OPERATIONAL ADDENDUM TO CORRECTIVE ACTION PLAN

FOR

HADNOT POINT FUEL FARM
MARINE CORPS BASE
CAMP LEJEUNE, NORTH CAROLINA

NCDENR UST INCIDENT NOs.: 3671, 10615 and 22788

MARCH 29, 2007

CONTRACT NO. N62470-04-D-6200
DELIVERY ORDER NO. 0016
CATLIN PROJECT NO. 205-077

PREPARED BY:

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A. PURPOSE AND AUTHORIZATION

To purpose of this report is to propose operational changes to the Hadnot Point Fuel Farm (HPFF) bio-pulse sparging system based on observations of the first complete round of bio-pulse sparge pilot tests performed by Shaw Environmental, Inc. (Shaw). This evaluation and report was authorized by NAVFAC Mid-Atlantic, in accordance with Contract No. N62470-04-D-6200 Delivery Order No. 0016.

B. SCOPE OF WORK

The scope of work for this project included an evaluation of the flow rate over time for injection of air into each of twenty-five (25) bio-pulse air sparge wells at the HPFF project site. The scope also included determining if operational modifications were necessary, and if so, make recommendations for adjusting the pulse duration. This evaluation stemmed from the discovery of petroleum vapors in Building 1101 assumed to be associated with the bio-pulse sparging events.

C. DESCRIPTION OF INITIAL PULSE SEQUENCE, LOCATION AND DURATION

Shaw initiated the first round of pilot test bio-pulse sparging on September 28, 2006 with well BP-1. The intent of this first round was to sparge the outer-most wells away from the center of the dissolved contaminant plume and work toward the plume core. The wells were sparged in the following sequence and on the stated dates.

No.	Well	Date
1	BP-1	September 28, 2006
2	BP-21	September 29, 2006
3	BP-12	October 2, 2006
4	BP-7	October 3, 2006

No.	Well	Date
5	BP-24	October 4. 2006
6	BP-4	October 9, 2006
7	BP-15	October 10, 2006
8	BP-22	October 11, 2006
9	BP-2	October 12, 2006
10	BP-14	October 16, 2006
11	BP-19	October 17, 2006
12	BP-10	October 18, 2006
13	BP-23	October 23, 2006
14	BP-9	October 25, 2006
15	BP-11	October 26, 2006
16	BP-20	October 27, 2006
17	BP-5	October 30, 2006
18	SP-100	October 31, 2006
19	BP-16	November 1, 2006
20	BP-6	November 2, 2006
21	BP-17	November 6, 2006
22	BP-8	November 7, 2006
23	BP-13	November 8, 2006
24	BP-18	November 9, 2006
25	BP-3	November 10, 2006

As recommended in the RCAP, each of the initial pilot test sparging events were for a duration of twenty four (24) hours. During each event, the air flow into the well was kept at a uniform pressure (95 psi) and the flow was allowed to continually increase until pulse termination. Air flow measurements were taken and recorded on a two hour basis during each pilot test sparging event.

After initiation of the bio-pulse event on BP-13 on November 8, 2006, elevated Flame Ionization Detector (FID) readings were noted in the breathing zone at the north end of Building 1101 from near cracks in the concrete floor and from expansion joints around columns. An odor (presumably petroleum) was also noted. Similar findings were noted by Shaw on November 9, 2006 and again on November 13 and 14, 2006 and continued to be noted for at least a month after the pilot test sparge event.

D. OBSERVATIONS FROM PILOT TESTS

Based on the elevated FID readings, CATLIN was tasked with evaluating the data collected by Shaw during the first round of bio-pulse sparging. Initially, CATLIN prepared a timeline that included the date of each bio-pulse sparging event along with the vapor readings collected from within Building 1101 (see Appendix A). Analysis of this graph suggests that petroleum vapors in Building 1101 were the result of sparging conducted on well BP-13 on November 8, 2006. Based on routine vapor readings collected by Shaw within Building 1101, no evidence of

elevated vapor readings were noted in the time period before the bio-pulse event on BP-13.

Well BP-13 is located in the roadway between Building 1101 and Building 1108. CATLIN concluded that the elevated FID readings were most likely the result of sparging this well. Further evaluations performed by CATLIN revealed that the vapors may have been increased by over sparging of BP-13.

As proposed in the RCAP for the HPFF site, air is injected into the subsurface at a depth of 150 feet BLS and a sphere of sparge air is allowed to grow within the interbedded sediments until it reaches the lower boundary of the high permeability zone (HPZ) identified at approximately 75 feet BLS. At this point, the pulse of air is terminated and the "sphere area" allowed to re-saturate as the sparge air diffuses through the contaminated groundwater to the surface. By graphing the air flow versus time during the sparge event it is possible to identify changes in graph that indicate that the "sphere area" has reached the lower boundary of the 75 foot HPZ or that some other zone of high permeability has been encountered.

CATLIN subsequently graphed air flow versus time for the first round of pilot test bio-pulse sparging events at the HPFF site. These graphs are included as Appendix B. Assuming a theoretical bio-pulse sparging event, the graph of the air flow over time would resemble the graph presented in Appendix C. The point at which the actual curve departs from this theoretical curve suggests that the pulse be terminated.

In the "real world", the actual graphs are not expected to exactly resemble the theoretical graph in Appendix C; however, as can be seen in Appendix B, the graphed information is useful in recognizing the point of departure from the theoretical type curve. CATLIN has evaluated the graphs from each sparge event and has marked the graphs with estimated departure points that may indicate the optimum safe termination time for the air pulses. The graphs developed from the Shaw data are based on flow measurements taken every two hours and CATLIN believes that utilizing a continuous flow meter with a recorder to produce the air flow versus time graphs would provide a better basis for determining the optimal pulse duration.

E. PROPOSED OPERATIONAL MODIFICATIONS

CATLIN proposes the following operational modifications to the bio-pulse sparging system:

1. Reduce the next round of bio-pulse sparging from 24 hours to the estimated time of the first departure point for each initial sparge pilot test as shown in the table below:

No.	Well	Pulse Duration (min.)
1	BP-1	360
2	BP-21	360
3	BP-12	480
4	BP-7	600
5	BP-24	480
6	BP-4	240
7	BP-15	240
8	BP-22	240
9	BP-2	140
10	BP-14	120
11	BP-19	140
12	BP-10	540
13	BP-23	240
14	BP-9	480
15	BP-11	240
16	BP-20	140
17	BP-5	1440
18	SP-100	480
19	BP-16	750
20	BP-6	120
21	BP-17	240
22	BP-8	1440
23	BP-13	120
24	BP-18	360
25	BP-3	720

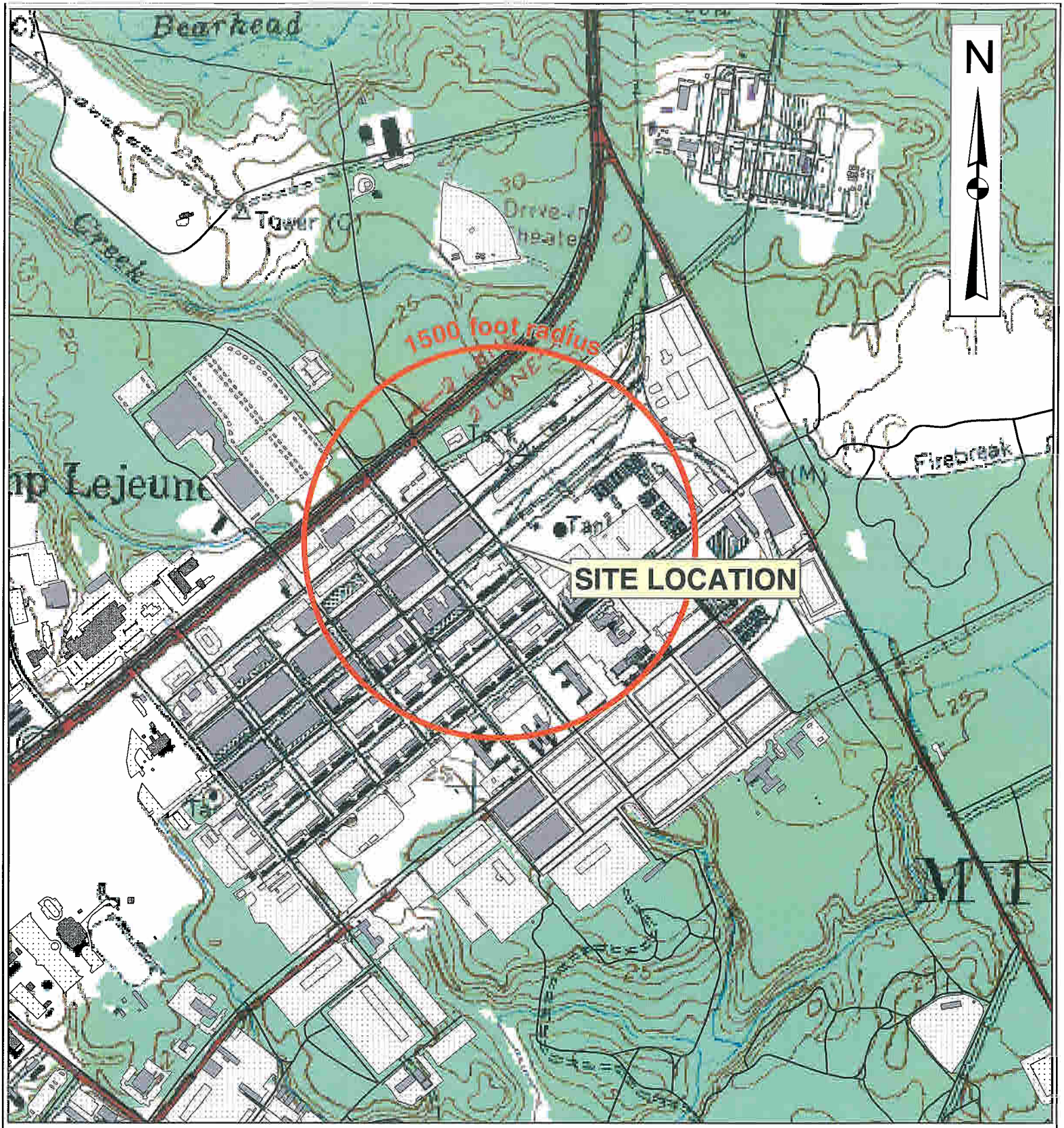
2. Utilize a continuous flow meter with recorder to develop an air flow versus time graph for each individual sparge well.

3. Evaluate the improved flow versus time curves and recommend adjustments in the duration of each pulse event, incrementally, for each sparge well to achieve maximum effect.

4. Continue to collect vapor readings within Building 1101 and other buildings within the assumed influence of the sparging events.

5. Prepare a summary report after each round of sparging and make specific recommendations for the next pulse event at each of the twenty five (25) sparging wells.

FIGURES



Data Sources: USGS Topographic Quadrangle Camp Lejeune (1952, Photorevised 1971). GIS data provided by Camp Lejeune GIS Department.

1,000 500 0 1,000 Feet

SCALE

CATLIN ENGINEERS and SCIENTISTS

PROJECT	TITLE	FIGURE
HADNOT POINT FUEL FARM MCB CAMP LEJEUNE, NC	SITE VICINITY MAP	1

JOB NO.	DATE	SCALE	DRAWN BY	CHECKED BY
205-077	MAR 2007	AS SHOWN	SAC	MEM

2205077-CAP ADDENDUM-2

FIGURE 2

TITLE: HPFF BIO-PULSE SPARGE WELL LOCATION MAP WITH SPARGE SCHEDULE

SCALE: AS SHOWN | DRAWN BY: THW | CHECKED BY: MEM

PROJECT: OPERATIONAL ADDENDUM TO CORRECTIVE ACTION PLAN FOR HADNOT POINT FUEL FARM MCB CAMP LEJEUNE, N.C.

JOB NO. 205077 | DATE: MAR 2007

ESTIMATED PLUME BOUNDARY AT 50 FEET BLS

ESTIMATED PLUME BOUNDARY AT 70 TO 90 FEET BLS

ESTIMATED PLUME BOUNDARY AT GREATER THAN 100 FEET BLS

ESTIMATED PLUME BOUNDARY AT SHALLOW ZONE

BP-1 BP-2 BP-3 BP-4 BP-5 BP-6 BP-7 BP-8 BP-9 BP-10 BP-11 BP-12 BP-13 BP-14 BP-15 BP-16 BP-17 BP-18 BP-19 BP-20 BP-21 BP-22 BP-23 BP-24 SP-100

BIRCH STREET | HOLCOMB BOULEVARD | WEST ROAD | CENTER ROAD | NW SECTOR | DOGWOOD | SECTOR | EAST ROAD | HAMMOND ROAD | ASH STREET | GIBB ROAD | BIRCH STREET | PAVED ROAD | PAVED PARKING LOT | MICHAEL ROAD

BUILDING 1101

CONCRETE SLAB | VEHICLE READY FUEL STORAGE | FUEL UNLOADING STATIONS | FORMER HADNOT POINT FUEL FARM | CONCRETE LOADING RAMP | CONCRETE DITCH | WASH STAND | OIL/WATER SEPARATOR | DISPENSER ISLANDS | 15,000 GAL ASTS U=UNLEADED D=DIESEL | 10,000 GAL DIESEL AST | 50,000 GAL AVGAS AST | 10,000 GAL AVGAS AST | D=DIESEL HD=HIGH SULPHUR DIESEL AST

LEGEND

EXISTING	DESCRIPTION
	BUILDING
	RAILROAD TRACKS
	CHAIN LINK FENCE
	TYPE I WELL
	TYPE II WELL
	TYPE III WELL (50' DEEP)
	TYPE III WELL (70'-90' DEEP)
	TYPE III WELL (GREATER THAN 100' DEEP)
	PUMPING WELL
	BIO-PULSE SPARGE WELL LOCATIONS
	BIO-PULSE SPARGE WELL SCHEDULE

100 50 0' 100 200
SCALE IN FEET

N

NOTE:
1. DRAWING ADAPTED FROM SHAW ENVIRONMENTAL, INC REPORT HPFF BIO-PULSE AIR SPARGE SYSTEM INSTALLATION AND BUILDING VAPOR PROTECTION INPLEMENTATION REPORT DATED OCTOBER 2006

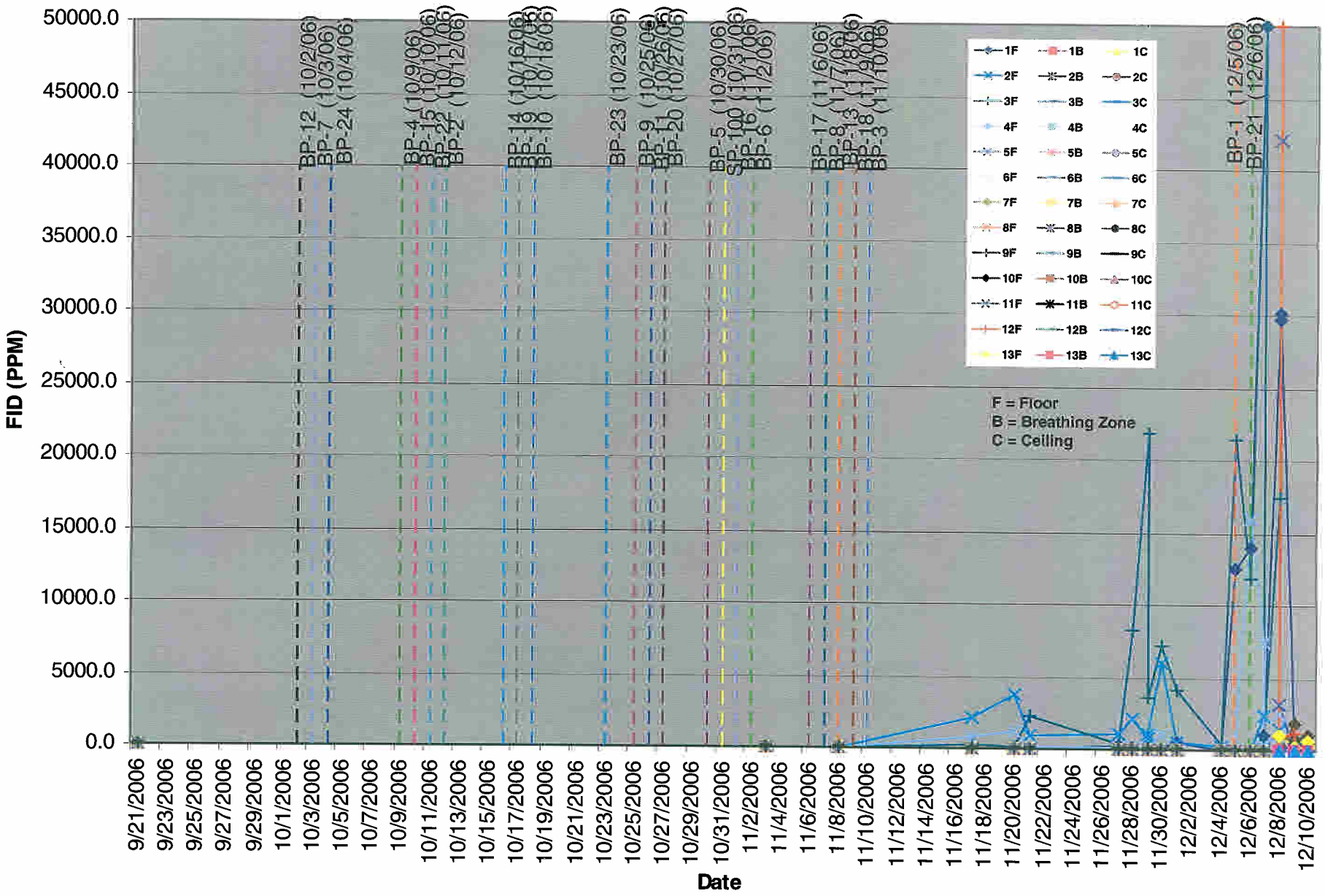
CABLUM ENGINEERS and SCIENTISTS WILMINGTON, NORTH CAROLINA

APPENDICES

APPENDIX A

VAPOR READINGS IN BUILDING 1101

Vapor Issue


FID (PPM)
50000.0
45000.0
40000.0
35000.0
30000.0
25000.0
20000.0
15000.0
10000.0
5000.0
0.0
BP-12 (10/2/06)
BP-7 (10/3/06)
BP-24 (10/4/06)
BP-4 (10/9/06)
BP-15 (10/10/06)
BP-22 (10/11/06)
BP-2 (10/12/06)
BP-14 (10/16/06)
BP-19 (10/17/06)
BP-10 (10/18/06)
BP-23 (10/23/06)
BP-9 (10/25/06)
BP-11 (10/26/06)
BP-20 (10/27/06)
BP-5 (10/30/06)
SP-100 (10/31/06)
BP-16 (11/1/06)
BP-6 (11/2/06)
BP-17 (11/6/06)
BP-8 (11/7/06)
BP-13 (11/8/06)
BP-18 (11/9/06)
BP-3 (11/10/06)
BP-1 (12/5/06)
BP-21 (12/6/06)
1F 1B 1C
2F 2B 2C
3F 3B 3C
4F 4B 4C
5F 5B 5C
6F 6B 6C
7F 7B 7C
8F 8B 8C
9F 9B 9C
10F 10B 10C
11F 11B 11C
12F 12B 12C
13F 13B 13C
F = Floor
B = Breathing Zone
C = Ceiling
9/21/2006
9/23/2006
9/25/2006
9/27/2006
9/29/2006
10/1/2006
10/3/2006
10/5/2006
10/7/2006
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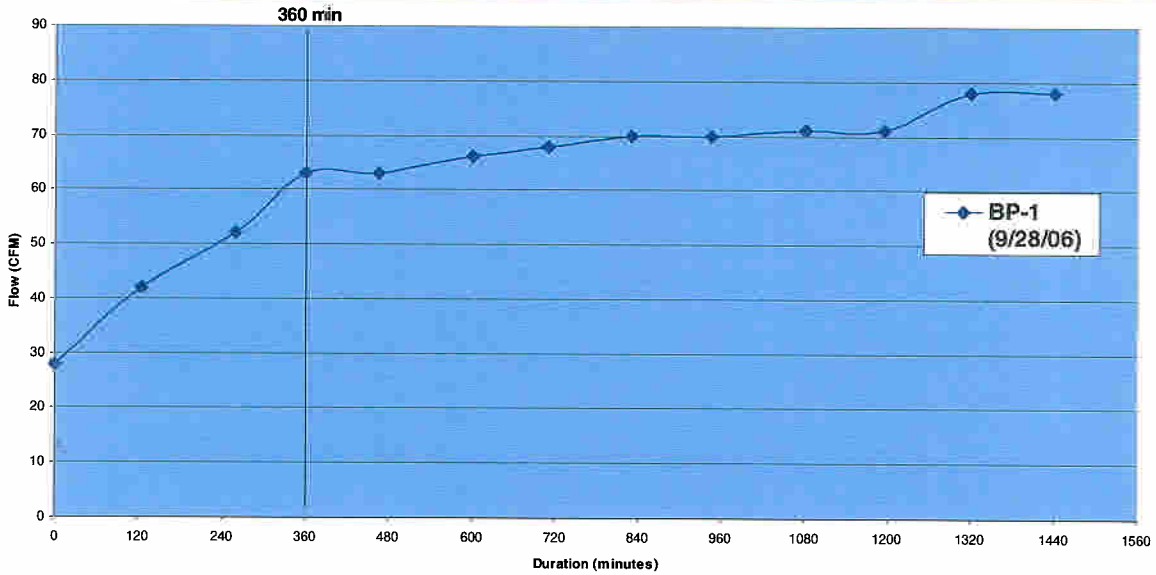
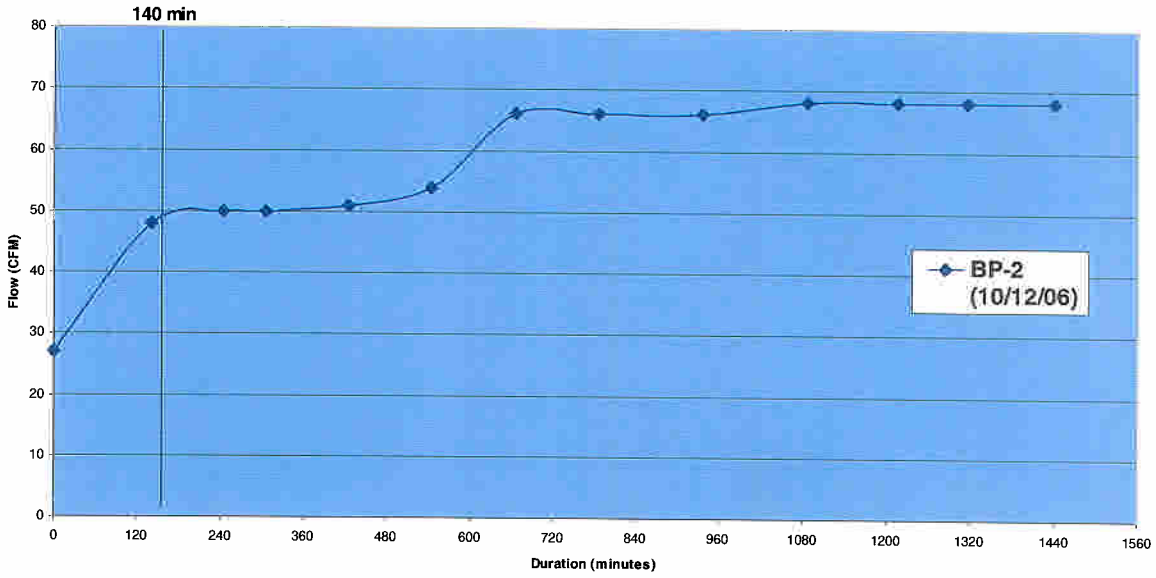
11/26/2006
11/28/2006
11/30/2006
12/2/2006
12/4/2006
12/6/2006
12/8/2006
12/10/2006
Date

APPENDIX B

GRAPHS OF AIR FLOW VS. TIME FOR FIRST ROUND OF PILOT TEST BIO-PULSE SPARGING EVENTS

Evaluate System Wide Pulse Pilot Test





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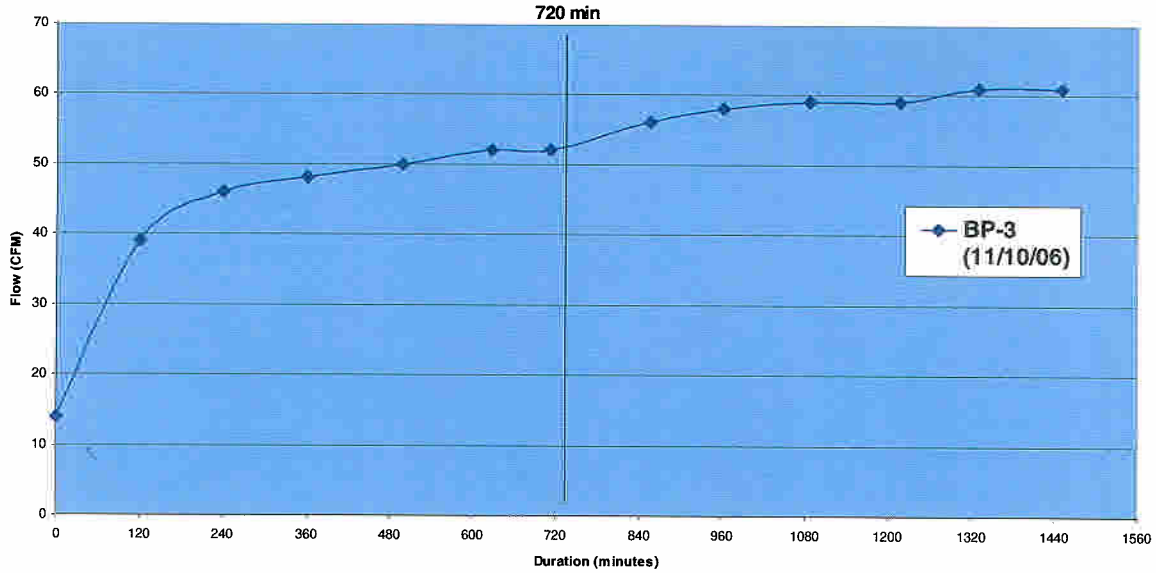

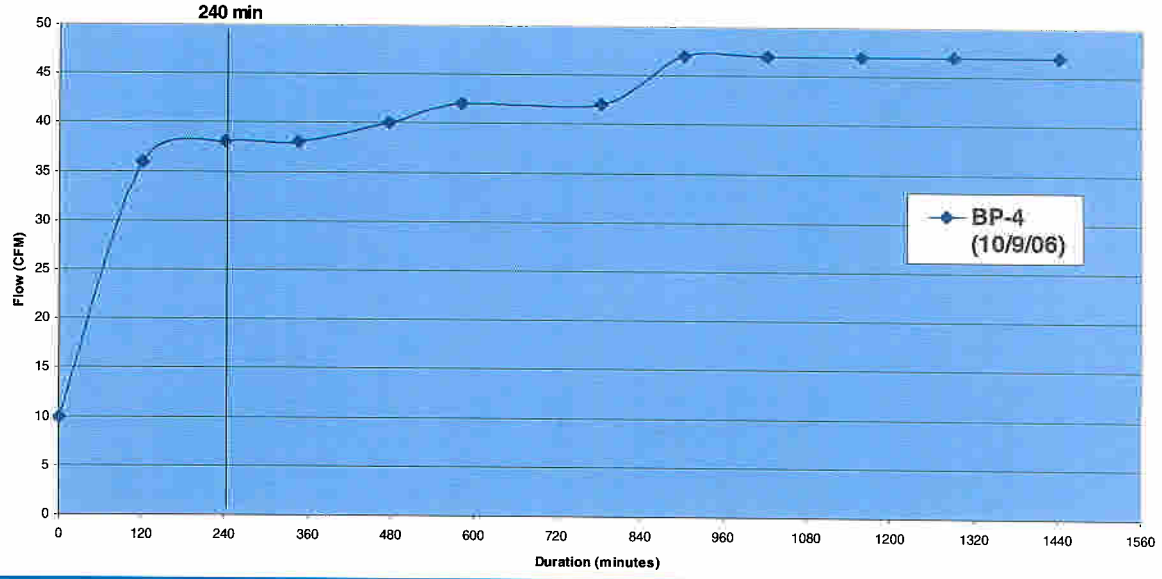

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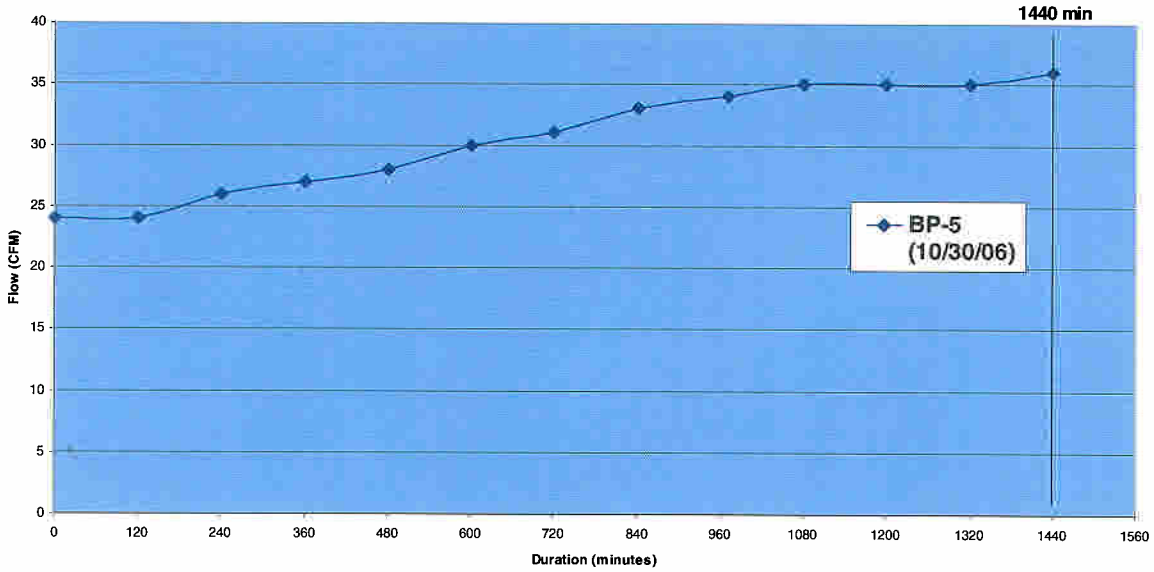

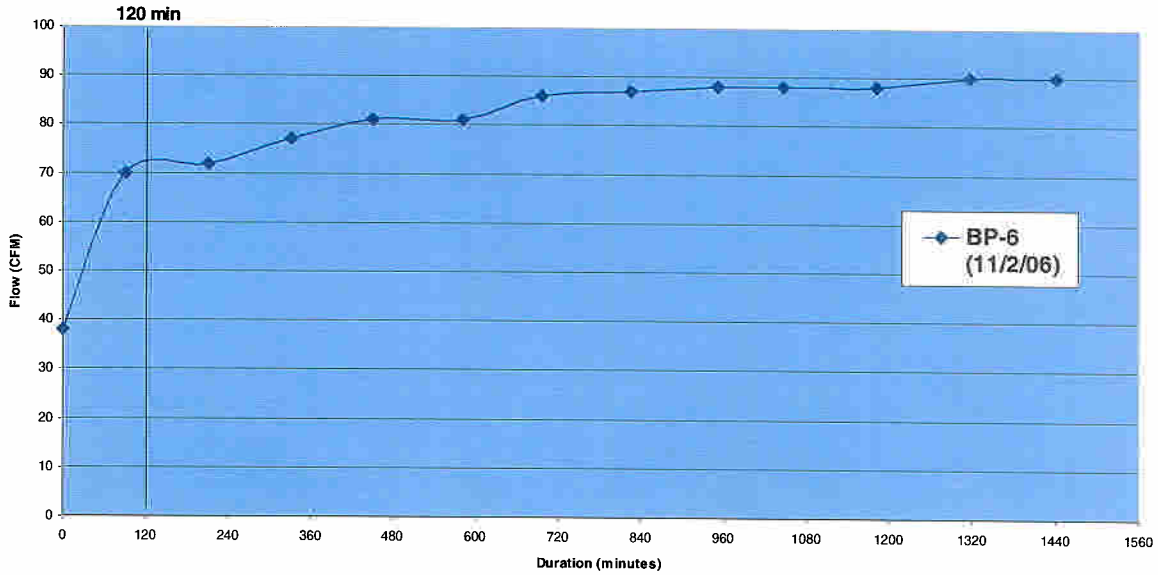

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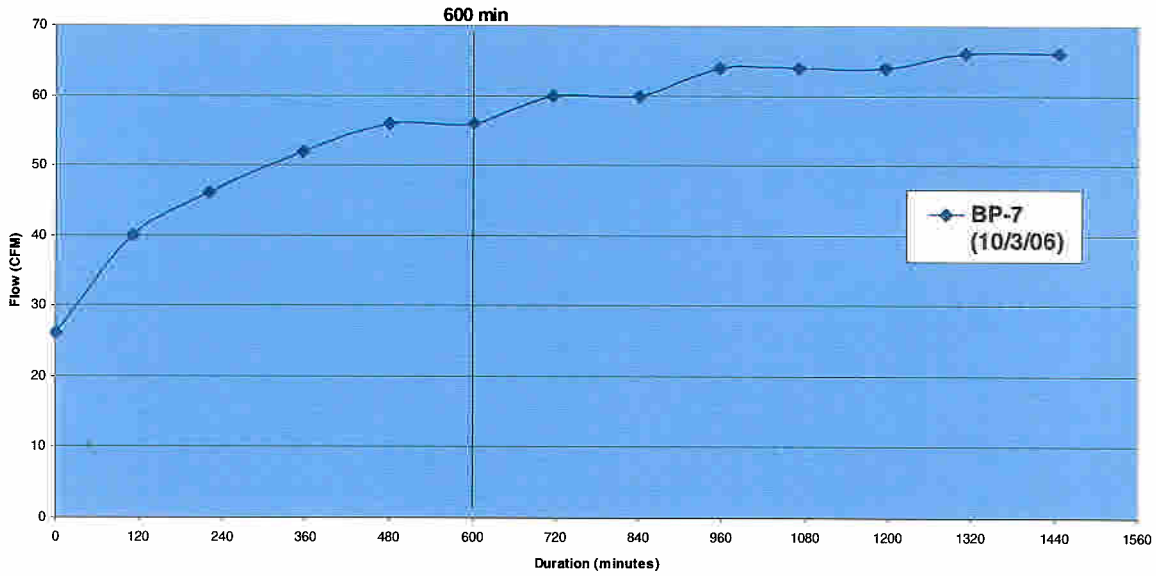

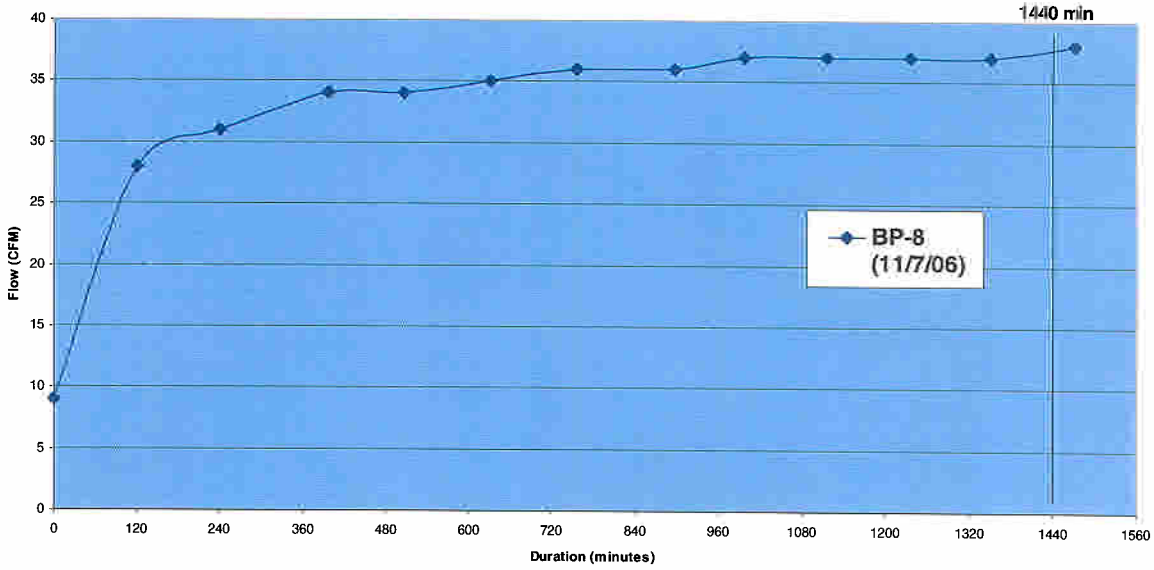

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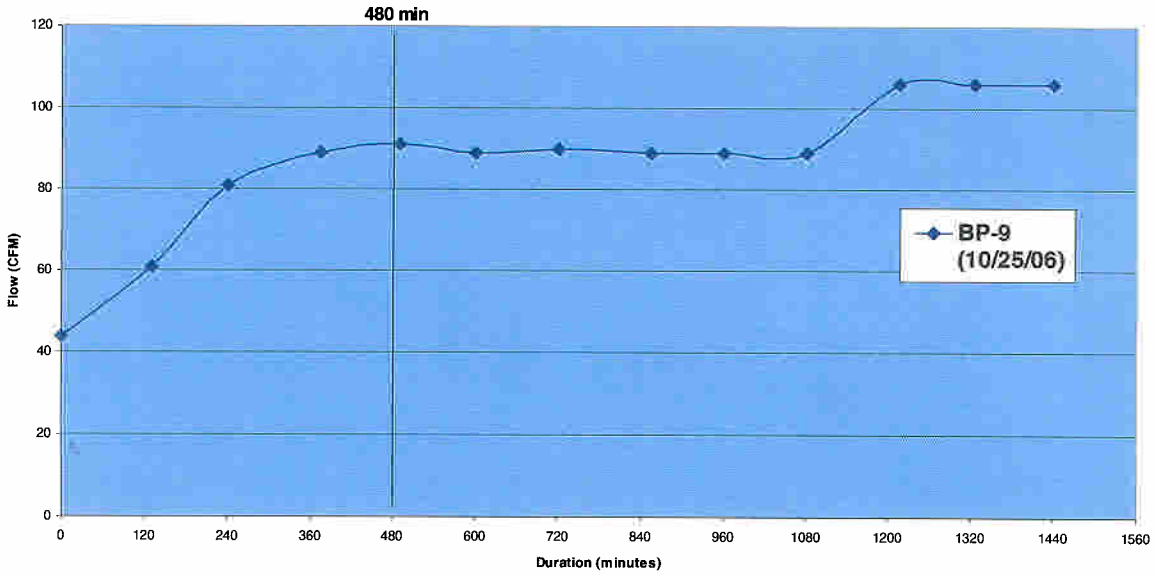

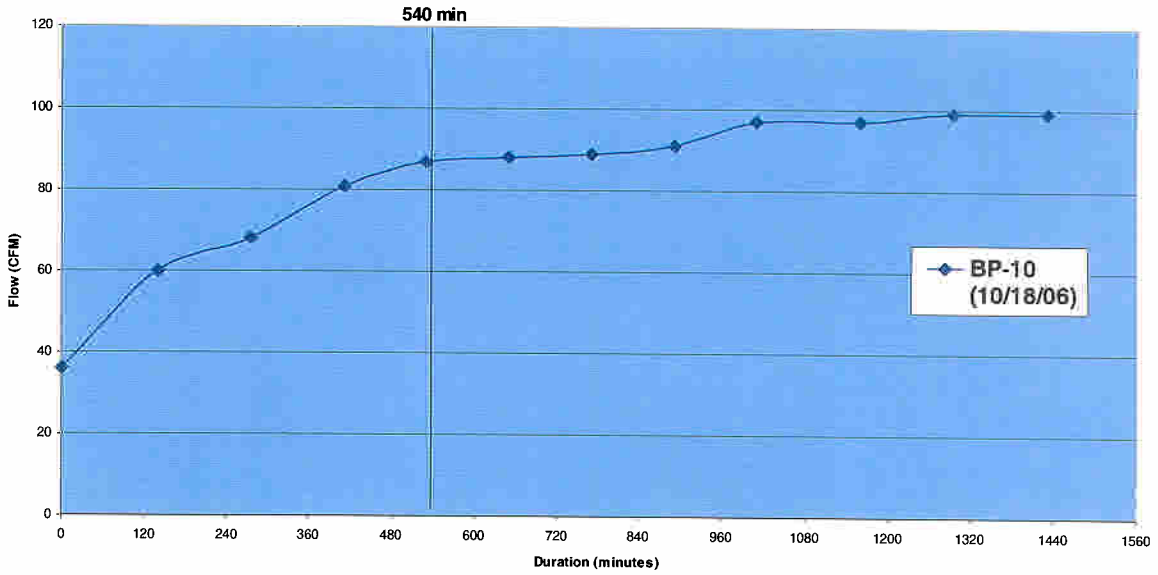

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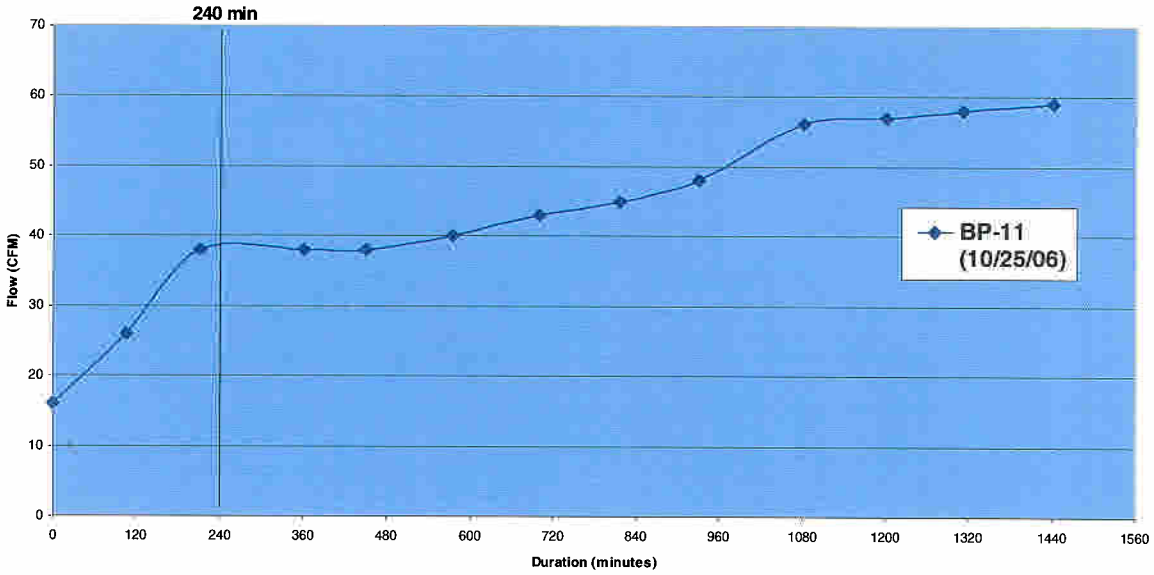

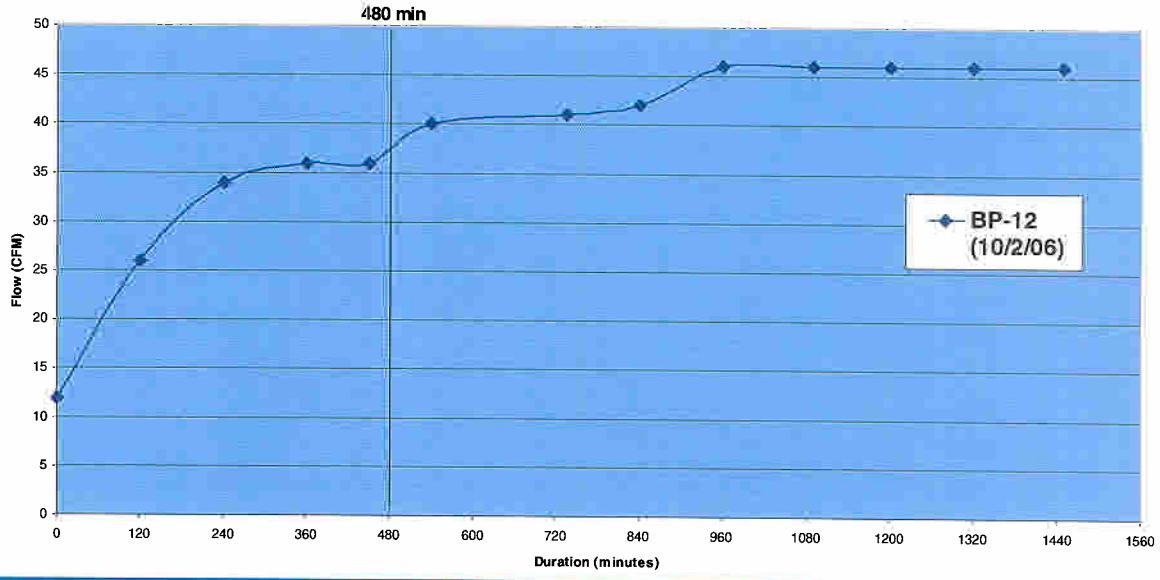

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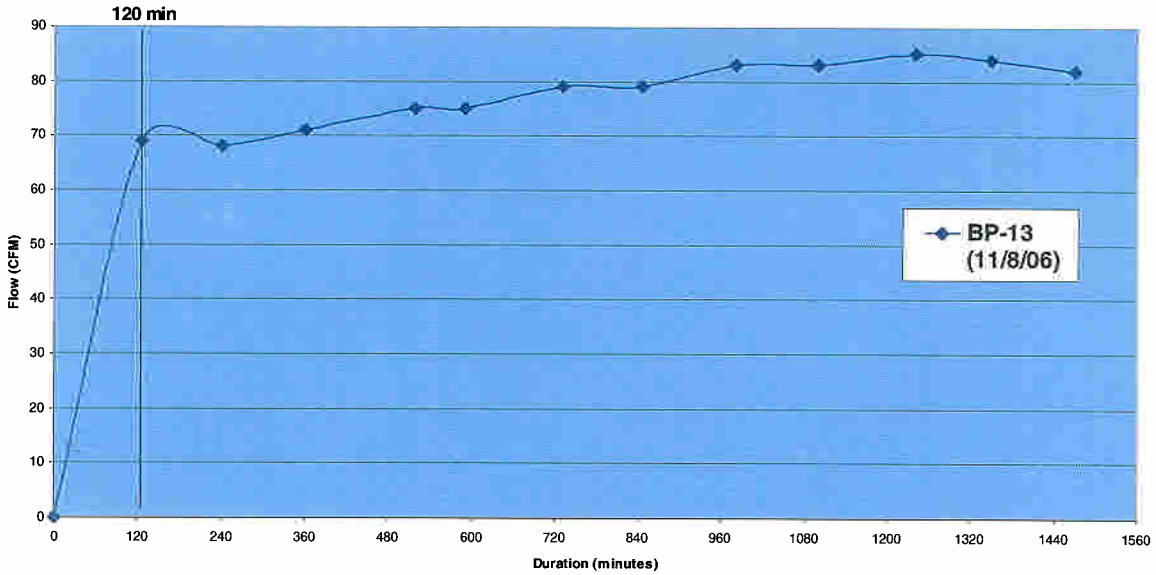

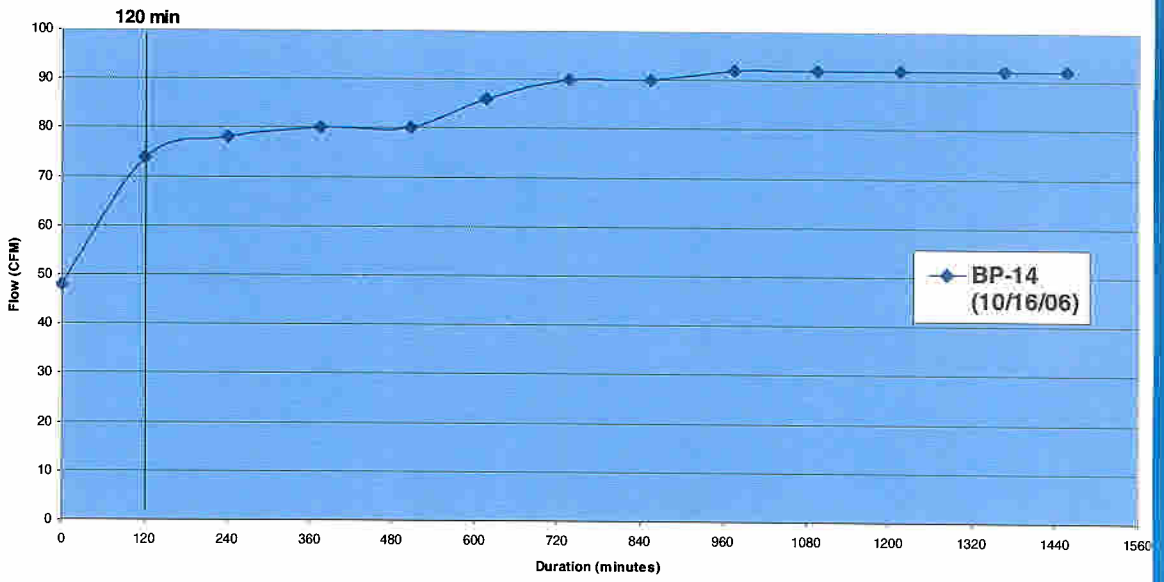

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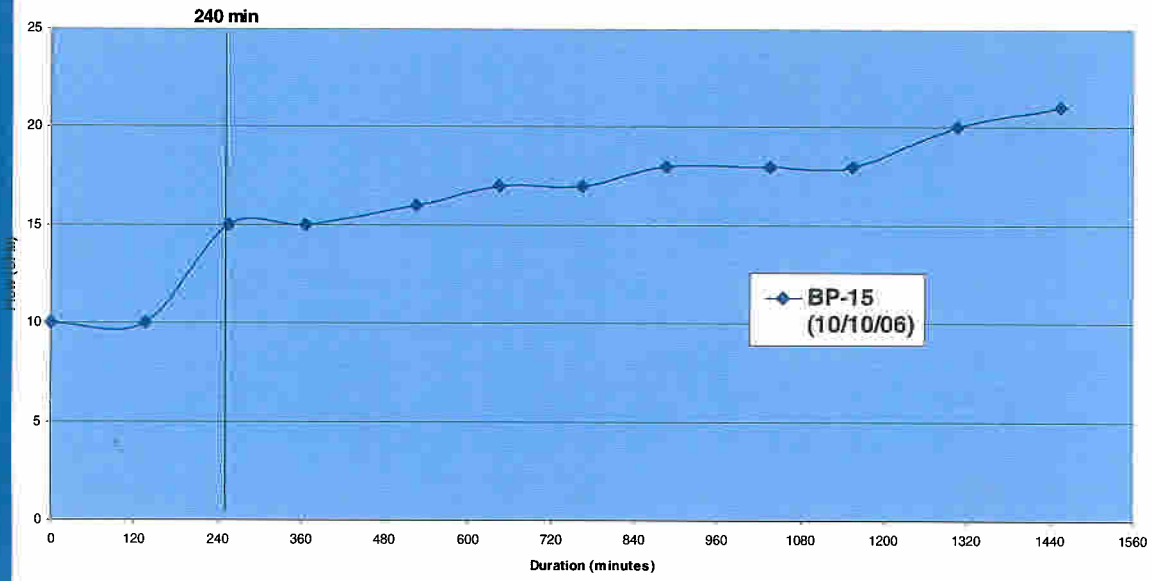

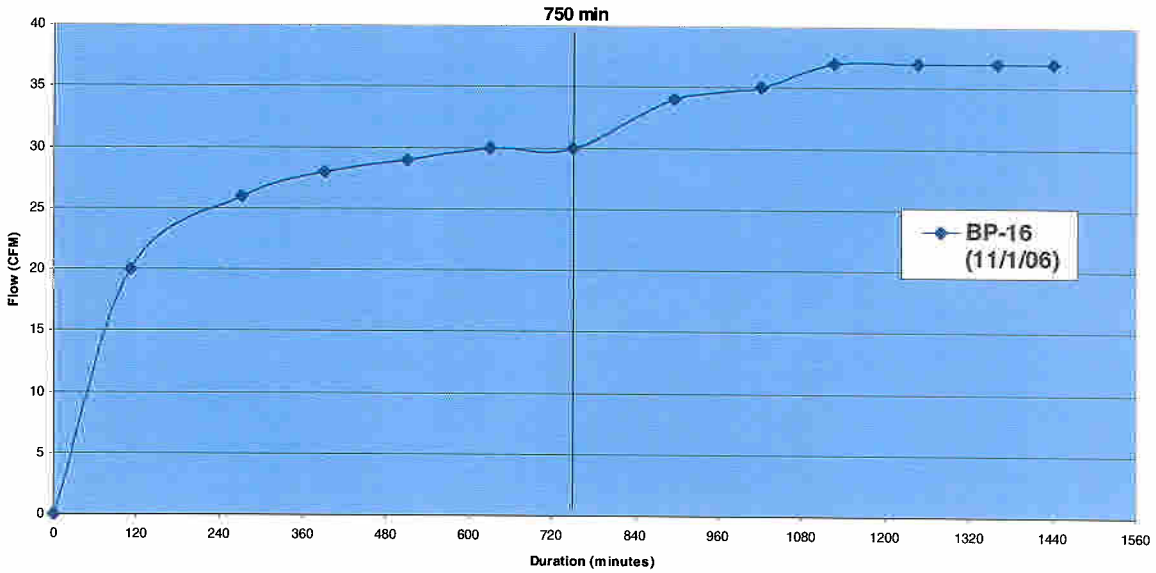

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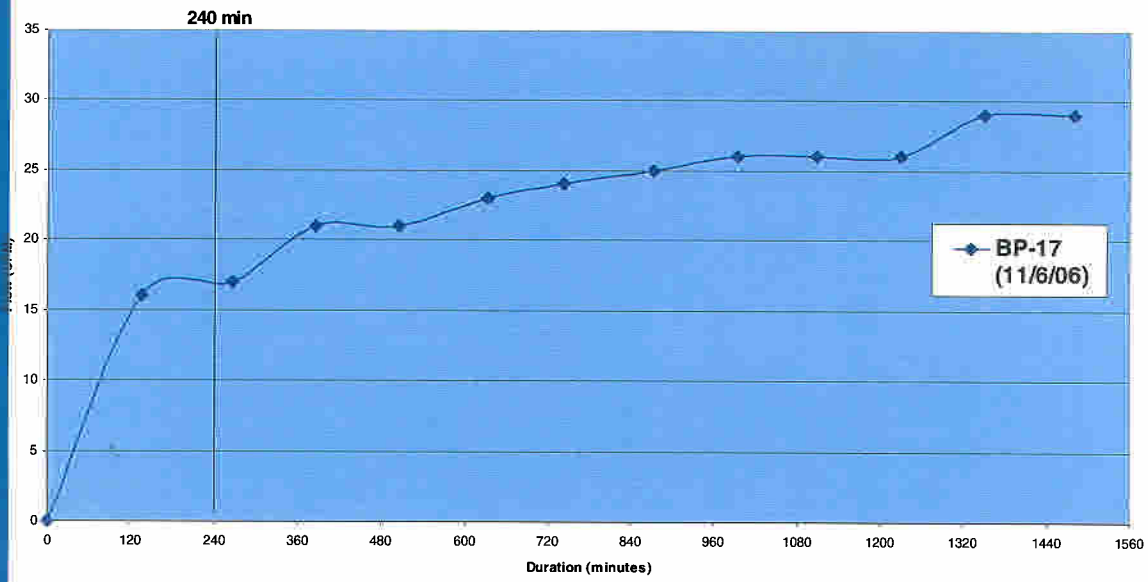

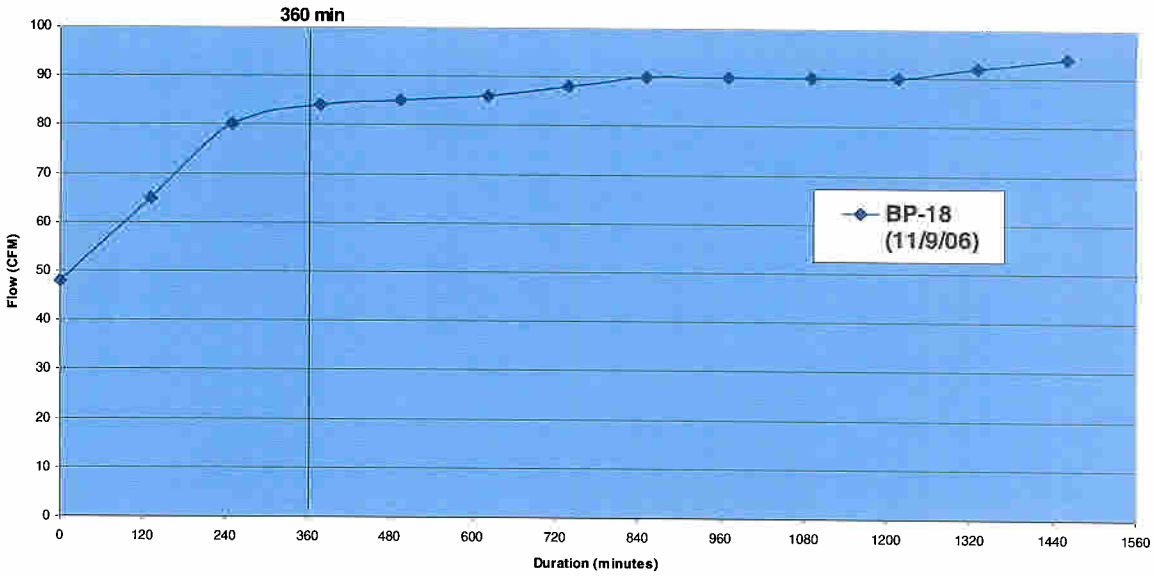

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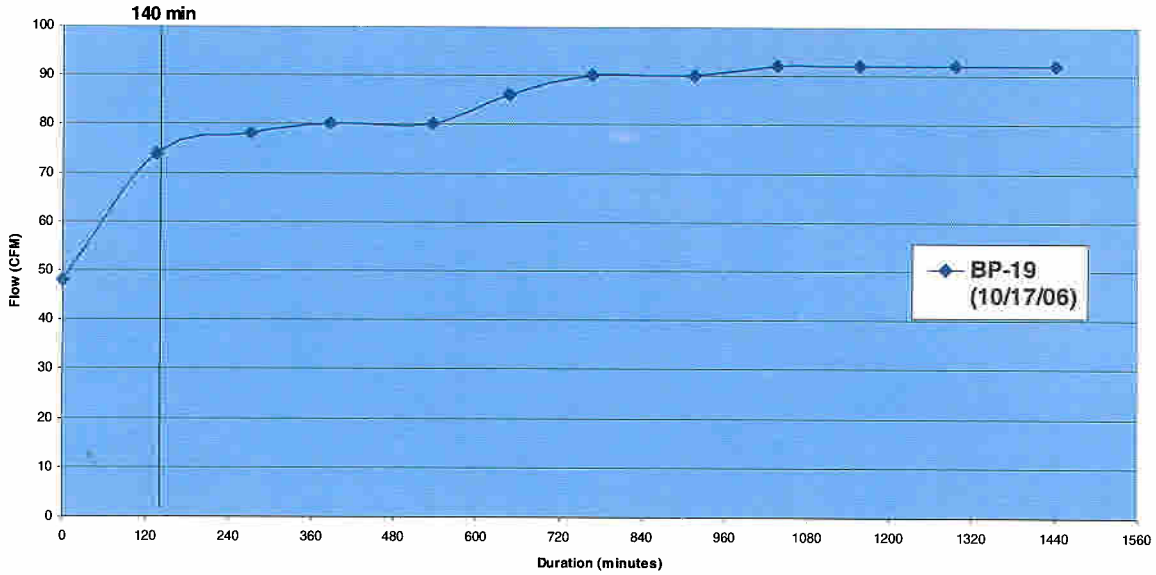

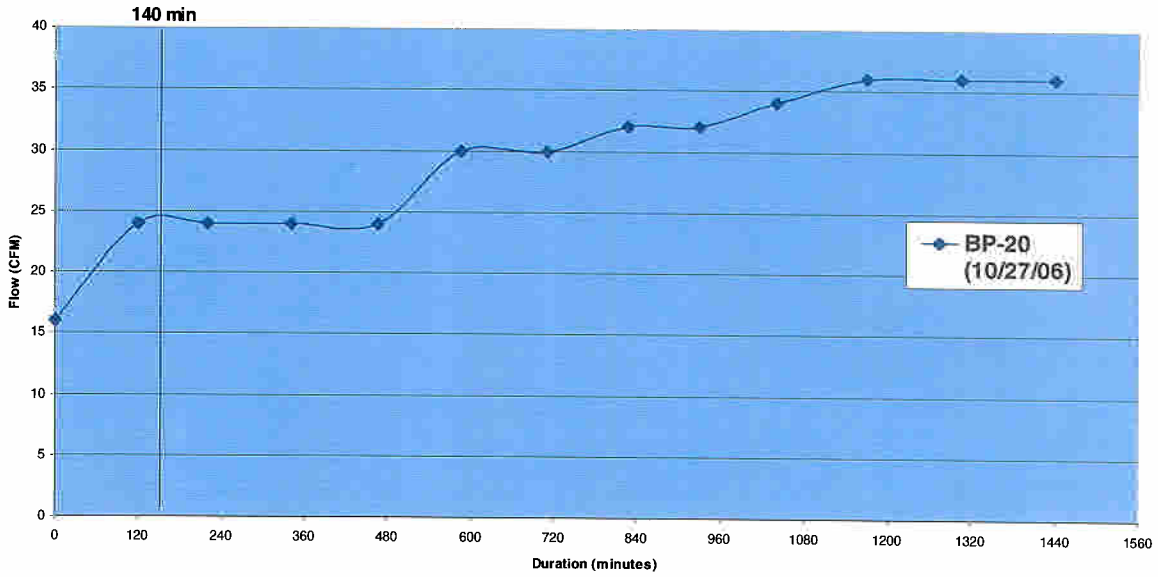

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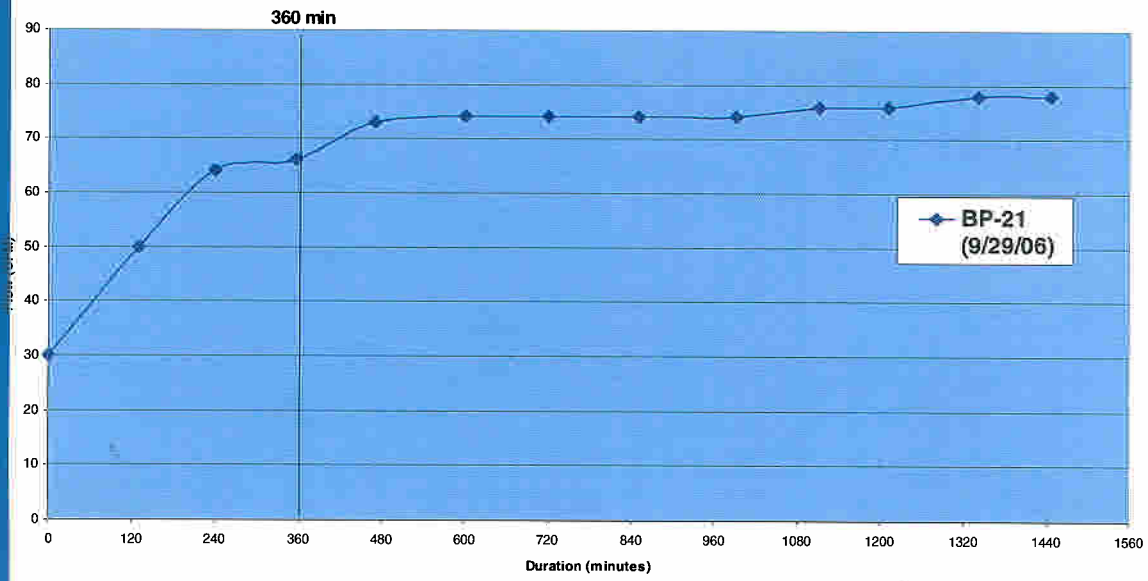

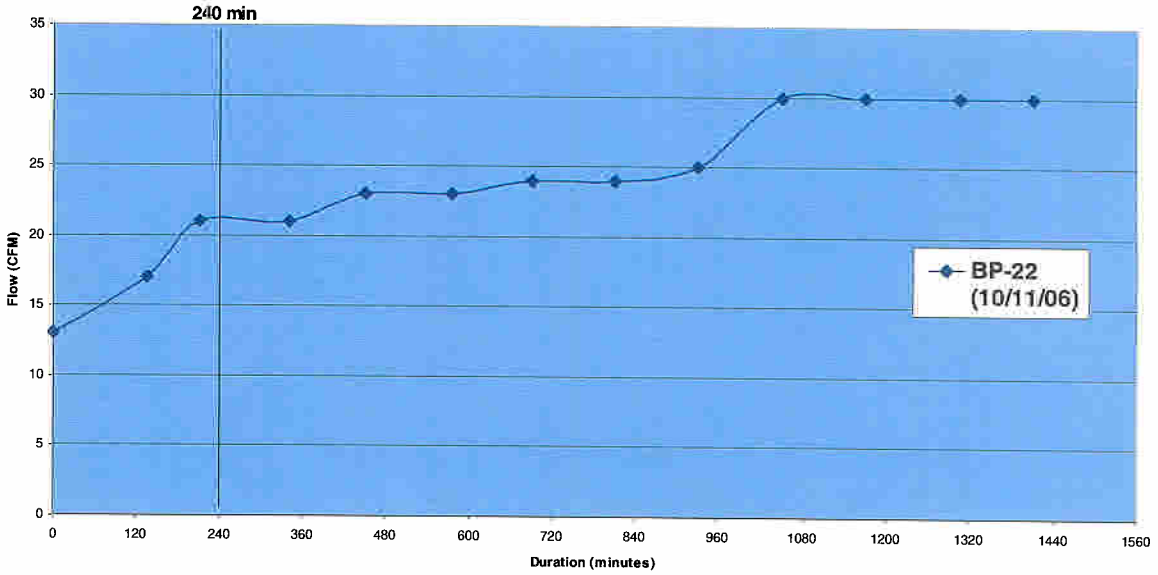

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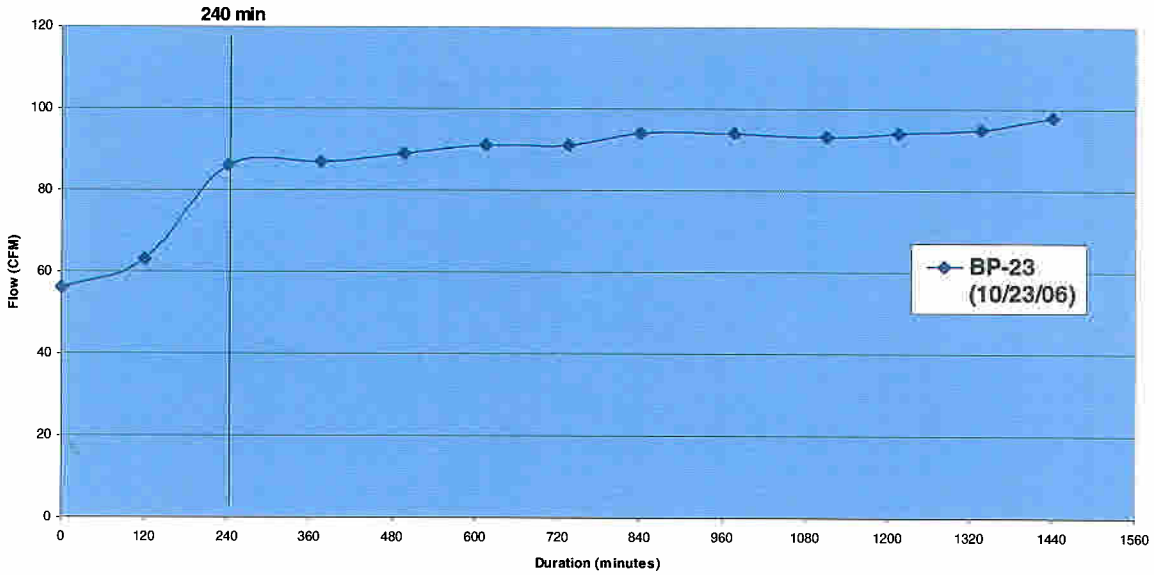

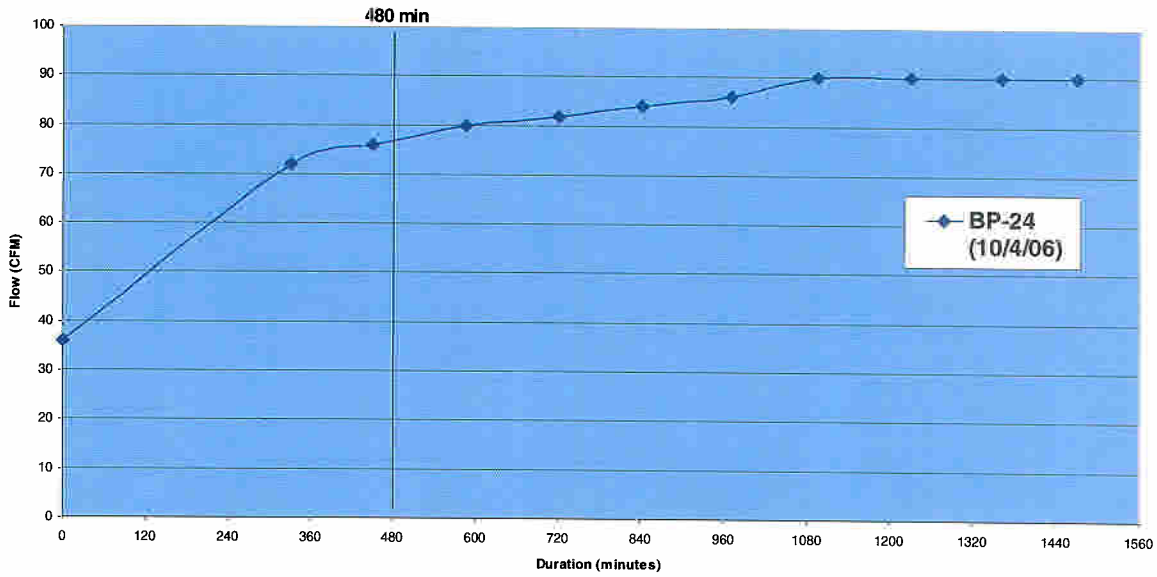

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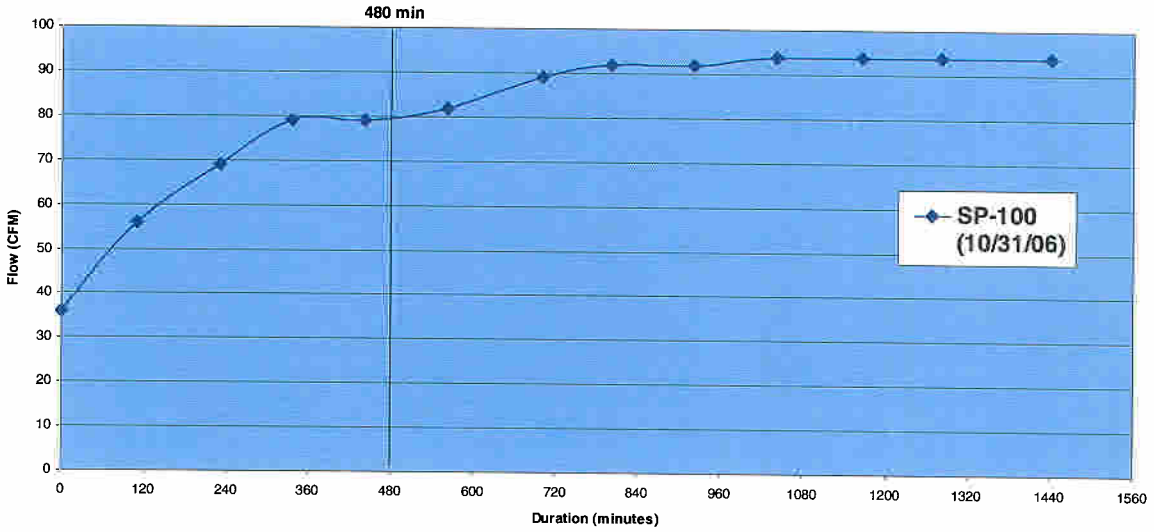
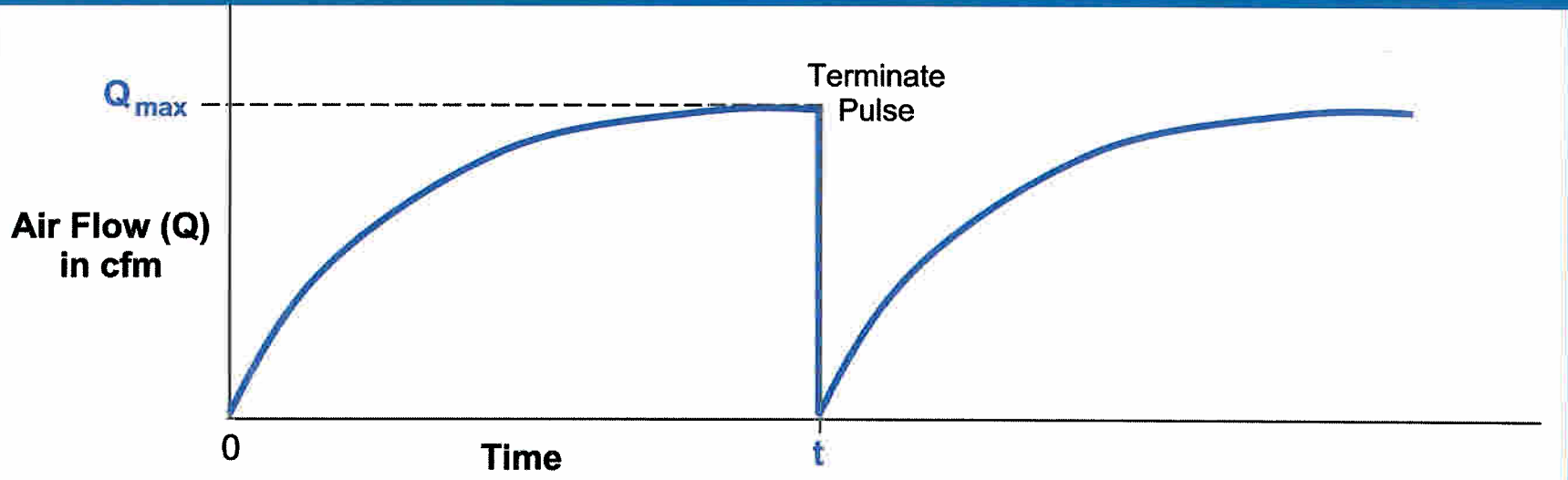


APPENDIX C

THEORETICAL GRAPH OF AIR FLOW VS. TIME

Volumetric Flow Rates

- As the de-watered sphere grows, the required volumetric flow rate increases. Air supply equipment should be selected to provide enough air to meet the maximum flow demand, which should occur just prior to "breakthrough."



Q_{max} depends on site characteristics

t = pulse duration

Pulse duration and maximum air flow should be verified by a pilot test.