainage and erosion control. The SWMU was closed on March 12, 2004 and is subject to continued monitoring and operation of the collection system.
SWMU 5 – North Petroleum Sludge (Area D) Landfill	SWMU 5 was assessed in the 1986 RFA, but the USEPA did not include SWMU 5 in the 1988 Permit. Since then, interim remedial measures were completed that involved re-grading the SWMU 5 area, erosion control measures, stabilization of the riverbank, limited removal and conditions of exposed surface waste, limited removal and conditioning of waste material from the riverbank and adjacent riverbed, and overall SWMU surface conditioning. The interim remedial measures were accepted by ODEQ in February 2007.
SWMU 6 – Northeast Landfill	Sunoco submitted a RFI Phase I Report/Phase II Workplan dated March 4, 1991. Interim measure for SWMU 6 were implemented involving re-grading of the SWMU area, erosion control measures, stabilization of the riverbank, limited removal and conditioning of exposed surface waste, limited removal of waste material from the riverbank and the adjacent riverbed, and overall SWMU surface conditioning. Remedial actions were completed in 2006, but the Refinery continues maintenance and monitoring of the SWMU. Interim Measures remediation at Area H constituted a repair of the previously constructed Interim Measures, because four (4) consecutive hydrocarbon sheening events had been observed along the easternmost two-thirds of Area H, adjacent to SWMU 6, in 2010. An Interim Measure Summary Report for Riverbank Areas B&H was submitted in January 2014.

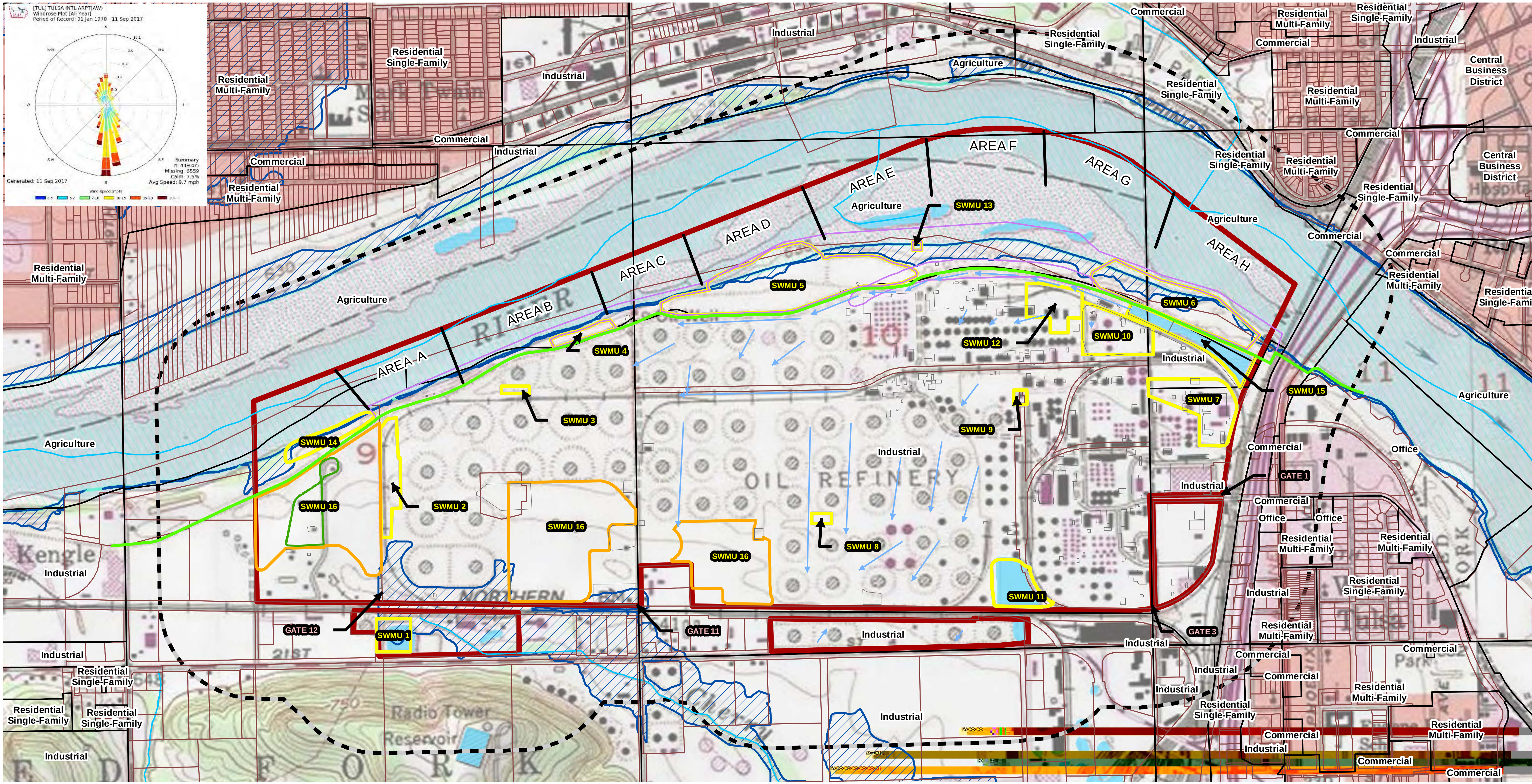
Table 9-2. Corrective Action History and Status (cont.)

Unit Name	Activity Status
SWMU 7 – East Landfill	An RFA Report dated July 21, 1986 included a recommendation for NFA, except for inclusion in the Refinery-wide groundwater program. SWMU 7 was not a regulated unit under the 1988 RCRA Permit. An RFI was completed, and as of June 1, 2009, the SWMU was in NFA.
SWMU 8 – Scrap Metal Landfill	An RFA Report dated July 21, 1986 included a recommendation for NFA, except for inclusion in the Refinery-wide groundwater program. The landfill was closed prior to 1980 and was not a regulated unit under the initial RCRA operating Permit of October 1988. As of the date of issuance of this Permit, the SWMU is in NFA status.
SWMU 9 – Concrete Sump	The July 21, 1986 RFA Report included a recommendation for NFA except for inclusion in the Refinery-wide groundwater program. The 1988 RCRA permit did require a RFI for SWMU 9. Sunoco completed the RFI in accordance with an approved workplan. They found influence of a hydrocarbon plume 12 to 13 feet below the ground surface. A clean zone was identified below the SWMU and above the hydrocarbon plume. This information indicates the hydrocarbon plume found beneath the SWMU did not originate from this unit, but from historical petroleum leaks and spills. This SWMU has been deleted from the permit.
SWMU 10 – Wastewater Treatment System	This unit is currently an active operations unit.
SWMU 11 – Spray Pond	The July 21, 1986 RFA Report included a recommendation for NFA except for inclusion in the Refinery-wide groundwater program. The 1988 RCRA permit did require a RFI for SWMU 11. Sunoco completed the RFI in accordance with an approved workplan. They concluded that the RFI results showed no significant results greater than background and requested a determination for NFA. They collected storm water samples from the SWMU on April 14, 1999. All results complied with NPDES permit limits. This SWMU has been deleted from the permit.
SWMU 12 – Cat Cracker Landfill	The unit was not a regulated unit under the initial RCRA operating Permit of October 1988. Sunoco completed the RFI in accordance with the approved workplan. They concluded that there were no concentrations of hazardous constituents greater than background and requested a determination of NFA. In 1993, USEPA requested that they install piezometers. ODEQ requested the data from the piezometers in 1998. By a letter dated March 22, 1999, ODEQ noted that the data appeared to be demonstrate limited mobility of constituents to the groundwater. As of June 1, 2009, the SWMU is in NFA status.
SWMU 13 – Scrap Metal Landfill	The July 21, 1986 RFA Report included a recommendation for NFA. The 1988 RCRA Permit did not require an RFI for this SWMU. As of June 1, 2009, the SWMU is in NFA status.

Table 9-2. Corrective Action History and Status (cont.)

Unit Name	Activity Status
SWMU 14 – Allison Property Landfill	The unit has undergone Interim Measures which were approved by the USEPA. These Interim Measures were completed in 1995. The unit was not a regulated unit under the initial RCRA operating Permit of October 1988. As of June 1, 2009, the SWMU is in NFA status.
SWMU 15 – Storm Water Impoundments	These were RCRA-regulated units from 1991 when they were managing hazardous wastewater. In 1994, they were clean closed and ceased being RCRA-regulated. The basins are underlain by a liner system composed of two feet of compacted clay and an eighty-mil HDPE liner. This SWMU has been deleted from the permit.
SWMU 16 – Land Treatment Units	Closure certificate for these units was accepted on August 22, 2003. All three units are currently under post-closure care.
SWMU 17 – Oily Sludge Roads	Deleted prior to the original November 1, 1988 Permit.
SWMU 18 – Tank Diked Areas	Deleted prior to the original November 1, 1988 Permit.

Figures



TRC - GIS

Coordinate System: NAD 1983 2011 StatePlane Oklahoma North FIPS 3501 FIUS (Foot US)
Map Rotation: 0

Plot Date: 11/27/2018, 14:41:00 PM by MHORN -- LAYOUT: ANSI B(11"x17")
Path:

LEGEND

- REFINERY BOUNDARY
- 1000 FT BUFFER
- BUILDINGS
- LTUs
- NON-WASTE
- AOCs
- SWMUs
- CITY OF TULSA ZONING
- COUNTY PARCELS
- 100-YEAR-FLOOD-PLAIN
- FLOODWAY
- SURFACE WATERBODIES
- LEVEE
- DISCHARGE PATH
- STREAMS

SOURCES:
FLOODPLAINS (FEMA, 8/23/18); SURFACE WATERS AND STREAMS (NATIONAL HYDROGRAPHY DATASET, 2018);
WINDROSE (IOWA ENVIRONMENTAL MESONET, 9/11/2018);
PARCELS (TULSA COUNTY, 6/11/18);
ZONING LANDUSE (CITY OF TULSA 11/13/17).
USGS TOPOGRAPHIC BASEMAP 24K, SAND SPRINGS, OK (1984).

HOLLYFRONTIER

0 500 1,000 Feet
1 " = 1,000 '
1:12,000

PROJECT:
HOLLYFRONTIER TULSA REFINING LLC
TULSA WEST REFINERY - PERMIT NO. 058078775-PC
TULSA, OKLAHOMA

TITLE:
SOLID WASTE MANAGEMENT UNITS

DRAWN BY:	MHORN	PROJ. NO.:	304508
CHECKED BY:	MWALTHER		
APPROVED BY:	KFOGARTY		**FIGURE 9-1**
DATE:	NOVEMBER 2018		

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