

# **ECOVAC SERVICES**

*The World Leader in Mobile Dual-Phase/Multi-Phase Extraction and  
Patented SURFAC<sup>®</sup>/ISCO-EFR<sup>®</sup>/COSOLV<sup>®</sup> Technologies  
Treatability Studies / Research & Development*

November 24, 2015

Ms. Patty Currier  
Apex Envirotech, Inc.  
1920 W 143<sup>rd</sup> Street, Suite 100  
Leawood, Kansas 66224  
[pcurrier@apexenvirotech.com](mailto:pcurrier@apexenvirotech.com)

**Subject: Enhanced Fluid Recovery (EFR<sup>®</sup>) Results  
Event Nos. 8 and 9  
Zill Inc.  
8316 East 31<sup>st</sup> Street  
Kansas City, Missouri**

Dear Ms. Currier:

Please find attached the data summary for the eighth and ninth EFR<sup>®</sup> events conducted at the subject site on November 11 and 12, 2015. Previous events have been conducted at the site from April 1 to June 18, 2015. The following summarizes the results of this EFR<sup>®</sup> event.

## **DESCRIPTION**

The EFR<sup>®</sup> process is best described as a mobile version of dual-phase or multi-phase extraction (DPE/MPE), but with a much higher vacuum and radius of influence. An EcoVac vacuum truck with two rotary vein vacuum pumps rated as high as 100 horsepower, 29 inches mercury vacuum, and 880 CFM "open air" flow was utilized during this event. EFR<sup>®</sup> simultaneously removes vapors, free product, dissolved-phase hydrocarbons, and groundwater from the subsurface. EFR<sup>®</sup> dewateres and exposes the smear zone to the effects of "high rate" soil vapor extraction. Importantly, EFR<sup>®</sup> also enhances biodegradation by introducing oxygen to the vadose and saturated zones.

## **SUMMARY OF RESULTS**

### **Event No. 8 (November 11, 2015)**

Separate-phase hydrocarbons (SPH) were detected in six of the gauged monitor wells (MW-18 – 5.40 feet, MW-20 – 1.72 feet, MW-21 – 2.97 feet, MW-22 – 0.43 feet, MW-23 – 3.69 feet, and MW-A – 0.02 feet) prior to conducting this EFR<sup>®</sup> event. Historical SPH thicknesses are shown in the attached Cumulative EFR<sup>®</sup> Data Table. EFR<sup>®</sup> was conducted for eight hours at five extraction points, consisting of the initial four hours of extraction at MW-21, MW-22, and MW-23 and the final four hours of this event at MW-18 and MW-20. SPH was detected MW-21 (0.24 feet), MW-22 (0.17 feet), MW-23 (0.05 feet), and MW-A (0.02 feet) following the event.

A calculated total of 971 pounds of petroleum hydrocarbons (approximately 149 equivalent gallons of gasoline) was removed during this EFR<sup>®</sup> event. Hydrocarbon removal rates ranged from 10 to 228 pounds per hour during this event. Removal rates ranged from 205 to greater than 228 pounds per hour during

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extraction from MW-21, MW-22, and MW-23 and decreased from 33 to 10 pounds per hour during the final four hours of this event at MW-18 and MW-20.

Vapor concentrations were measured by a TLV Sniffer and calibrated to a hexane standard. Samples were collected into Tedlar<sup>®</sup> bags from a sampling port in the vacuum truck stack. Vapor concentrations ranged from 5,000 to greater than 100,000 parts per million by volume (PPM<sub>v</sub>) during this EFR<sup>®</sup> event. Vapor flows were measured by a Dwyer Thermal Anemometer Model 470 (factory calibrated) and collected from the stack sampling port. Vapor flow rates ranged from 123 to 137 cubic feet per minute (CFM).

In-well vacuums recorded during this EFR<sup>®</sup> event are detailed in the EFR<sup>®</sup> Field Data Sheet and summarized below:

<u>Extraction Well</u>	<u>In-Well Vacuum</u>
MW-18	1 inch of mercury
MW-20	7 inches of mercury
MW-21	3 inches of mercury
MW-22	13 inches of mercury
MW-23	5 inches of mercury

Differential pressures were recorded at surrounding wells during the event to assess the vacuum induced by EFR<sup>®</sup> in the vadose zone. Differential pressures were measured with a Dwyer Digital Manometer Model 477 and are detailed in the attached table and summarized below:

Extraction at MW-21, MW-22, and MW-23

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-24	-10.77 inch of water	MW-21 (44 feet)
MW-A	0.00 inch of water	MW-21 (50 feet)
MW-25	-1.13 inches of water	MW-23 (59 feet)

Extraction at MW-18 and MW-20

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-17	-0.37 inch of water	MW-18 (33 feet)

Groundwater levels were recorded during this event to assess the groundwater drawdown created by EFR<sup>®</sup>. The groundwater drawdown data are detailed in the attached table and summarized below:

Extraction at MW-21, MW-22, and MW-23

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-24	-4.77 feet	MW-21 (44 feet)
MW-A	-0.03 feet	MW-21 (50 feet)
MW-25	-4.96 feet	MW-23 (59 feet)

Extraction at MW-18 and MW-20

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-17	-0.04 feet	MW-18 (33 feet)

Approximately 920 gallons of liquid were extracted during this EFR<sup>®</sup> event and offloaded into a frac tank supplied by Apex Envirotech, Inc. SPH was not detected in the vacuum truck tank following completion of the event.

**Event No. 9 (November 12, 2015)**

SPH was detected in 11 of the gauged monitor wells (MW-7 – 1.23 feet, MW-9 – 0.02 feet, MW-10 – 0.56 feet, MW-13 – 0.19 feet, MW-18 – 0.01 feet, MW-21 – 0.69 feet, MW-22 – 0.48 feet, and MW-23 – 1.45 feet, MW-A – 0.23 feet, OW-N – 0.06 feet, and OW-S – 0.07 feet) prior to conducting this EFR<sup>®</sup> event. EFR<sup>®</sup> was conducted for seven hours at eight extraction points, consisting of the initial four hours of extraction at MW-21, MW-22, MW-23, MW-A and the final three hours of this event at MW-7, MW-9, MW-10, and MW-13. SPH was detected MW-7 (0.13 feet), MW-10 (0.01 feet), MW-18 (0.01 feet), MW-21 (0.49 feet), MW-22 (0.03 feet), MW-23 (0.06 feet), and MW-A (0.10 feet) following extraction.

A calculated total of 845 pounds of petroleum hydrocarbons (approximately 130 equivalent gallons of gasoline) was removed during this EFR<sup>®</sup> event. Hydrocarbon removal rates ranged from 90 to 171 pounds per hour during this event. Removal rates decreased from 171 to 96 during the initial four hours of extraction at MW-21, MW-22, MW-23, and MW-A and decreased from 155 to 90 pounds per during the final three hours of this event at MW-7, MW-9, MW-10, and MW-13.

Vapor concentrations were measured by a TLV Sniffer and calibrated to a hexane standard. Samples were collected into Tedlar<sup>®</sup> bags from a sampling port in the vacuum truck stack. Vapor concentrations ranged from 42,000 to 76,000 PPM<sub>v</sub> during this EFR<sup>®</sup> event. Vapor flows were measured by a Dwyer Thermal Anemometer Model 470 (factory calibrated) and collected from the stack sampling port. Vapor flow rates ranged from 123 to 137 CFM.

In-well vacuums recorded during this EFR<sup>®</sup> event are detailed in the EFR<sup>®</sup> Field Data Sheet and summarized below:

<u>Extraction Well</u>	<u>In-Well Vacuum</u>
MW-7	1 inch of mercury
MW-9	5 inches of mercury
MW-10	1 inch of mercury
MW-13	1 inch of mercury
MW-21	6 inches of mercury
MW-22	8 inches of mercury
MW-23	18 inches of mercury
MW-A	9 inches of mercury

Differential pressures were recorded at surrounding wells during the event to assess the vacuum induced by EFR<sup>®</sup> in the vadose zone. Differential pressures were measured with a Dwyer Digital Manometer Model 477 and are detailed in the attached table and summarized below:

<u>Extraction at MW-21, MW-22, MW-23, and MW-A</u>		
<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-24	-12.64 inches of water	MW-21 (44 feet)
MW-25	-1.01 inches of water	MW-23 (59 feet)

Extraction at MW-7, MW-9, MW-10, and MW-13

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-12	0.00 inch of water	MW-9 (26 feet)
MW-16	0.00 inch of water	MW-9 (52 feet)

Groundwater levels were recorded during this event to assess the groundwater drawdown created by EFR<sup>®</sup>. The groundwater drawdown data are detailed in the attached table and summarized below:

Extraction at MW-21, MW-22, MW-23, and MW-A

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-24	-0.46 feet	MW-21 (44 feet)
MW-25	-1.25 feet	MW-23 (59 feet)

Extraction at MW-7, MW-9, MW-10, and MW-13

<u>Monitor Well</u>	<u>Maximum Change</u>	<u>Nearest Extraction Well (Approximate Distance)</u>
MW-12	-0.70 feet	MW-9 (26 feet)
MW-16	-0.26 feet	MW-9 (52 feet)

Approximately 475 gallons of liquid were extracted during this EFR<sup>®</sup> event and offloaded into a frac tank supplied by Apex Envirotech, Inc. SPH was not detected in the vacuum truck tank following completion of the event.

Thank you for this opportunity to team with Apex Envirotech in serving the environmental needs of your clients. We look forward to working with you again in the future to provide innovative and cost effective environmental solutions at this and other sites.

Sincerely,

EcoVac Services



Matthew C. Wittich

# EFR<sup>®</sup> FIELD DATA SHEET

Client: Apex Envirotech			Facility Name: Zill Inc.						Event #: 8					
Facility Address: 3816 East 31st Street, Kansas City, Missouri						Technician: K. Free			Date: 11/11/15					
Extraction Well(s)	Time hh:mm	Extraction Well-head Vacuum (in. Hg)							Vacuum Truck Exhaust					
		Inlet	MW-21	MW-22	MW-23	MW-18	MW-20			Concentration PPM	Offgas Velocity FT/MIN	Flow Rate CFM	Removal Rate LBS/HR	Interval Removal LBS
Start Time:	9:00													
MW-21,22,23	9:15	20	3	13	5	-	-		100,000	2,800	137	228	57	
"	9:30	20	3	13	5	-	-		100,000	2,800	137	228	57	
"	9:45	20	3	13	5	-	-		100,000	2,800	137	228	57	
"	10:00	20	3	13	5	-	-		100,000	2,800	137	228	57	
"	10:30	20	3	13	5	-	-		100,000	2,800	137	228	114	
"	11:00	20	3	13	5	-	-		100,000	2,800	137	228	114	
"	11:30	20	3	13	5	-	-		100,000	2,800	137	228	114	
"	12:00	20	3	13	5	-	-		100,000	2,800	137	228	114	
"	13:00	20	3	13	5	-	-		90,000	2,800	137	205	205	
MW-18,20	14:00	20	-	-	-	1	7		16,000	2,500	123	33	33	
"	15:00	20	-	-	-	1	7		11,000	2,500	123	22	22	
"	16:00	20	-	-	-	1	7		8,000	2,500	123	16	16	
"	17:00	20	-	-	-	1	7		5,000	2,500	123	10	10	
Well Gauging Data:			Before EFR <sup>®</sup> Event			After EFR <sup>®</sup> Event			Corr. DTW					
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)					
MW-17	2"		-	5.91	0.00	-	5.95	0.00	-0.04					
MW-18	2"	20.50	13.25	18.65	5.40	-	19.60	0.00	-5.54					
MW-20	2"	14.95	2.88	4.60	1.72	-	9.50	0.00	-6.36					
MW-21	2"	20.20	11.57	14.54	2.97	14.65	14.89	0.24	-2.67					
MW-22	2"	16.20	8.48	8.91	0.43	12.89	13.06	0.17	-4.37					
MW-23	2"	15.00	8.05	11.74	3.69	12.89	12.93	0.04	-4.29					
MW-24	2"		-	12.75	0.00	-	13.96	0.00	-1.21					
MW-25	2"		-	11.45	0.00	-	12.90	0.00	-1.45					
MW-A	2"		14.12	14.14	0.02	14.21	14.23	0.02	-0.09					
Vacuum Truck Information		Well ID	Breather Port	Stinger Depth	Recovery/Disposal Information									
Subcontractor:	AllVac	MW-18	0 (closed)	20'	Hydrocarbons Removed (vapor):		971	pounds						
Truck Operator:	K. Free	MW-20	0 (closed)	5', 7'@15:30	Hydrocarbons Removed (liquid):		0.0	gallons						
Truck No.:	148	MW-21	0 (closed)	15'	Total Hydrocarbons Removed:		149	equiv. gallon						
Vacuum Pumps:	Becker	MW-22	0 (closed)	11', 13'@10:00	Molecular Weight Utilized:		105	g/mole						
Pump Type:	Twin LC-44s	MW-23	0 (closed)	12'	Disposal Facility:		Johnson County Landfill							
Tank Capacity (gal.):	2,894				Manifest Number:									
Stack I.D. (inches)	3.0				Total Liquids Removed:		920	gallons						
 www.ecovacservices.com 859-266-5053		Pump Information		Notes:										
		Time:	9:00 - 17:00											
		# Pumps:	2											
		RPMs:	900											

Differential Pressure and Groundwater Drawdown Data Recorded During EFR<sup>®</sup>  
 Event No. 8 - November 11, 2015  
 Zill Inc.  
 3816 East 31st Street  
 Kansas City, Missouri

**DIFFERENTIAL PRESSURE DATA**  
**Extraction from MW-21, MW-22, and MW-23**

		Well Designation:		
		<u>MW-24</u>	<u>MW-A</u>	<u>MW-25</u>
Nearest Extraction Well:		MW-21	MW-21	MW-23
Approximate Distance:		44 feet	50 feet	59 feet
<u>Time</u>	<u>Elapsed Time</u>	Differential Pressures (inches of water):		
10:00	1.0 hrs.	-8.92	0.00	-0.20
11:00	2.0 hrs.	-9.74	0.00	-0.64
12:00	3.0 hrs.	-10.28	0.00	-0.89
13:00	4.0 hrs.	-10.77	0.00	-1.13
Maximum Change:		-10.77	0.00	-1.13

**Extraction from MW-18 and MW-20**

		Well Designation:
		<u>MW-17</u>
Nearest Extraction Well:		MW-18
Approximate Distance:		33 feet
<u>Time</u>	<u>Elapsed Time</u>	Differential Pressures (inches of water):
14:00	1.0 hrs.	-0.12
15:00	2.0 hrs.	-0.28
16:00	3.0 hrs.	-0.37
Maximum Change:		-0.37

**GROUNDWATER DRAWDOWN DATA**  
**Extraction from MW-21, MW-22, and MW-23**

		Well Designation:		
		<u>MW-24</u>	<u>MW-A</u>	<u>MW-25</u>
Nearest Extraction Well:		MW-21	MW-21	MW-23
Approximate Distance:		44 feet	50 feet	59 feet
<u>Time</u>	<u>Elapsed Time</u>	Depth to Liquid (feet below top of casing):		
Prior to EFR <sup>®</sup>		10.12	13.28	8.19
13:00	4.0 hrs.	14.89	13.31	13.15
Maximum Change:		-4.77	-0.03	-4.96

**Extraction from MW-18 and MW-20**

		Well Designation:
		<u>MW-17</u>
Nearest Extraction Well:		MW-18
Approximate Distance:		33 feet
<u>Time</u>	<u>Elapsed Time</u>	Depth to Liquid (feet below top of casing):
Prior to EFR <sup>®</sup>		5.91
17:00	4.0 hrs.	5.95
Maximum Change:		-0.04



# EFR<sup>®</sup> GAUGING DATA SHEET

Client: Apex Envirotech	Facility Name: Zill Inc.	Event #: 9
Facility Address: 3816 East 31st Street, Kansas City, Missouri	Technician: K. Free	Date: 11/12/15

Well Gauging Data:			Before EFR <sup>®</sup> Event			After EFR <sup>®</sup> Event			Corr. DTW
Well No.	Diam.	TD (ft)	DTS (ft)	DTW (ft)	SPH (ft)	DTS (ft)	DTW (ft)	SPH (ft)	Change (ft)
MW-7	2"		10.75	11.98	1.23	12.00	12.13	0.13	-1.09
MW-9	2"		11.95	11.97	0.02	-	12.35	0.00	-0.40
MW-10	2"		12.76	13.32	0.56	13.54	13.55	0.01	-0.70
MW-12	2"		-	15.89	0.00	-	16.59	0.00	-0.70
MW-13	2"		10.36	10.55	0.19	-	14.37	0.00	-3.98
MW-16	2"		-	11.29	0.00	-	11.55	0.00	-0.26
MW-17	2"		-	6.22	0.00	-	6.25	0.00	-0.03
MW-18	2"	20.50	16.22	16.23	0.01	16.00	16.01	0.01	0.22
MW-20	2"	14.95	-	4.90	0.00	-	4.90	0.00	0.00
MW-21	2"	20.20	12.66	13.35	0.69	13.77	14.26	0.49	-1.08
MW-22	2"	16.20	10.95	11.43	0.48	14.32	14.35	0.03	-3.30
MW-23	2"	15.00	9.32	10.77	1.45	11.69	11.75	0.06	-2.16
MW-24	2"		-	12.66	0.00	-	13.12	0.00	-0.46
MW-25	2"		-	12.30	0.00	-	13.55	0.00	-1.25
MW-A	2"		14.20	14.31	0.11	15.55	15.65	0.10	-1.35
OW-N	4"		10.69	10.75	0.06				
OW-S	4"		10.62	10.69	0.07				

 <p style="margin: 0;">www.ecovacservices.com 859-266-5053</p>	Notes: <hr/> <hr/> <hr/>
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Differential Pressure and Groundwater Drawdown Data Recorded During EFR<sup>®</sup>  
 Event No. 9 - November 12, 2015  
 Zill Inc.  
 3816 East 31st Street  
 Kansas City, Missouri

**DIFFERENTIAL PRESSURE DATA**  
**Extraction from MW-21, MW-22, MW-23, and MW-A**

		Well Designation:	
		<u>MW-24</u>	<u>MW-25</u>
Nearest Extraction Well:		MW-21	MW-23
Approximate Distance:		44 feet	59 feet
<u>Time</u>	<u>Elapsed Time</u>	Differential Pressures (inches of water):	
9:15	1.0 hrs.	-11.13	-0.64
10:15	2.0 hrs.	-11.48	-0.78
11:15	3.0 hrs.	-11.77	-0.89
12:15	4.0 hrs.	-12.64	-1.01
Maximum Change:		-12.64	-1.01

**Extraction from MW-7, MW-9, MW-10, and MW-13**

		Well Designation:	
		<u>MW-12</u>	<u>MW-16</u>
Nearest Extraction Well:		MW-9	MW-9
Approximate Distance:		26 feet	52 feet
<u>Time</u>	<u>Elapsed Time</u>	Differential Pressures (inches of water):	
13:15	1.0 hrs.	0.00	0.00
14:15	2.0 hrs.	0.00	0.00
15:15	3.0 hrs.	0.00	0.00
Maximum Change:		0.00	0.00

**GROUNDWATER DRAWDOWN DATA**  
**Extraction from MW-21, MW-22, MW-23, and MW-A**

		Well Designation:	
		<u>MW-24</u>	<u>MW-25</u>
Nearest Extraction Well:		MW-21	MW-23
Approximate Distance:		44 feet	59 feet
<u>Time</u>	<u>Elapsed Time</u>	Depth to Liquid (feet below top of casing):	
Prior to EFR <sup>®</sup>		12.66	12.30
12:15	4.0 hrs.	13.12	13.55
Maximum Change:		-0.46	-1.25

**Extraction from MW-7, MW-9, MW-10, and MW-13**

		Well Designation:	
		<u>MW-12</u>	<u>MW-16</u>
Nearest Extraction Well:		MW-9	MW-9
Approximate Distance:		26 feet	52 feet
<u>Time</u>	<u>Elapsed Time</u>	Depth to Liquid (feet below top of casing):	
Prior to EFR <sup>®</sup>		15.89	11.29
16:15	4.0 hrs.	16.59	11.55
Maximum Change:		-0.70	-0.26

# CUMULATIVE EFR® DATA TABLE

Zill Inc.

3816 East 31st Street  
Kansas City, Missouri

	4/1/15	4/2/15	4/28/15	4/29/15	4/30/15	6/16/15	6/17/15	6/18/15	11/11/15	11/12/15
Event No.	1	2	3	4	1 (On Site)	5	6	7	8	9
Extraction Wells	MW-21, 22, 23	MW-18, 20, 22, 23	MW- 22,23	MW-18, 20, 21, 22, 23	MW-7, 9, 10	MW-18,20	MW-21, 22, 23	MW-21, 22, 23	MW-18, 20, 21, 22, 23	MW-7, 9, 10, 13, 21, 22, 23, A
SPH Thickness (ft.) MW-7					0.25					1.23
SPH Thickness (ft.) MW-9					0.00					0.02
SPH Thickness (ft.) MW-10					1.03					0.56
SPH Thickness (ft.) MW-13										0.19
SPH Thickness (ft.) MW-18		0.12		1.06		0.06	0.00	0.00	5.40	0.01
SPH Thickness (ft.) MW-20		0.20		0.07		0.02	0.00	0.00	1.72	0.00
SPH Thickness (ft.) MW-21	0.53	0.00	0.02	0.00		1.18	1.08	0.29	2.97	0.69
SPH Thickness (ft.) MW-22	0.42	0.13	3.00	1.22		1.49	1.37	0.15	0.43	0.48
SPH Thickness (ft.) MW-23	2.71	0.47	0.52	2.65		0.42	0.39	0.10	3.69	1.45
SPH Thickness (ft.) MW-A									0.02	0.11
Liquid Removed/Event (Gal.)	913	723	896	1,182	370	760	1,338	695	920	475
Cumulative Liquid Removed (Gal.)	913	1,636	2,532	3,714	4,084	4,844	6,182	6,877	7,797	8,272
Pounds Removed/Event	977	343	756	270	1,625	28	731	334	971	845
Cumulative Pounds Removed	977	1,320	2,076	2,346	3,971	3,999	4,730	5,065	6,036	6,881
Equiv. Gal. Gasoline Removed/Event	150	53	116	42	250	4.4	112	51	149	130
Cumulative Equiv. Gal. Removed	150	203	319	361	611	615	728	779	929	1,059

# CUMULATIVE EFR® GRAPH

Zill Inc.  
 3816 East 31st Street  
 Kansas City, Missouri

