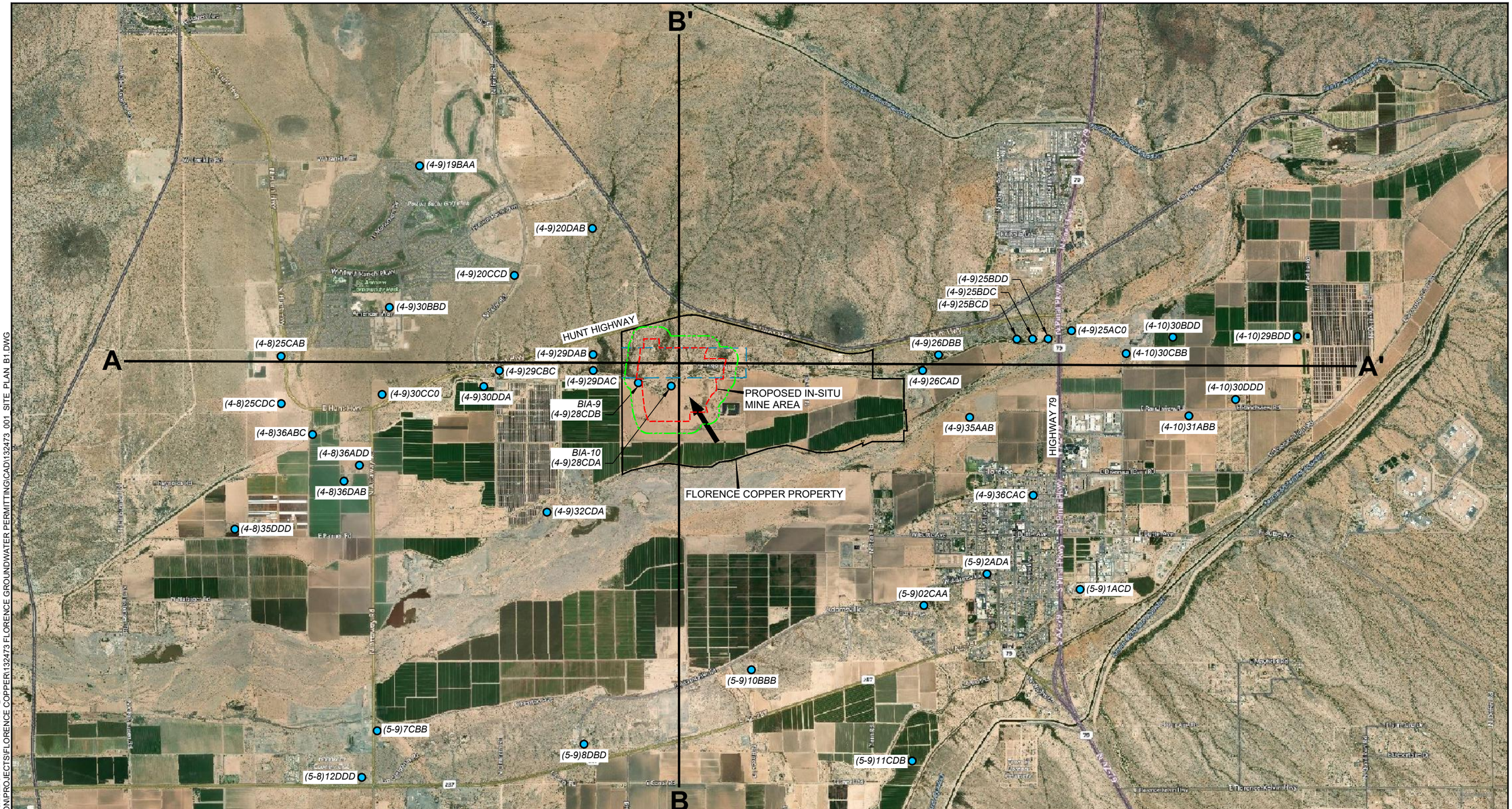


LEGEND

- ISCR AREA
- AREA OF REVIEW
- FLORENCE COPPER PROPERTY BOUNDARY
- STATE MINERAL LEASE BOUNDARY
- A —— A' REGIONAL CROSS SECTION LOCATION LINE
- (5-8)12DDD LOCATION OF WELL REPRESENTED IN CROSS SECTIONS AA' AND B-B'
- TYPICAL GROUNDWATER FLOW DIRECTION IN USDWs WITHIN THE AREA OF REVIEW

N

0 4,000 8,000
SCALE IN FEET

HALEY ALDRICH

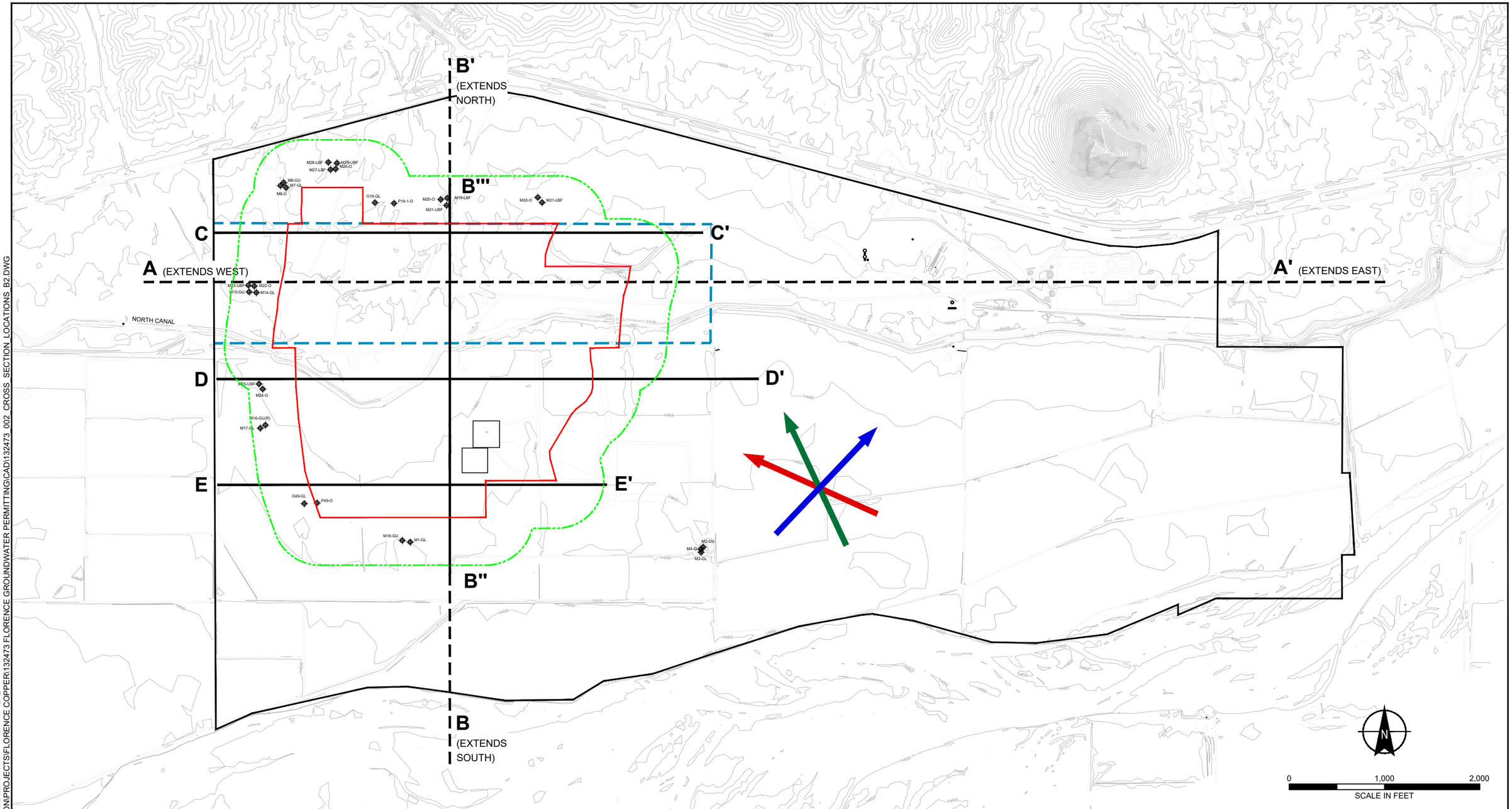
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

REGIONAL CROSS SECTION LOCATION MAP

SCALE: AS SHOWN
MARCH 2022

FIGURE B-1

Saved by: KHENSEN Printed: 3/3/2022 3:41 PM Sheet: B-1
\\HALEYALDRICH\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_001_SITE_PLAN_B1.DWG



LEGEND

M6-GU	POC WELL		REGIONAL CROSS SECTION LOCATION LINES A-A' AND B-B'
	ISCR AREA		ISCR AREA CROSS SECTION LOCATION LINES B''-B''', C-C', D-D', AND E-E'
	STATE MINERAL LEASE BOUNDARY		BEDROCK OXIDE UNIT GROUNDWATER FLOW DIRECTION - JANUARY 2019
	FLORENCE COPPER PROPERTY BOUNDARY		UBFU GROUNDWATER FLOW DIRECTION - JANUARY 2019
	AREA OF REVIEW		LBFU GROUNDWATER DIRECTION - JANUARY 2019

HALEY ALDRICH

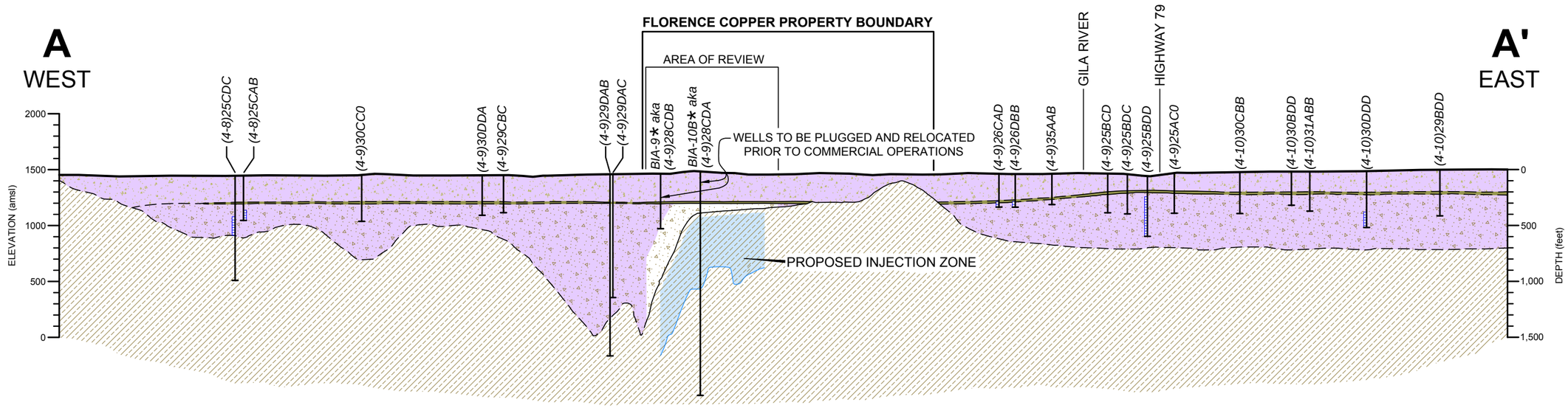
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

ISCR AREA CROSS SECTION LOCATION MAP

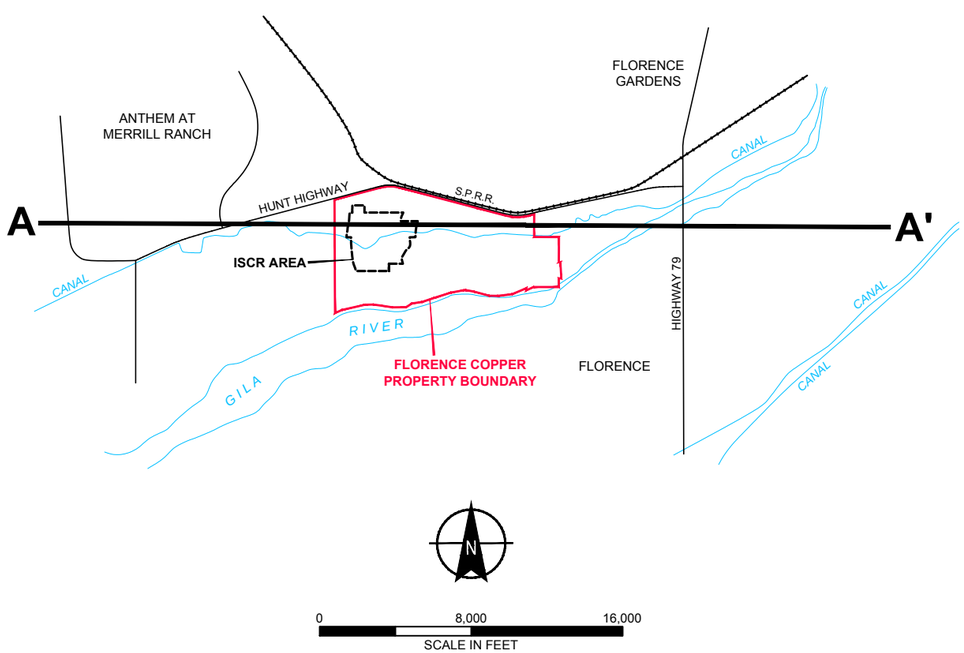
SCALE: AS SHOWN
MARCH 2022

FIGURE B-2

Saved by: KHENSEN Printed: 3/3/2022 3:26 PM Sheet: B-2
\\HALEYALDRICH\SHAREPHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_002_CROSS_SECTION_LOCATIONS_B2.DWG



KEYMAP



LEGEND

- UPPER BASIN FILL ALLUVIAL UNIT
- MIDDLE FINE-GRAINED UNIT
- LOWER BASIN FILL ALLUVIAL UNIT
- BEDROCK
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- INFERRED EXTENT OF MIDDLE FINE-GRAINED UNIT
- SULFIDE BOUNDARY

APPROXIMATE WELL LOCATION
(GENERALLY PROJECTED ONTO CROSS-SECTION)

- SCREENED INTERVAL (WHERE DATA IS AVAILABLE)
- TOTAL DEPTH OF BOREHOLE

HORIZ. 0 4,000 8,000
VERT. 0 1,000 2,000
SCALE IN FEET

HORIZONTAL SCALE: 1" = 4,000'
VERTICAL SCALE: 1" = 1,000'

4X VERTICAL EXAGGERATION

NOTES:

BEDROCK SURFACE CONTOURS COMPILED BY BROWN AND CALDWELL FROM EXISTING WATER WELL LOGS, EXPLORATORY COREHOLE LOGS AND REGIONAL GRAVITY SURVEYS (BHP COPPER INC. APP APPLICATION, VOLUME II FIGURES 3.4-2 (II) AND 3.4-3 (II), 1996).

* WELLS BIA-9 AND BIA-10B (LOCATED IN THE PROPOSED IN-SITU COPPER RECOVERY AREA) WILL BE PLUGGED AND RELOCATED PRIOR TO COMMERCIAL OPERATIONS.

UNIT CONTACTS DASHED WHERE INFERRED

HALEY ALDRICH

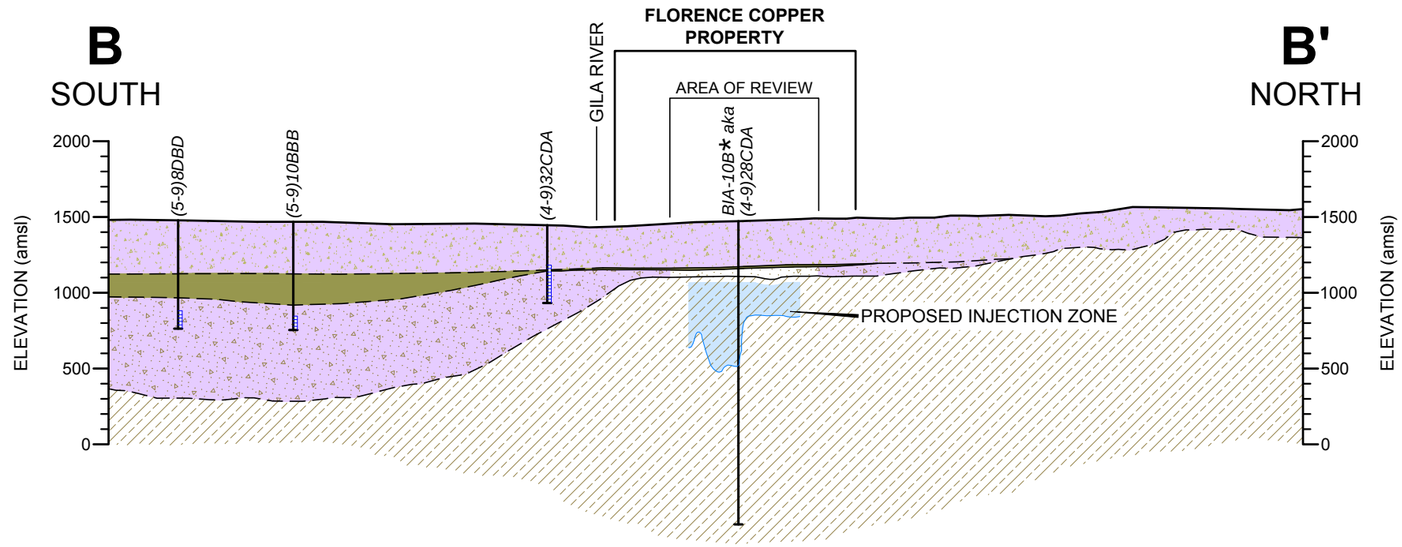
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED REGIONAL GEOLOGIC CROSS SECTION A-A'

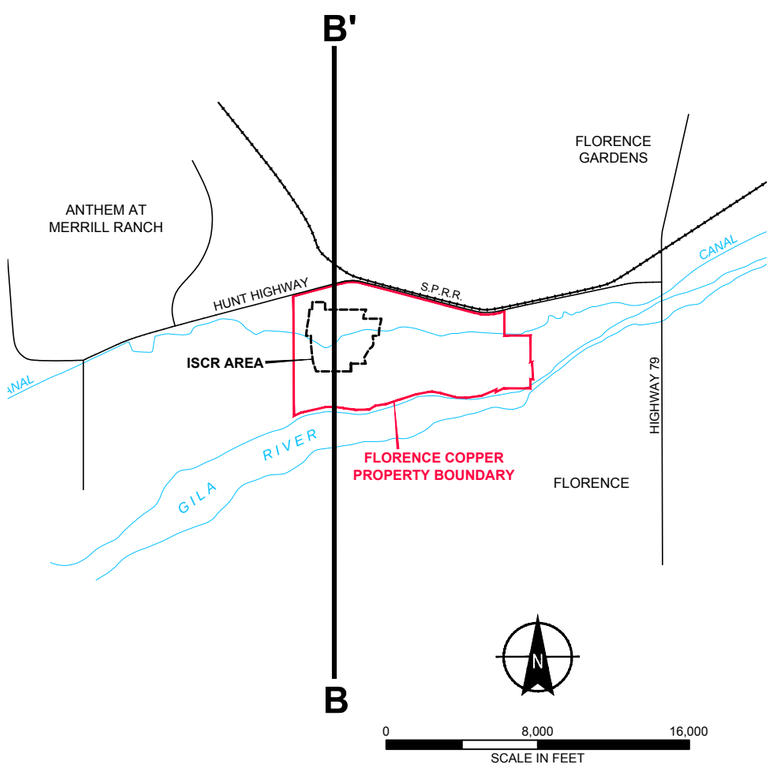
SCALE: AS SHOWN
MARCH 2022

FIGURE B-3

Saved by: OSLIVNYAK Printed: 7/8/2019 2:36 PM Sheet: B-3
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_003_CROSS_SECTION_B3.DWG



KEYMAP



LEGEND

- UPPER BASIN FILL ALLUVIAL UNIT
- MIDDLE FINE-GRAINED UNIT
- LOWER BASIN FILL ALLUVIAL UNIT
- BEDROCK
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- INFERRED EXTENT OF MIDDLE FINE-GRAINED UNIT
- SULFIDE BOUNDARY

APPROXIMATE WELL LOCATION
(GENERALLY PROJECTED ONTO CROSS-SECTION)

- SCREENED INTERVAL (WHERE DATA IS AVAILABLE)
- TOTAL DEPTH OF BOREHOLE

HORIZ. 0 4,000 8,000
VERT. 0 1,000 2,000
SCALE IN FEET

HORIZONTAL SCALE: 1" = 4,000'
VERTICAL SCALE: 1" = 1,000'

4X VERTICAL EXAGGERATION

NOTES:

BEDROCK SURFACE CONTOURS COMPILED BY BROWN AND CALDWELL FROM EXISTING WATER WELL LOGS, EXPLORATORY COREHOLE LOGS AND REGIONAL GRAVITY SURVEYS (BHP COPPER INC. APP APPLICATION, VOLUME II FIGURES 3.4-2 (II) AND 3.4-3 (II), 1996).

WELL BIA-10B (LOCATED IN THE PROPOSED IN-SITU COPPER RECOVERY AREA) WILL BE PLUGGED AND RELOCATED PRIOR TO COMMERCIAL OPERATIONS.

MIDDLE FINE-GRAINED UNIT SHOWN AT WELLS (5-9)8DBD, (5-9)10BBB AND (4-9)32CDA ESTIMATED FROM ADWR WELL REPORTS.

UNIT CONTACTS DASHED WHERE INFERRED.

HALEY ALDRICH

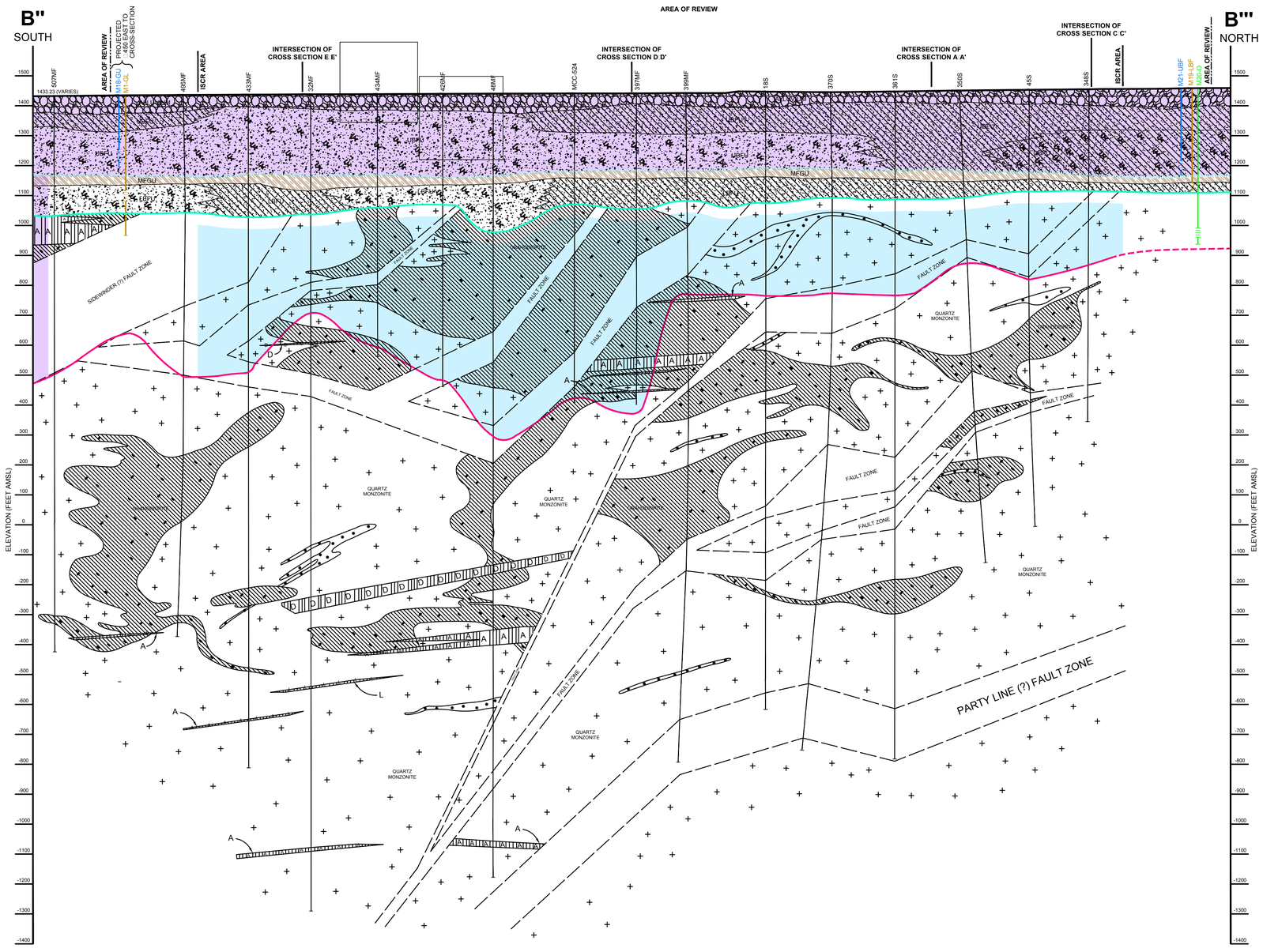
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED REGIONAL GEOLOGIC CROSS SECTION B-B'

SCALE: AS SHOWN
MARCH 2022

FIGURE B-4

Saved by: OSLIVNYAK Printed: 7/8/2019 2:30 PM Sheet: B-4
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_004_CROSS_SECTION_B4.DWG



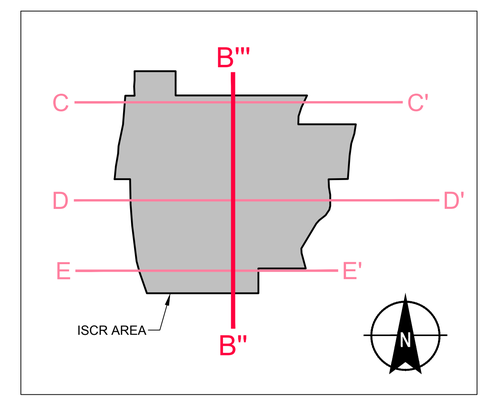
LEGEND

- ALLUVIUM
- SAND, SILT AND CLAY
- SAND, BOULDERS AND CLAY
- SAND, GRAVEL AND BOULDERS
- SAND AND GRAVEL
- SAND, GRAVEL AND CLAY
- SILT AND CLAY
- BASALT
- UBFU — UPPER BASIN FILL UNIT
- MFGU — MIDDLE FINE-GRAINED UNIT (CONFINING FORMATION)
- LBFU — LOWER BASIN FILL UNIT
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- PROPOSED INJECTION ZONE
- GRANODIORITE PORPHYRY
- QUARTZ MONZONITE PORPHYRY
- DIABASE / DIORITE
- A — ANDESITE
- D — DACITE
- L — QUARTZ LATITE
- INTERPRETED UNCONFORMITY
- LBFU/OXIDE CONTACT
- OXIDE/SULFIDE CONTACT (DASHED WHERE INFERRED)
- 391MF — COREHOLE ID
- EXISTING COREHOLES
- M21-UBF — POC WELL SCREENED IN THE UBFU
- M19-LBF — POC WELL SCREENED IN THE LBFU
- M20-O — POC WELL SCREENED IN THE OXIDE UNIT
- SCREENED INTERVAL OF POC WELL
- TOTAL DEPTH OF BOREHOLE

NOTE:

POC WELLS ARE PROJECTED ONTO THE GEOLOGIC CROSS SECTION LINES. DUE TO CHANGES IN THE DEPTH TO BEDROCK ACROSS THE SITE, THE PROJECTED SCREENED INTERVAL OF EACH POC WELL MAY NOT BE REPRESENTED BY THE UNIT SHOWN ON THE CROSS SECTION. UNIT CONTACT AND GEOLOGY WAS DEVELOPED BY BHP COPPER (1995) AND IS BASED ON COREHOLE DATA.

KEYMAP



HORIZ. 0 200 400 600 800
VERT. 0 200 400 600 800
SCALE IN FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 200'

1X VERTICAL EXAGGERATION

HALEY ALDRICH

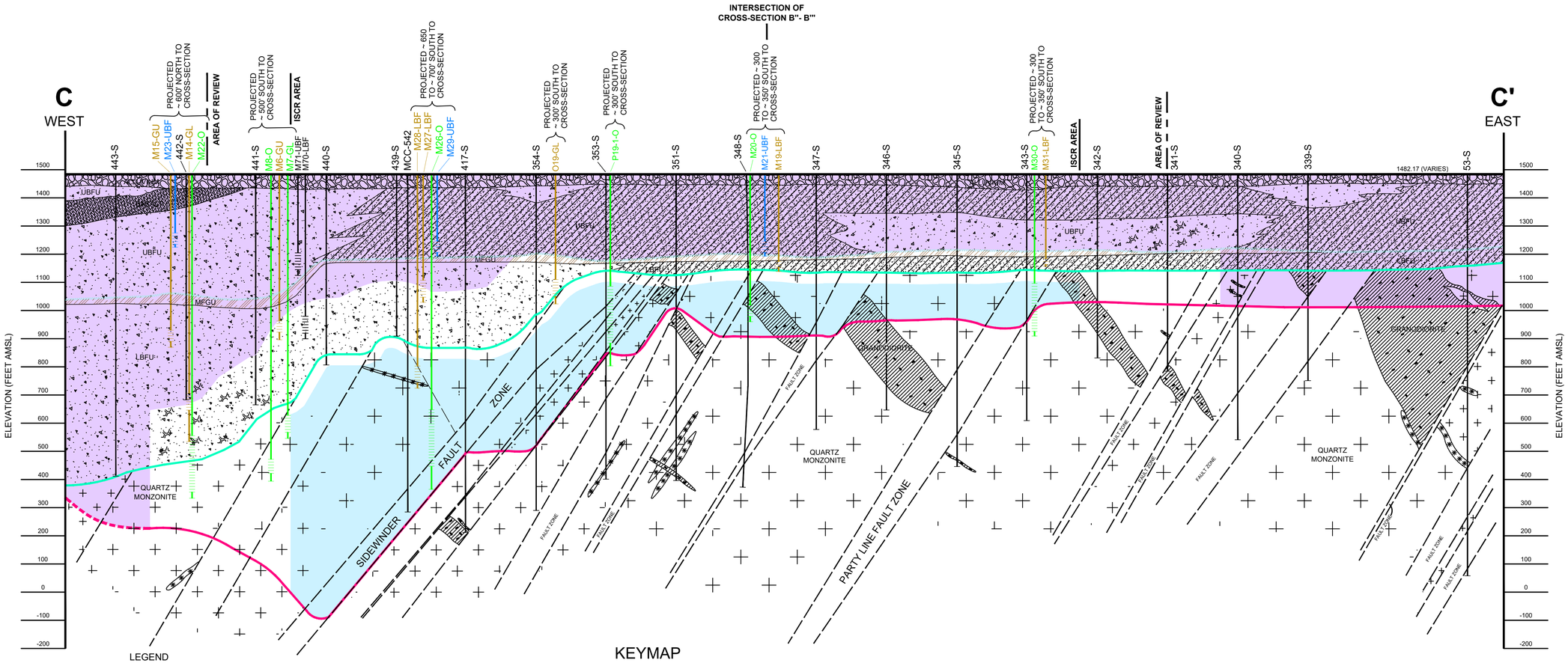
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED GEOLOGIC CROSS SECTION B"-B'''

SCALE: AS SHOWN
MARCH 2022

FIGURE B-5

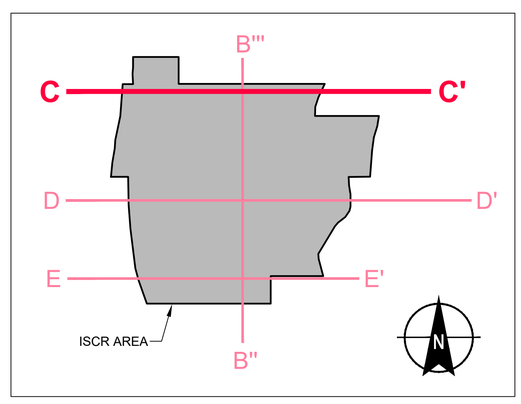
Saved by: OSLIVNYAK Printed: 7/12/2019 10:05 AM Sheet: B-5
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_005_CROSS_SECTION_B5.DWG



LEGEND

- ALLUVIUM
- SAND, SILT AND CLAY
- SAND, BOULDERS AND CLAY
- SAND, GRAVEL AND BOULDERS
- SAND AND GRAVEL
- SAND, GRAVEL AND CLAY
- SILT AND CLAY
- BASALT
- UBFU — UPPER BASIN FILL UNIT
- MFGU — MIDDLE FINE-GRAINED UNIT (CONFINING FORMATION)
- LBFU — LOWER BASIN FILL UNIT
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- PROPOSED INJECTION ZONE
- GRANODIORITE PORPHYRY
- QUARTZ MONZONITE PORPHYRY
- DIABASE / DIORITE
- INTERPRETED UNCONFORMITY
- LBFU/OXIDE CONTACT
- OXIDE/SULFIDE CONTACT (DASHED WHERE INFERRED)
- 391MF — COREHOLE ID
- EXISTING COREHOLES
- M21-UBF — POC WELL SCREENED IN THE UBFU
- M19-LBF — POC WELL SCREENED IN THE LBFU
- M71-UBF — USDW MONITORING WELLS
- M20-O — POC WELL SCREENED IN THE OXIDE UNIT
- SCREENED INTERVAL OF POC WELL
- TOTAL DEPTH OF BOREHOLE

KEYMAP



NOTE:

POC WELLS ARE PROJECTED ONTO THE GEOLOGIC CROSS SECTION LINES. DUE TO CHANGES IN THE DEPTH TO BEDROCK ACROSS THE SITE, THE PROJECTED SCREENED INTERVAL OF EACH POC WELL MAY NOT BE REPRESENTED BY THE UNIT SHOWN ON THE CROSS SECTION. UNIT CONTACT AND GEOLOGY WAS DEVELOPED BY BHP COPPER (1995) AND IS BASED ON COREHOLE DATA.

HORIZ. 0 200 400 600 800
VERT. 0 200 400 600 800
SCALE IN FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 200'

1X VERTICAL EXAGGERATION

HALEY ALDRICH

FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED GEOLOGIC CROSS SECTION C-C'

SCALE: AS SHOWN
MARCH 2022

FIGURE B-6

Saved by: OSLIVNYAK
\\HALEYALDRICH.COM\SHAREPHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_006_CROSS_SECTION_B6.DWG
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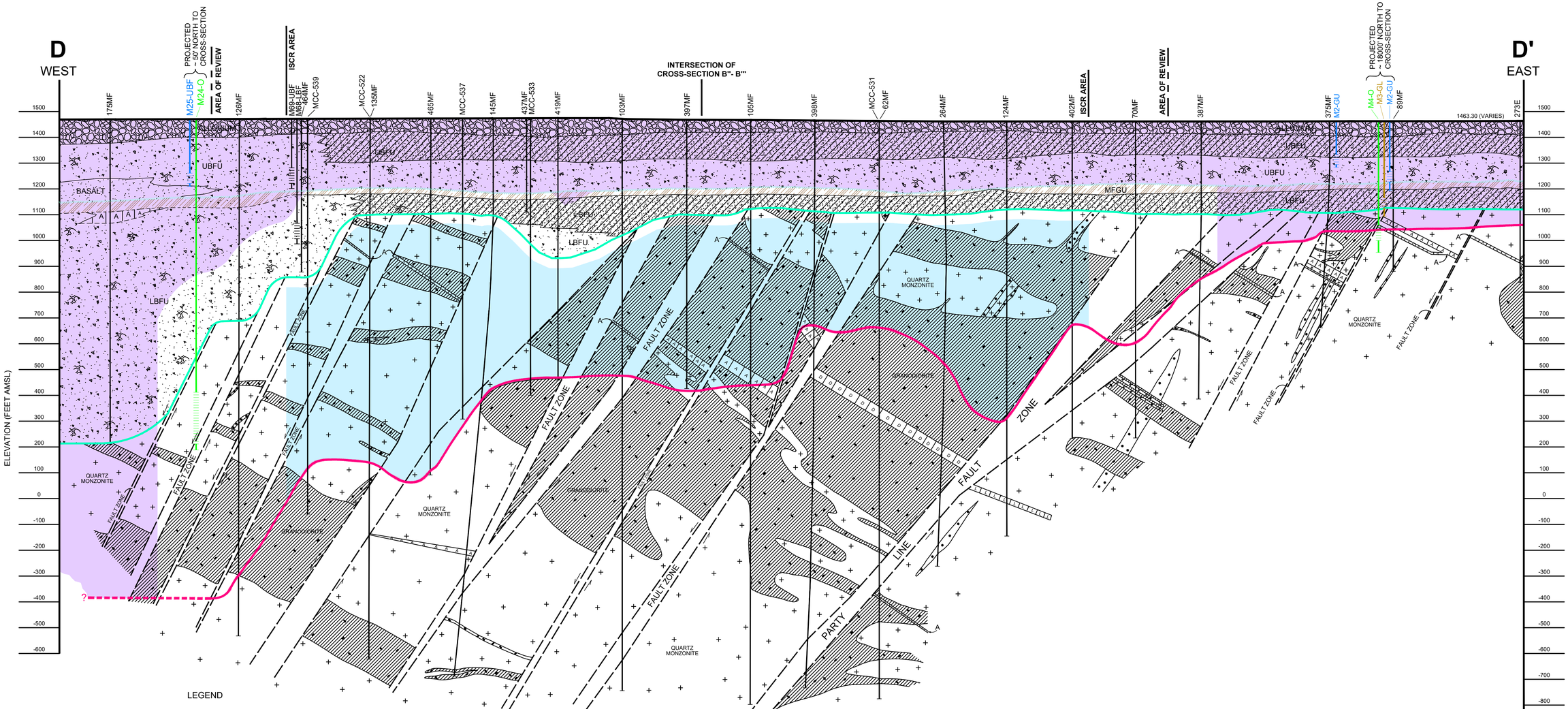


LEGEND

- ALLUVIUM
- SAND, SILT AND CLAY
- SAND, BOULDERS AND CLAY
- SAND, GRAVEL AND BOULDERS
- SAND AND GRAVEL
- SAND, GRAVEL AND CLAY
- SILT AND CLAY
- BASALT
- UBFU — UPPER BASIN FILL UNIT
- MFGU — MIDDLE FINE-GRAINED UNIT (CONFINING FORMATION)
- LBFU — LOWER BASIN FILL UNIT
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- PROPOSED INJECTION ZONE
- GRANODIORITE PORPHYRY
- QUARTZ MONZONITE PORPHYRY
- DIABASE / DIORITE
- A — ANDESITE
- D — DACITE
- L — QUARTZ LATITE
- INTERPRETED UNCONFORMITY
- LBFU/OXIDE CONTACT
- OXIDE/SULFIDE CONTACT (DASHED WHERE INFERRED)
- 391MF — COREHOLE ID
- EXISTING COREHOLES
- M21-UBF — POC WELL SCREENED IN THE UBFU
- M19-LBF — POC WELL SCREENED IN THE LBFU
- M69-UBF — USDW MONITORING WELLS
- M20-O — POC WELL SCREENED IN THE OXIDE UNIT
- SCREENED INTERVAL OF POC WELL
- TOTAL DEPTH OF BOREHOLE

HORIZ. 0 200 400 600 800
VERT. 0 200 400 600 800
SCALE IN FEET

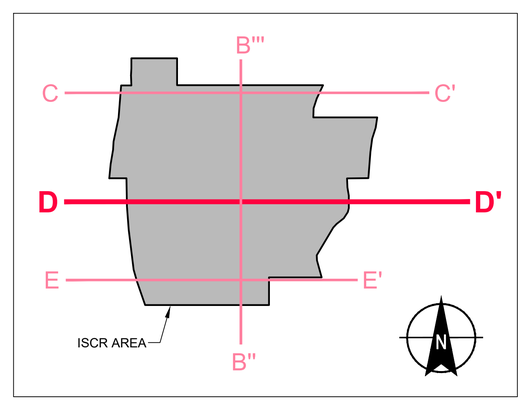
HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 200'

1X VERTICAL EXAGGERATION

NOTE:

POC WELLS ARE PROJECTED ONTO THE GEOLOGIC CROSS SECTION LINES. DUE TO CHANGES IN THE DEPTH TO BEDROCK ACROSS THE SITE, THE PROJECTED SCREENED INTERVAL OF EACH POC WELL MAY NOT BE REPRESENTED BY THE UNIT SHOWN ON THE CROSS SECTION. UNIT CONTACT AND GEOLOGY WAS DEVELOPED BY BHP COPPER (1995) AND IS BASED ON COREHOLE DATA.

KEYMAP



HALEY ALDRICH

FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED GEOLOGIC CROSS SECTION D-D'

SCALE: AS SHOWN
MARCH 2022

FIGURE B-7

Saved by: OSLIVNYAK
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\132473_007_CROSS SECTION_B7.DWG
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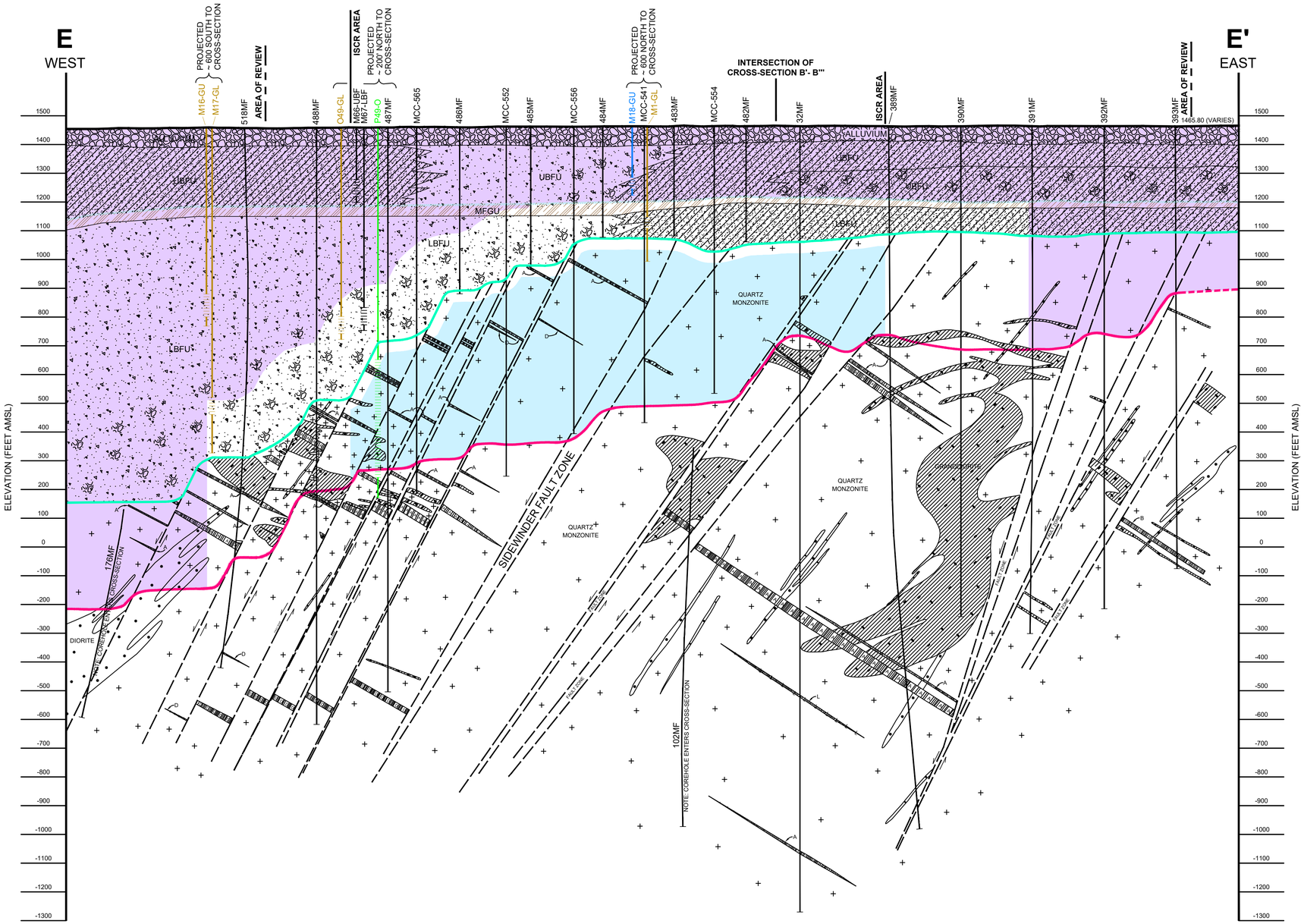


HORIZ. 0 200 400 600 800

VERT. 0 200 400 600 800

SCALE IN FEET

HORIZONTAL SCALE: 1" = 200'
VERTICAL SCALE: 1" = 200'

1X VERTICAL EXAGGERATION

LEGEND

- ALLUVIUM
- SAND, SILT AND CLAY
- SAND, BOULDERS AND CLAY
- SAND, GRAVEL AND BOULDERS
- SAND AND GRAVEL
- SAND, GRAVEL AND CLAY
- SILT AND CLAY
- BASALT
- UBFU — UPPER BASIN FILL UNIT
- MFGU — MIDDLE FINE-GRAINED UNIT (CONFINING FORMATION)
- LBFU — LOWER BASIN FILL UNIT
- VERTICAL LIMITS OF USDWs WITHIN THE AREA OF REVIEW
- PROPOSED INJECTION ZONE
- GRANODIORITE PORPHYRY
- QUARTZ MONZONITE PORPHYRY
- DIABASE / DIORITE
- A — ANDESITE
- D — DACITE
- L — QUARTZ LATITE
- INTERPRETED UNCONFORMITY
- LBFU/OXIDE CONTACT
- OXIDE/SULFIDE CONTACT (DASHED WHERE INFERRED)
- 391MF — COREHOLE ID
- EXISTING COREHOLES

M21-UBF — POC WELL SCREENED IN THE UBFU

M19-LBF — POC WELL SCREENED IN THE LBFU

M66-UBF — USDW MONITORING WELLS

M20-O — POC WELL SCREENED IN THE OXIDE UNIT

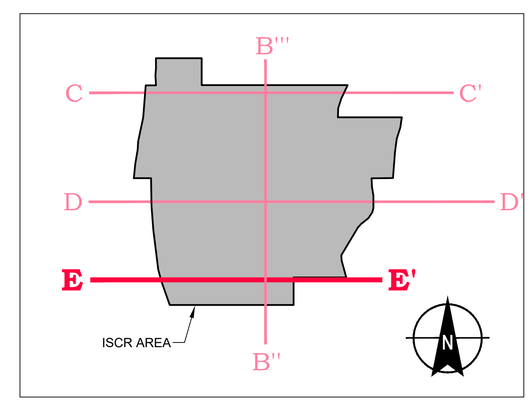
SCREENED INTERVAL OF POC WELL

TOTAL DEPTH OF BOREHOLE

NOTE:

POC WELLS ARE PROJECTED ONTO THE GEOLOGIC CROSS SECTION LINES. DUE TO CHANGES IN THE DEPTH TO BEDROCK ACROSS THE SITE, THE PROJECTED SCREENED INTERVAL OF EACH POC WELL MAY NOT BE REPRESENTED BY THE UNIT SHOWN ON THE CROSS SECTION. UNIT CONTACT AND GEOLOGY WAS DEVELOPED BY BHP COPPER (1995) AND IS BASED ON COREHOLE DATA.

KEYMAP



HALEY ALDRICH

FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

GENERALIZED GEOLOGIC CROSS SECTION E-E'

SCALE: AS SHOWN
MARCH 2022

FIGURE B-8

Saved by: OSLIVNYAK
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473-FLORENCE GROUNDWATER PERMITTING\CAD\132473_008_CROSS SECTION_B8.DWG
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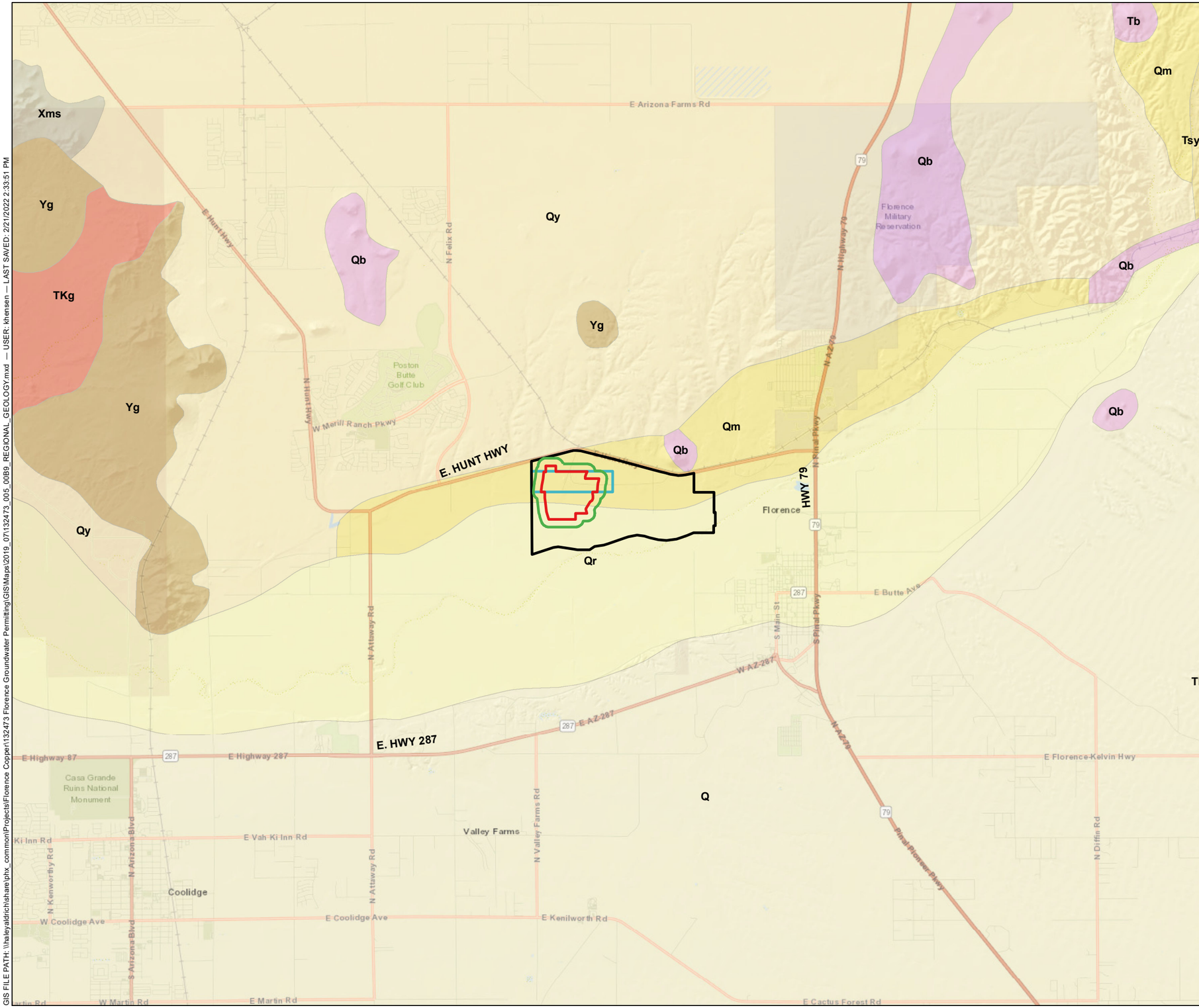


LEGEND

- STATE MINERAL LEASE BOUNDARY
- ISCR WELL FIELD
- PROPOSED AOR / FORMER BHP AOR
- FLORENCE COPPER PROPERTY BOUNDARY
- (Qs) QUATERNARY SURFICIAL DEPOSITS
- (Qr) HOLOCENE RIVER ALLUVIUM
- (Qy) HOLOCENE SURFICIAL DEPOSITS
- (Qm) LATE AND MIDDLE PLEISTOCENE SURFICIAL DEPOSITS
- (Tsy) PLIOCENE TO MIDDLE MIOCENE DEPOSITS
- (Qb) LATE TO MIDDLE MIOCENE BASALTIC ROCKS
- (Tkg) EARLY TERTIARY TO LATE CRETACEOUS GRANITIC ROCKS
- (Yg) MIDDLE PROTEROZOIC GRANITIC ROCKS
- (Xms) EARLY PROTEROZOIC METASEDIMENTARY ROCKS

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. GEOLOGY SOURCE: GEOLOGIC MAP OF ARIZONA, 2019
3. AERIAL IMAGERY SOURCE: ESRI

N

0 6,400 12,800
SCALE IN FEET

HALEY ALDRICH

FLORENCE COPPER, INC
FLORENCE, ARIZONA 85132

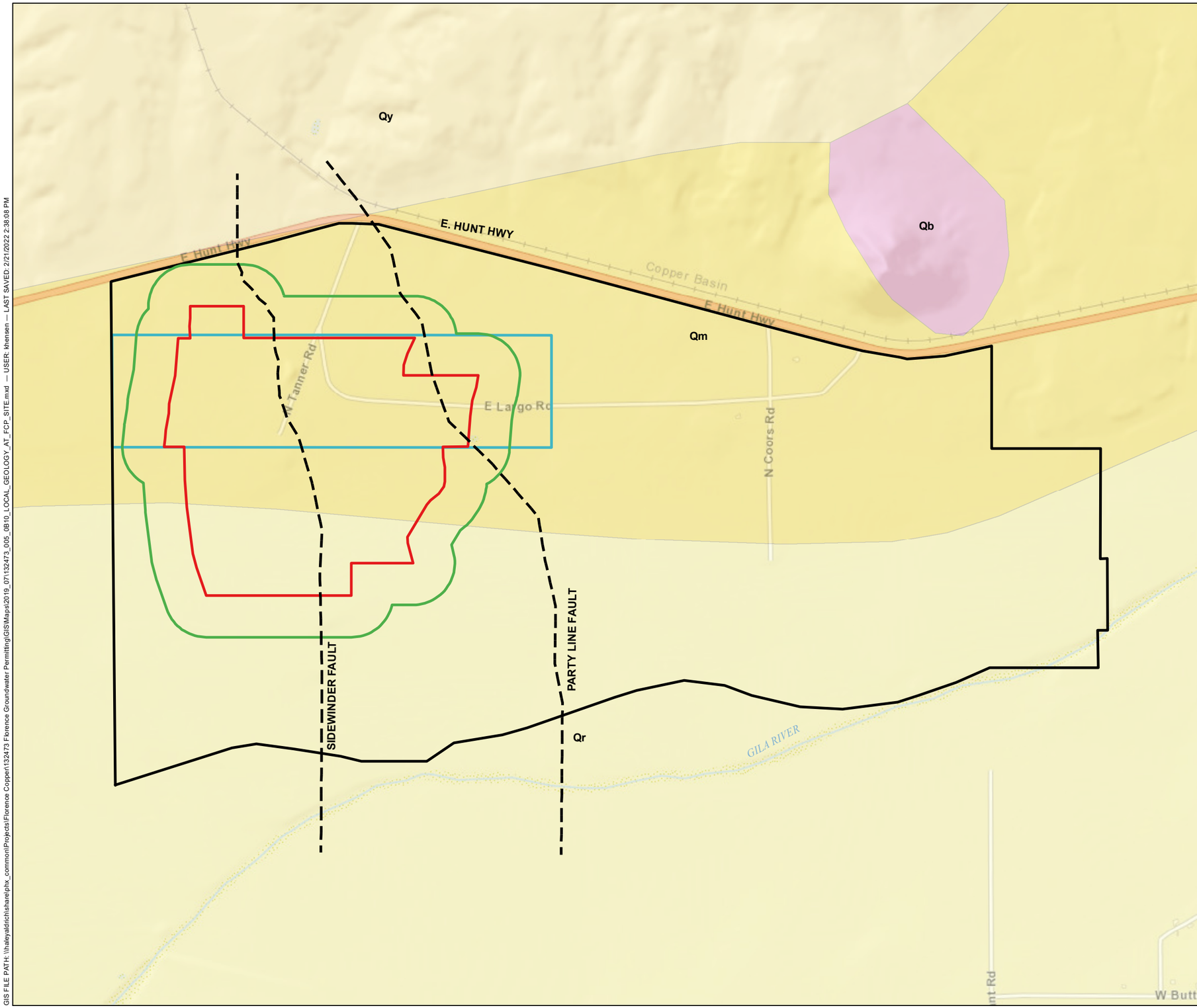
REGIONAL GEOLOGY

FLORENCE COPPER

MARCH 2022

FIGURE B-9

GIS FILE PATH: \\haleyaldrich\share\phx_common\Projects\Florence Copper\132473 Florence Groundwater Permitting\GIS\Maps\2019_07\132473_005_00B9_REGIONAL_GEOLOGY.mxd — USER: khensen — LAST SAVED: 2/21/2022 2:33:51 PM



LEGEND

- FAULT BOUNDARY
- STATE MINERAL LEASE BOUNDARY
- ISCR WELL FIELD
- PROPOSED AOR / FORMER BHP AOR
- FLORENCE COPPER PROPERTY BOUNDARY
- (Qr) HOLOCENE RIVER ALLUVIUM
- (Qy) HOLOCENE SURFICIAL DEPOSITS
- (Qm) LATE AND MIDDLE PLEISTOCENE SURFICIAL DEPOSITS
- (Qb) LATE TO MIDDLE MIOCENE BASALTIC ROCKS

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. GEOLOGY SOURCE: GEOLOGIC MAP OF ARIZONA, 2019
3. AERIAL IMAGERY SOURCE: ESRI

N

0 1,200 2,400
SCALE IN FEET

HALEY ALDRICH

FLORENCE COPPER, INC
FLORENCE, ARIZONA 85132

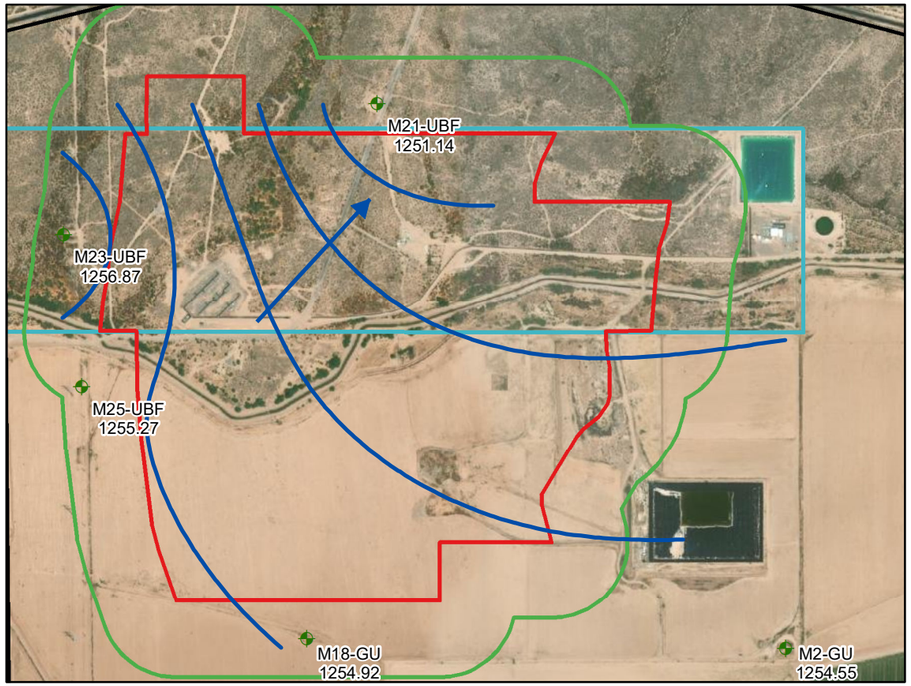
LOCAL GEOLOGY AT FCP SITE

FLORENCE COPPER

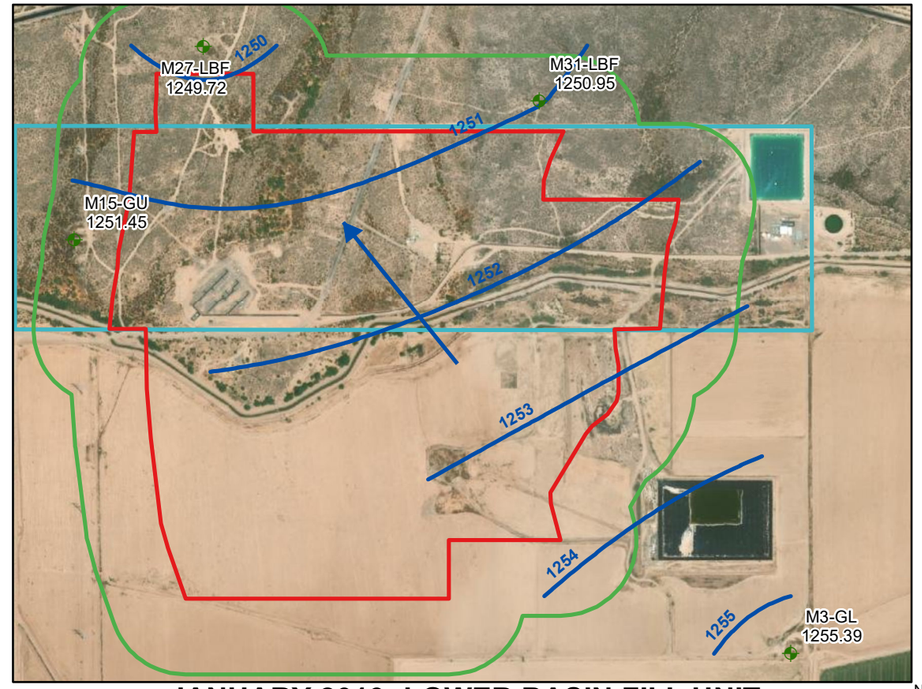
MARCH 2022

FIGURE B-10

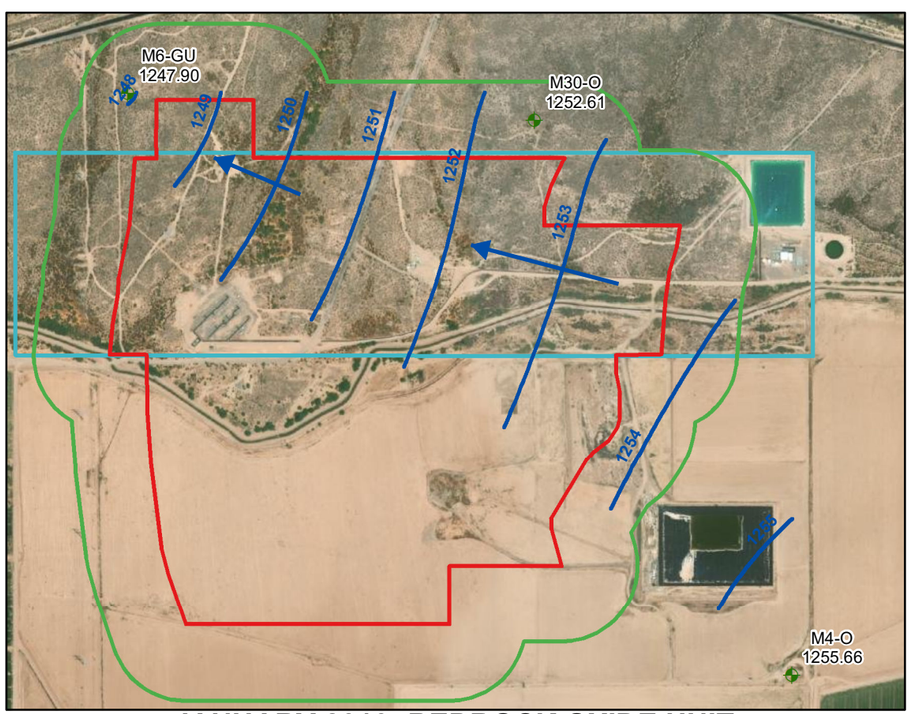
GIS FILE PATH: \\haleyaldrich\share\phx_common\Projects\Florence Copper\132473 Florence Groundwater Permitting\GIS\Maps\2019_07\132473_005_0B10_LOCAL_GEOLOGY_AT_FCP_SITE.mxd -- USER: khensen -- LAST SAVED: 2/21/2022 2:38:08 PM



JANUARY 2019 - UPPER BASIN FILL UNIT



JANUARY 2019- LOWER BASIN FILL UNIT



JANUARY 2019- BEDROCK OXIDE UNIT

Legend

- MONITORING WELL LOCATIONS
- GROUNDWATER FLOW DIRECTION
- GROUNDWATER ELEVATION CONTOUR
- ISCR WELL FIELD
- PROPOSED AOR / FORMER BHP AOR
- STATE MINERAL LEASE BOUNDARY

N

0 350 700 1,050 1,400

SCALE IN FEET

NOTES

1. ALL LOCATIONS AND DIMENSIONS APPROXIMATE
2. GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
3. CONTOUR INTERVAL = 1 FOOT

HALEY ALDRICH

PRODUCTION TEST FACILITY
FLORENCE COPPER INC.
FLORENCE ARIZONA

JANUARY 2019 GROUNDWATER ELEVATION CONTOURS

MARCH 2022

FIGURE B-11

EXHIBIT B-1

MFGU Sample Laboratory Reports

CORE LABORATORIES

PARTICLE-SIZE ANALYSIS RESULTS

MAGMA FLORENCE

CL AURORA FILE # 57209-954427
CL BKRSFLD FILE # 57111-095334

PERFORMED BY:
CORE LABORATORIES
3430 UNICORN ROAD
BAKERSFIELD, CA 93308
(805) 392-8600

FINAL REPORT PRESENTED
OCTOBER 12, 1995

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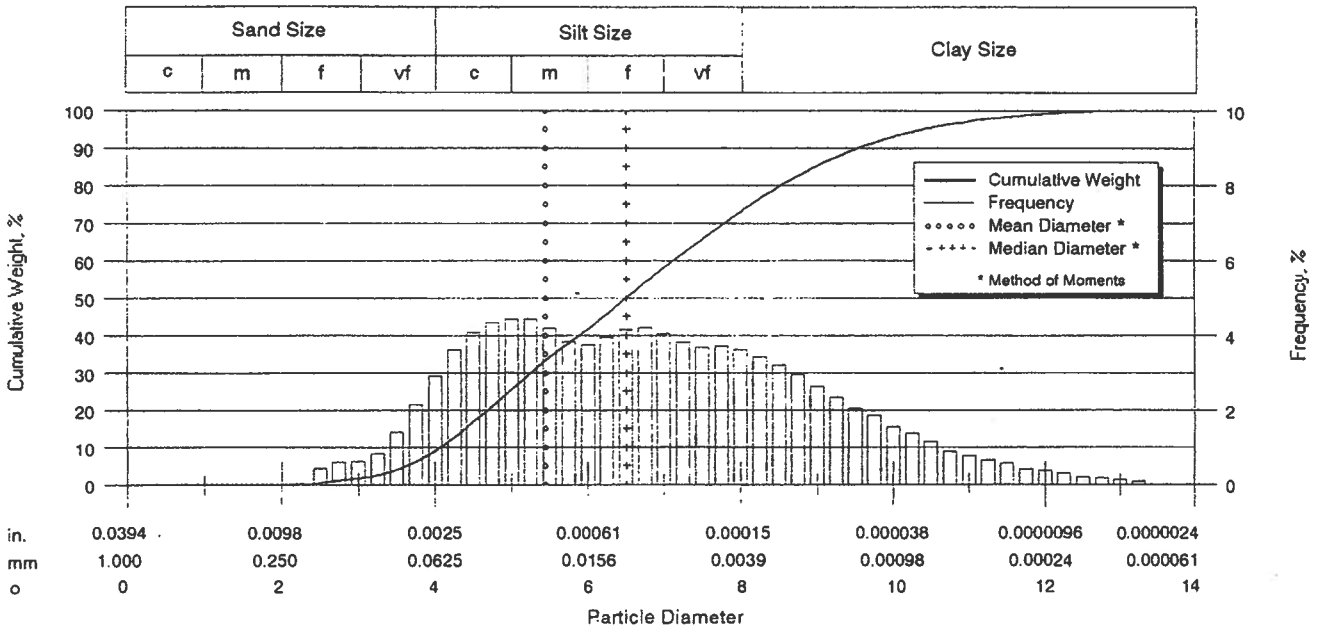
CORE LAB

CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	P1-80-55	File Number	57111-95334
I.D.	954427-1	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.00	0.00
	25	0.0280	0.71	0.50	0.00	0.00
	30	0.0232	0.59	0.75	0.00	0.00
	35	0.0197	0.50	1.00	0.00	0.00
Medium Sand	40	0.0165	0.42	1.25	0.00	0.00
	45	0.0138	0.35	1.50	0.00	0.00
	50	0.0118	0.30	1.75	0.00	0.00
	60	0.0098	0.25	2.00	0.00	0.00
Fine Sand	70	0.0083	0.210	2.25	0.03	0.03
	80	0.0070	0.177	2.50	0.44	0.47
	100	0.0059	0.149	2.75	0.60	1.07
	120	0.0049	0.125	3.00	0.62	1.69
Very Fine Sand	140	0.0041	0.105	3.25	0.84	2.53
	170	0.0035	0.088	3.50	1.40	3.93
	200	0.0029	0.074	3.75	2.15	6.08
	230	0.0025	0.063	4.00	2.92	9.00
Silt	270	0.0021	0.053	4.25	3.62	12.62
	325	0.0017	0.044	4.50	4.11	16.73
	400	0.0015	0.037	4.75	4.32	21.05
	450	0.0012	0.031	5.00	4.44	25.49
	500	0.0010	0.025	5.32	5.65	31.14
	635	0.0008	0.020	5.64	5.16	36.30
		0.00061	0.0156	6.00	5.41	41.71
		0.00031	0.0078	7.00	16.36	58.07
		0.00015	0.0039	8.00	14.85	72.92
Clay		0.000079	0.0020	9.00	12.21	85.13
		0.000039	0.00098	10.0	7.80	92.93
		0.000019	0.00049	11.0	4.18	97.11
		0.0000094	0.00024	12.0	2.00	99.11
		0.0000047	0.00012	13.0	0.80	99.91
		0.0000039	0.00010	13.3	0.09	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0009	0.0004	0.0004	0.0004
Mean, mm	0.0229	0.0106	0.0098	0.0102
Mean, phi	5.4472	6.5619	6.6725	6.6187
Median, in	0.0004	0.0004	0.0004	0.0004
Median, mm	0.0110	0.0110	0.0110	0.0110
Median, phi	6.5103	6.5110	6.5110	6.5110
Std Deviation, in	0.0012	0.0161	0.0084	0.0089
Std Deviation, mm	0.0298	0.4116	0.2152	0.2280
Std Deviation, phi	5.0700	1.2805	2.2160	2.1331
Skewness	2.5040	0.9561	0.2286	0.1113
Kurtosis	8.2100	0.2899	0.5264	0.8717
Mode, mm	0.0296			
95% Confidence	0.0171			
Limits, mm	0.0288			
Variance, mm2	0.0009			
Coef. of Variance, %	129.80			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0031	0.0805	3.6349
10	0.0023	0.0593	4.0749
16	0.0018	0.0455	4.4565
25	0.0012	0.0319	4.9716
50	0.0004	0.0110	6.5110
75	0.0001	0.0035	8.1523
84	0.0001	0.0021	8.8885
90	0.0001	0.0013	9.5609
95	0.0000	0.0007	10.4002

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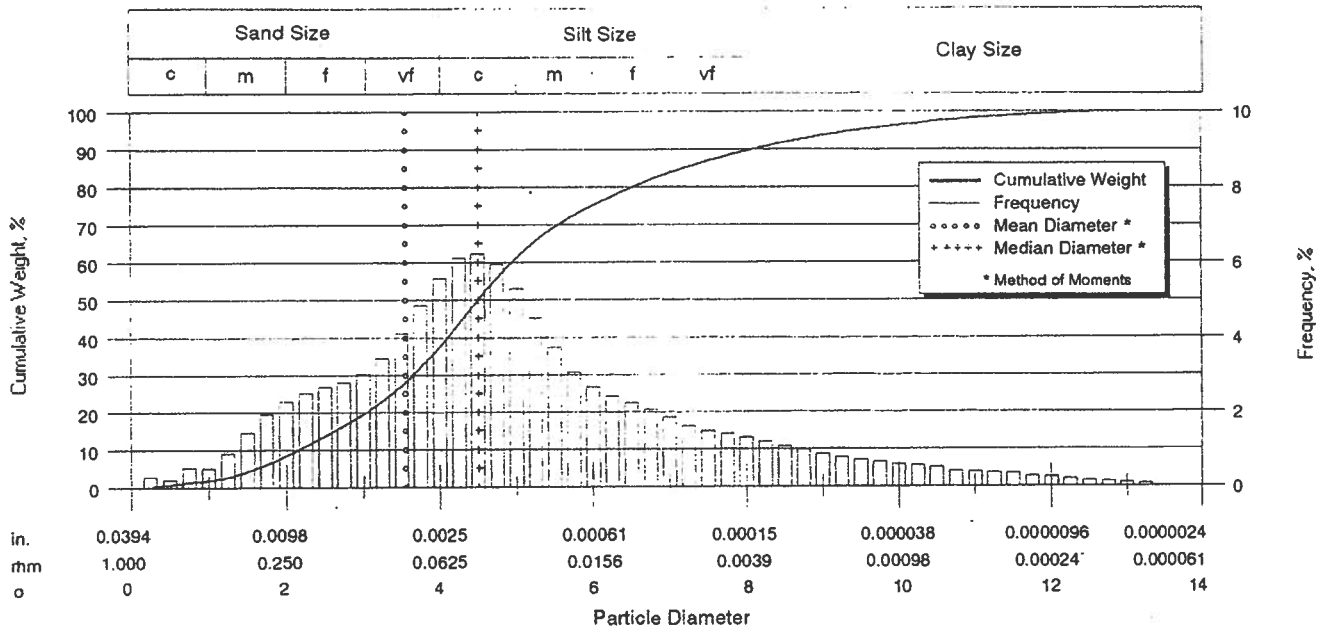
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	P1-80-80	File Number	57111-95334
I.D.	954427-2	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.58	0.58
	25	0.0280	0.71	0.50	0.20	0.78
	30	0.0232	0.59	0.75	0.52	1.30
	35	0.0197	0.50	1.00	0.52	1.82
Medium Sand	40	0.0165	0.42	1.25	0.90	2.72
	45	0.0138	0.35	1.50	1.45	4.17
	50	0.0118	0.30	1.75	1.96	6.13
	60	0.0098	0.25	2.00	2.29	8.42
Fine Sand	70	0.0083	0.210	2.25	2.52	10.94
	80	0.0070	0.177	2.50	2.69	13.63
	100	0.0059	0.149	2.75	2.81	16.44
	120	0.0049	0.125	3.00	3.03	19.47
Very Fine Sand	140	0.0041	0.105	3.25	3.46	22.93
	170	0.0035	0.088	3.50	4.11	27.04
	200	0.0029	0.074	3.75	4.85	31.89
	230	0.0025	0.063	4.00	5.58	37.47
Silt	270	0.0021	0.053	4.25	6.12	43.59
	325	0.0017	0.044	4.50	6.24	49.83
	400	0.0015	0.037	4.75	5.93	55.76
	450	0.0012	0.031	5.00	5.29	61.05
	500	0.0010	0.025	5.32	5.64	66.69
	635	0.0008	0.020	5.64	4.39	71.08
		0.00061	0.0156	6.00	3.94	75.02
		0.00031	0.0078	7.00	8.57	83.59
		0.00015	0.0039	8.00	5.83	89.42
Clay		0.000079	0.0020	9.00	4.13	93.55
		0.000039	0.00098	10.0	2.73	96.28
		0.000019	0.00049	11.0	1.88	98.16
		0.0000094	0.00024	12.0	1.20	99.36
		0.0000047	0.00012	13.0	0.57	99.93
		0.0000039	0.00010	13.3	0.07	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0033	0.0015	0.0013	0.0014
Mean, mm	0.0854	0.0388	0.0338	0.0369
Mean, phi	3.5495	4.6896	4.8856	4.7592
Median, in	0.0017	0.0017	0.0017	0.0017
Median, mm	0.0440	0.0440	0.0440	0.0440
Median, phi	4.5067	4.5065	4.5065	4.5065
Std Deviation, in	0.0047	0.0155	0.0086	0.0080
Std Deviation, mm	0.1217	0.3973	0.2215	0.2058
Std Deviation, phi	3.0386	1.3318	2.1745	2.2808
Skewness	3.0590	0.9986	0.4808	0.2199
Kurtosis	11.7700	0.2194	0.8113	1.2338
Mode, mm	0.0511			
95% Confidence	0.0616			
Limits, mm	0.1093			
Variance, mm2	0.0148			
Coef. of Variance, %	142.50			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0127	0.3268	1.6134
10	0.0087	0.2242	2.1572
16	0.0060	0.1527	2.7111
25	0.0037	0.0960	3.3813
50	0.0017	0.0440	4.5065
75	0.0006	0.0156	5.9979
84	0.0003	0.0075	7.0600
90	0.0001	0.0036	8.1190
95	0.0001	0.0014	9.4907

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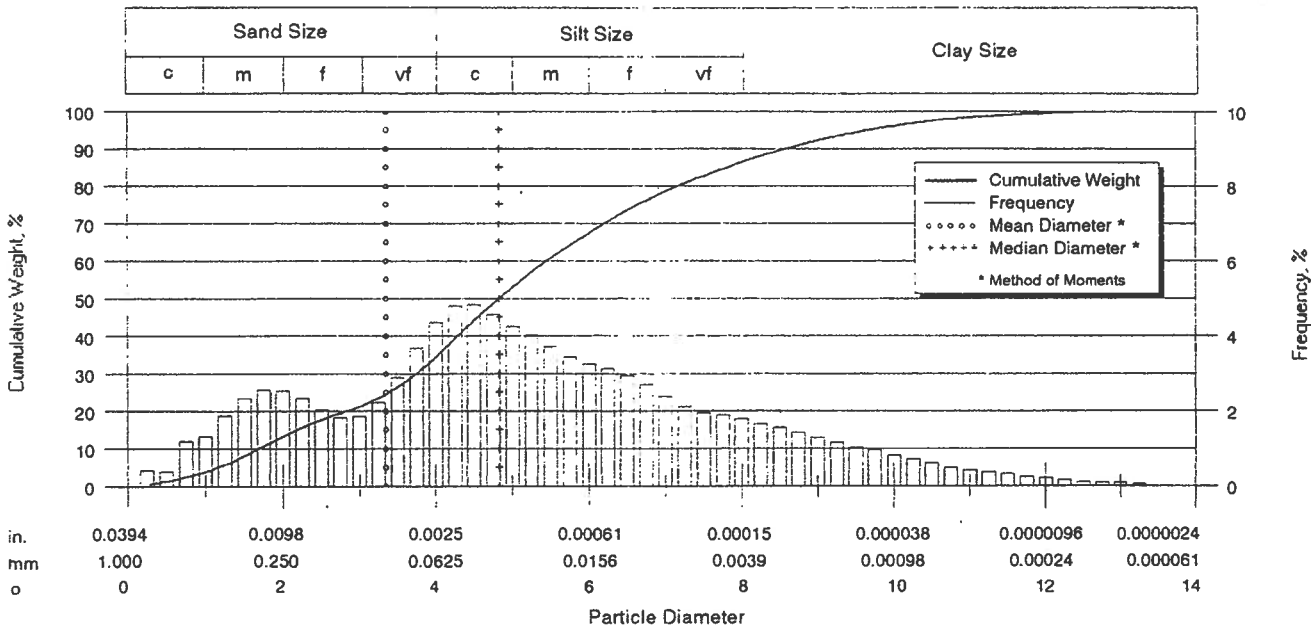
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	P2-90-45	File Number	57111-95334
I.D.	954427-3	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.95	0.95
	25	0.0280	0.71	0.50	0.39	1.34
	30	0.0232	0.59	0.75	1.19	2.53
	35	0.0197	0.50	1.00	1.34	3.87
Medium Sand	40	0.0165	0.42	1.25	1.86	5.73
	45	0.0138	0.35	1.50	2.34	8.07
	50	0.0118	0.30	1.75	2.57	10.64
	60	0.0098	0.25	2.00	2.55	13.19
Fine Sand	70	0.0083	0.210	2.25	2.35	15.54
	80	0.0070	0.177	2.50	2.03	17.57
	100	0.0059	0.149	2.75	1.82	19.39
	120	0.0049	0.125	3.00	1.85	21.24
Very Fine Sand	140	0.0041	0.105	3.25	2.22	23.46
	170	0.0035	0.088	3.50	2.90	26.36
	200	0.0029	0.074	3.75	3.68	30.04
	230	0.0025	0.063	4.00	4.37	34.41
Silt	270	0.0021	0.053	4.25	4.80	39.21
	325	0.0017	0.044	4.50	4.85	44.06
	400	0.0015	0.037	4.75	4.56	48.62
	450	0.0012	0.031	5.00	4.26	52.88
	500	0.0010	0.025	5.32	5.08	57.96
	635	0.0008	0.020	5.64	4.60	62.56
		0.00061	0.0156	6.00	4.74	67.30
		0.00031	0.0078	7.00	11.16	78.46
		0.00015	0.0039	8.00	7.73	86.19
Clay		0.000079	0.0020	9.00	5.92	92.11
		0.000039	0.00098	10.0	3.95	96.06
		0.000019	0.00049	11.0	2.28	98.34
		0.0000094	0.00024	12.0	1.15	99.49
		0.0000047	0.00012	13.0	0.46	99.95
		0.0000039	0.00010	13.3	0.05	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0038	0.0012	0.0012	0.0013
Mean, mm	0.0981	0.0308	0.0313	0.0325
Mean, phi	3.3498	5.0195	4.9989	4.9421
Median, in	0.0014	0.0014	0.0014	0.0014
Median, mm	0.0352	0.0352	0.0352	0.0352
Median, phi	4.8287	4.8286	4.8286	4.8286
Std Deviation, in	0.0060	0.0148	0.0060	0.0063
Std Deviation, mm	0.1551	0.3789	0.1544	0.1606
Std Deviation, phi	2.6887	1.4001	2.6952	2.6387
Skewness	2.4990	0.9669	0.2200	0.1012
Kurtosis	6.4300	0.2355	0.5809	1.0724
Mode, mm	0.0511			
95% Confidence	0.0677			
Limits, mm	0.1285			
Variance, mm2	0.0241			
Coef. of Variance, %	158.10			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0174	0.4472	1.1609
10	0.0121	0.3104	1.6877
16	0.0079	0.2025	2.3037
25	0.0037	0.0953	3.3911
50	0.0014	0.0352	4.8286
75	0.0004	0.0100	6.6479
84	0.0002	0.0048	7.6941
90	0.0001	0.0026	8.6029
95	0.0000	0.0012	9.6825

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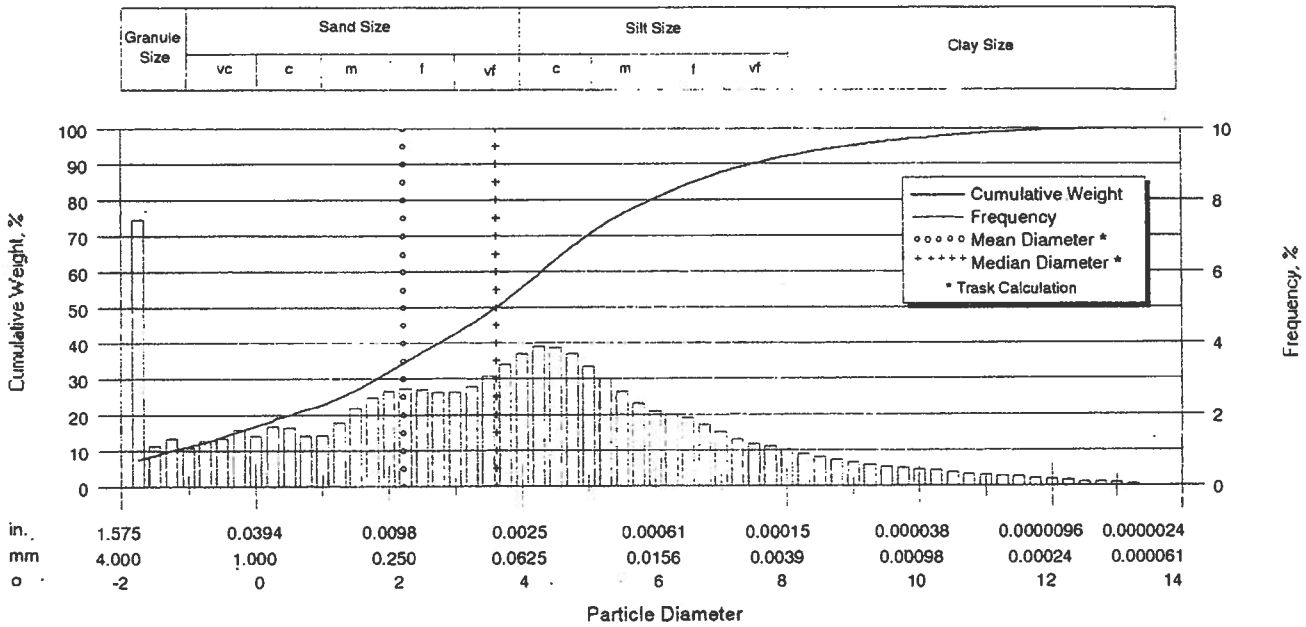
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	P2-90-70	File Number	57111-95334
I.D.	954427-4	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	7.46	7.46
	8	0.0936	2.38	-1.25	2.46	9.92
V Coarse Sand	12	0.0662	1.68	-0.75	2.35	12.27
	16	0.0468	1.19	-0.25	2.93	15.20
Coarse Sand	20	0.0331	0.84	0.25	3.08	18.28
	25	0.0280	0.71	0.50	1.63	19.91
	30	0.0232	0.59	0.75	1.42	21.33
	35	0.0197	0.50	1.00	1.43	22.76
Medium Sand	40	0.0165	0.42	1.25	1.78	24.54
	45	0.0138	0.35	1.50	2.18	26.72
	50	0.0118	0.30	1.75	2.47	29.19
	60	0.0098	0.25	2.00	2.66	31.85
Fine Sand	70	0.0083	0.210	2.25	2.74	34.59
	80	0.0070	0.177	2.50	2.70	37.29
	100	0.0059	0.149	2.75	2.63	39.92
	120	0.0049	0.125	3.00	2.63	42.55
Very Fine Sand	140	0.0041	0.105	3.25	2.77	45.32
	170	0.0035	0.088	3.50	3.08	48.40
	200	0.0029	0.074	3.75	3.39	51.79
	230	0.0025	0.063	4.00	3.70	55.49
Silt	270	0.0021	0.053	4.25	3.90	59.39
	325	0.0017	0.044	4.50	3.90	63.29
	400	0.0015	0.037	4.75	3.67	66.96
	450	0.0012	0.031	5.00	3.35	70.31
	500	0.0010	0.025	5.32	3.79	74.10
	635	0.0008	0.020	5.64	3.17	77.27
		0.00061	0.0156	6.00	3.07	80.34
		0.00031	0.0078	7.00	7.09	87.43
		0.00015	0.0039	8.00	4.58	92.01
Clay		0.000079	0.0020	9.00	3.09	95.10
		0.000039	0.00098	10.0	2.05	97.15
		0.000019	0.00049	11.0	1.43	98.58
		0.0000094	0.00024	12.0	0.93	99.51
		0.0000047	0.00012	13.0	0.44	99.95
		0.0000039	0.00010	13.3	0.05	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0083	0.0043	0.0039
Mean, mm	0.2139	0.1112	0.1002
Mean, phi	2.2249	3.1682	3.3191
Median, in	0.0032	0.0032	0.0032
Median, mm	0.0813	0.0813	0.0813
Median, phi	3.6209	3.6209	3.6209
Standard Deviation, in	0.1614	0.0039	
Standard Deviation, mm	4.1392	0.1013	
Standard Deviation, phi	-2.0493	3.3036	
Skewness	1.4436		
Kurtosis	0.0810		

* calculated using mm values
* *calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	ERR 5	ERR 5	ERR 5
10	0.0918	2.3543	-1.2353
16	0.0428	1.0983	-0.1353
25	0.0158	0.4042	1.3068
50	0.0032	0.0813	3.6209
75	0.0009	0.0236	5.4054
84	0.0004	0.0113	6.4718
90	0.0002	0.0054	7.5201
95	0.0001	0.0020	8.9587

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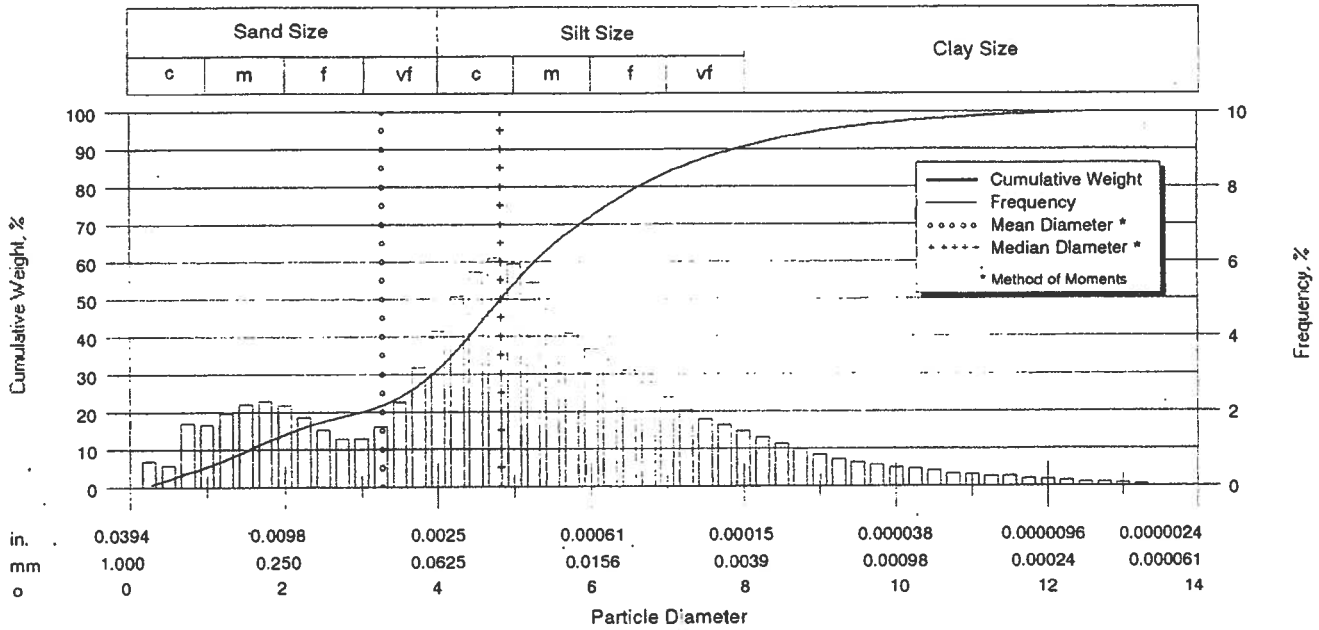
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B1-35	File Number	57111-95334
I.D.	954427-5	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	1.47	1.47
	25	0.0280	0.71	0.50	0.57	2.04
	30	0.0232	0.59	0.75	1.68	3.72
	35	0.0197	0.50	1.00	1.64	5.36
Medium Sand	40	0.0165	0.42	1.25	1.97	7.33
	45	0.0138	0.35	1.50	2.22	9.55
	50	0.0118	0.30	1.75	2.30	11.85
	60	0.0098	0.25	2.00	2.17	14.02
Fine Sand	70	0.0083	0.210	2.25	1.87	15.89
	80	0.0070	0.177	2.50	1.52	17.41
	100	0.0059	0.149	2.75	1.28	18.69
	120	0.0049	0.125	3.00	1.29	19.98
Very Fine Sand	140	0.0041	0.105	3.25	1.61	21.59
	170	0.0035	0.088	3.50	2.26	23.85
	200	0.0029	0.074	3.75	3.17	27.02
	230	0.0025	0.063	4.00	4.14	31.16
Silt	270	0.0021	0.053	4.25	5.06	36.22
	325	0.0017	0.044	4.50	5.75	41.97
	400	0.0015	0.037	4.75	6.06	48.03
	450	0.0012	0.031	5.00	5.95	53.98
	500	0.0010	0.025	5.32	6.84	60.82
	635	0.0008	0.020	5.64	5.68	66.50
		0.00061	0.0156	6.00	5.38	71.88
		0.00031	0.0078	7.00	11.64	83.52
		0.00015	0.0039	8.00	6.92	90.44
Clay		0.000079	0.0020	9.00	4.25	94.69
		0.000039	0.00098	10.0	2.41	97.10
		0.000019	0.00049	11.0	1.50	98.60
		0.0000094	0.00024	12.0	0.91	99.51
		0.0000047	0.00012	13.0	0.44	99.95
		0.0000039	0.00010	13.3	0.05	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0040	0.0013	0.0015	0.0015
Mean, mm	0.1036	0.0331	0.0395	0.0380
Mean, phi	3.2709	4.9156	4.6609	4.7174
Median, in	0.0014	0.0014	0.0014	0.0014
Median, mm	0.0352	0.0351	0.0351	0.0351
Median, phi	4.8303	4.8305	4.8305	4.8305
Std Deviation, in	0.0067	0.0157	0.0074	0.0072
Std Deviation, mm	0.1707	0.4018	0.1901	0.1852
Std Deviation, phi	2.5505	1.3155	2.3950	2.4327
Skewness	2.4870	0.9614	0.0821	-0.0113
Kurtosis	5.8340	0.2063	0.7020	1.2704
Mode, mm	0.0389			
95% Confidence	0.0702			
Limits, mm	0.1371			
Variance, mm2	0.0291			
Coef. of Variance, %	164.70			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0202	0.5174	0.9508
10	0.0133	0.3419	1.5482
16	0.0081	0.2079	2.2659
25	0.0032	0.0824	3.6005
50	0.0014	0.0351	4.8305
75	0.0005	0.0133	6.2306
84	0.0003	0.0075	7.0558
90	0.0002	0.0041	7.9224
95	0.0001	0.0018	9.1034

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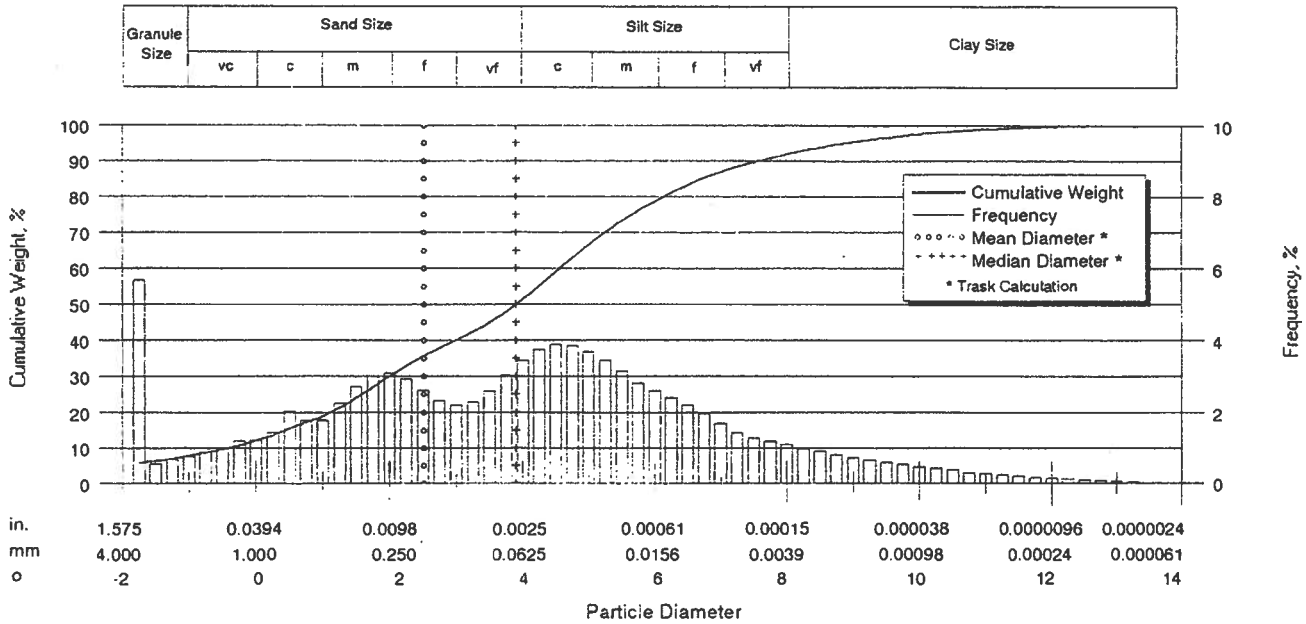
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B1-90	File Number	57111-95334
I.D.	954427-6	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	5.67	5.67
	8	0.0936	2.38	-1.25	1.22	6.88
V Coarse Sand	12	0.0662	1.68	-0.75	1.64	8.52
	16	0.0468	1.19	-0.25	2.21	10.73
	20	0.0331	0.84	0.25	2.66	13.39
Coarse Sand	25	0.0280	0.71	0.50	2.03	15.42
	30	0.0232	0.59	0.75	1.76	17.18
	35	0.0197	0.50	1.00	1.78	18.96
	40	0.0165	0.42	1.25	2.24	21.20
Medium Sand	45	0.0138	0.35	1.50	2.71	23.91
	50	0.0118	0.30	1.75	3.01	26.92
	60	0.0098	0.25	2.00	3.10	30.02
	70	0.0083	0.210	2.25	2.92	32.94
Fine Sand	80	0.0070	0.177	2.50	2.61	35.55
	100	0.0059	0.149	2.75	2.32	37.87
	120	0.0049	0.125	3.00	2.19	40.06
	140	0.0041	0.105	3.25	2.29	42.35
Very Fine Sand	170	0.0035	0.088	3.50	2.59	44.94
	200	0.0029	0.074	3.75	3.03	47.97
	230	0.0025	0.063	4.00	3.45	51.42
	270	0.0021	0.053	4.25	3.75	55.17
Silt	325	0.0017	0.044	4.50	3.89	59.06
	400	0.0015	0.037	4.75	3.83	62.89
	450	0.0012	0.031	5.00	3.69	66.58
	500	0.0010	0.025	5.32	4.38	70.96
	635	0.0008	0.020	5.64	3.84	74.80
		0.00061	0.0156	6.00	3.78	78.58
		0.00031	0.0078	7.00	8.26	86.84
		0.00015	0.0039	8.00	4.98	91.82
		0.000079	0.0020	9.00	3.44	95.26
Clay		0.000039	0.00098	10.0	2.26	97.52
		0.000019	0.00049	11.0	1.37	98.89
		0.0000094	0.00024	12.0	0.75	99.64
		0.0000047	0.00012	13.0	0.33	99.97
		0.0000039	0.00010	13.3	0.03	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0068	0.0032	0.0030
Mean, mm	0.1756	0.0830	0.0773
Mean, phi	2.5097	3.5905	3.6937
Median, in	0.0026	0.0026	0.0026
Median, mm	0.0670	0.0670	0.0670
Median, phi	3.9000	3.9000	3.9000
Standard Deviation, in	0.1596	0.0048	
Standard Deviation, mm	4.0914	0.1243	
Standard Deviation, phi	-2.0326	3.0085	
Skewness	1.4621		
Kurtosis	0.1156		

* calculated using mm values
* *calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	ERR 5	ERR 5	ERR 5
10	0.0528	1.3527	-0.4359
16	0.0261	0.6680	0.5820
25	0.0129	0.3314	1.5934
50	0.0026	0.0670	3.9000
75	0.0008	0.0198	5.6586
84	0.0004	0.0103	6.5990
90	0.0002	0.0052	7.5926
95	0.0001	0.0021	8.9080

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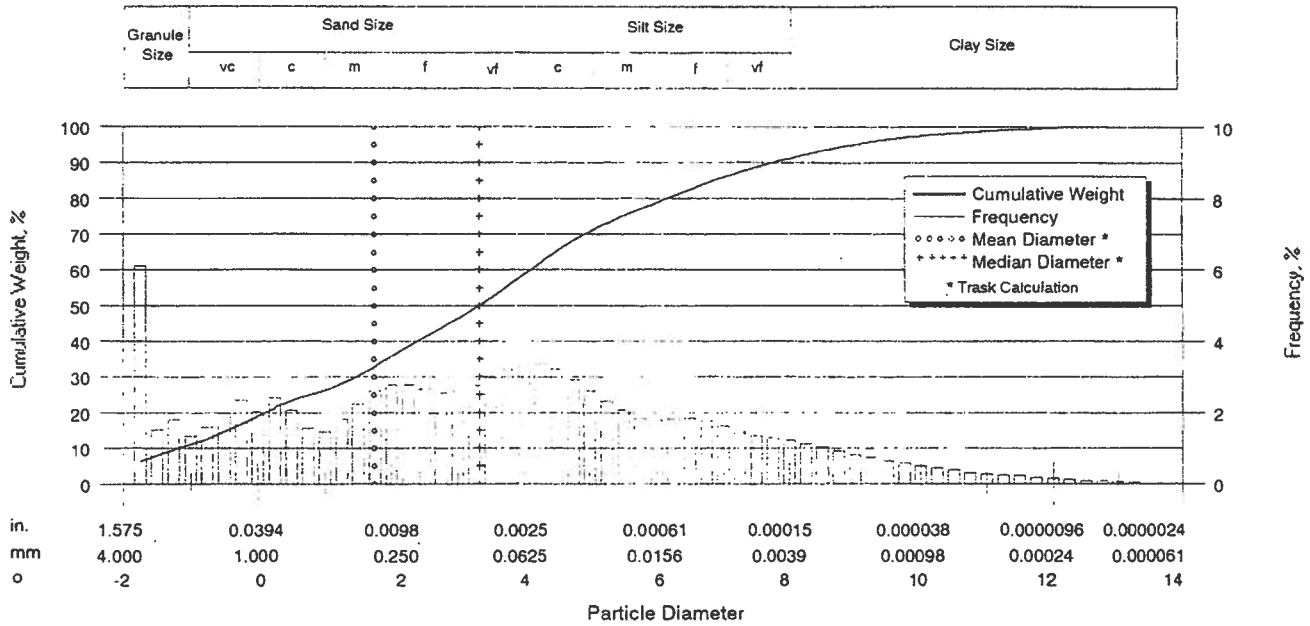
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B2-55	File Number	57111-95334
I.D.	954427-7	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	6.11	6.11
	8	0.0936	2.38	-1.25	3.32	9.42
V Coarse Sand	12	0.0662	1.68	-0.75	2.93	12.35
	16	0.0468	1.19	-0.25	4.32	16.68
	20	0.0331	0.84	0.25	4.45	21.12
Coarse Sand	25	0.0280	0.71	0.50	2.06	23.18
	30	0.0232	0.59	0.75	1.57	24.75
	35	0.0197	0.50	1.00	1.45	26.20
	40	0.0165	0.42	1.25	1.83	28.03
Medium Sand	45	0.0138	0.35	1.50	2.25	30.28
	50	0.0118	0.30	1.75	2.61	32.89
	60	0.0098	0.25	2.00	2.79	35.68
	70	0.0083	0.210	2.25	2.77	38.45
Fine Sand	80	0.0070	0.177	2.50	2.66	41.11
	100	0.0059	0.149	2.75	2.56	43.67
	120	0.0049	0.125	3.00	2.60	46.27
	140	0.0041	0.105	3.25	2.76	49.03
Very Fine Sand	170	0.0035	0.088	3.50	2.99	52.02
	200	0.0029	0.074	3.75	3.21	55.23
	230	0.0025	0.063	4.00	3.33	58.56
	270	0.0021	0.053	4.25	3.36	61.92
Silt	325	0.0017	0.044	4.50	3.23	65.15
	400	0.0015	0.037	4.75	2.94	68.09
	450	0.0012	0.031	5.00	2.60	70.69
	500	0.0010	0.025	5.32	2.92	73.61
	635	0.0008	0.020	5.64	2.50	76.11
		0.00061	0.0156	6.00	2.58	78.69
		0.00031	0.0078	7.00	7.06	85.75
		0.00015	0.0039	8.00	5.31	91.06
		0.000079	0.0020	9.00	3.86	94.92
Clay		0.000039	0.00098	10.0	2.45	97.37
		0.000019	0.00049	11.0	1.45	98.82
		0.0000094	0.00024	12.0	0.79	99.61
		0.0000047	0.00012	13.0	0.35	99.96
		0.0000039	0.00010	13.3	0.04	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0117	0.0043	0.0041
Mean, mm	0.2988	0.1092	0.1057
Mean, phi	1.7428	3.1953	3.2415
Median, in	0.0039	0.0039	0.0039
Median, mm	0.0992	0.0992	0.0992
Median, phi	3.3339	3.3339	3.3339
Standard Deviation, in	0.1984	0.0034	
Standard Deviation, mm	5.0879	0.0862	
Standard Deviation, phi	-2.3471	3.5360	
Skewness	1.3002		
Kurtosis	0.1236		

* calculated using mm values
* *calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	ERR 5	ERR 5	ERR 5
10	0.0874	2.2415	-1.1645
16	0.0494	1.2663	-0.3407
25	0.0224	0.5754	0.7975
50	0.0039	0.0992	3.3339
75	0.0009	0.0222	5.4916
84	0.0004	0.0094	6.7313
90	0.0002	0.0045	7.7816
95	0.0001	0.0019	9.0256

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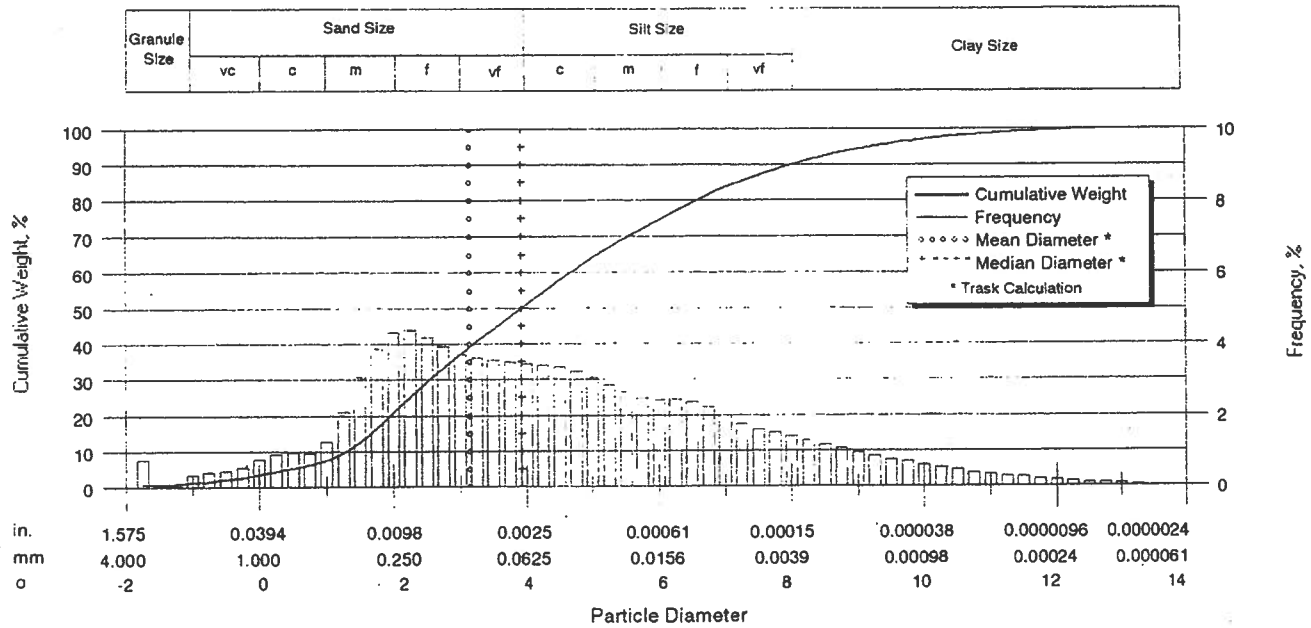
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B2-75	File Number	57111-95334
I.D.	954427-8	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	Diameter [U.S. Sieve]	[in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	0.75	0.75
	8	0.0936	2.38	-1.25	0.06	0.81
V Coarse Sand	12	0.0662	1.68	-0.75	0.75	1.56
	16	0.0468	1.19	-0.25	1.00	2.56
Coarse Sand	20	0.0331	0.84	0.25	1.68	4.24
	25	0.0280	0.71	0.50	0.97	5.21
	30	0.0232	0.59	0.75	0.94	6.15
	35	0.0197	0.50	1.00	1.26	7.41
Medium Sand	40	0.0165	0.42	1.25	2.09	9.50
	45	0.0138	0.35	1.50	3.07	12.57
	50	0.0118	0.30	1.75	3.87	16.44
	60	0.0098	0.25	2.00	4.32	20.76
Fine Sand	70	0.0083	0.210	2.25	4.39	25.15
	80	0.0070	0.177	2.50	4.19	29.34
	100	0.0059	0.149	2.75	3.92	33.26
	120	0.0049	0.125	3.00	3.72	36.98
Very Fine Sand	140	0.0041	0.105	3.25	3.60	40.58
	170	0.0035	0.088	3.50	3.54	44.12
	200	0.0029	0.074	3.75	3.48	47.60
	230	0.0025	0.063	4.00	3.44	51.04
Silt	270	0.0021	0.053	4.25	3.39	54.43
	325	0.0017	0.044	4.50	3.37	57.80
	400	0.0015	0.037	4.75	3.22	61.02
	450	0.0012	0.031	5.00	3.06	64.08
	500	0.0010	0.025	5.32	3.61	67.69
	635	0.0008	0.020	5.64	3.27	70.96
		0.00061	0.0156	6.00	3.51	74.47
		0.00031	0.0078	7.00	9.02	83.49
		0.00015	0.0039	8.00	6.26	89.75
Clay		0.000079	0.0020	9.00	4.46	94.21
		0.000039	0.00098	10.0	2.83	97.04
		0.000019	0.00049	11.0	1.65	98.69
		0.0000094	0.00024	12.0	0.89	99.58
		0.0000047	0.00012	13.0	0.38	99.96
		0.0000039	0.00010	13.3	0.04	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0044	0.0019	0.0021
Mean, mm	0.1133	0.0475	0.0529
Mean, phi	3.1421	4.3969	4.2394
Median, in	0.0026	0.0026	0.0026
Median, mm	0.0659	0.0659	0.0659
Median, phi	3.9244	3.9244	3.9244
Standard Deviation, in	0.1463	0.0061	0.0061
Standard Deviation, mm	3.7512	0.1569	0.1572
Standard Deviation, phi	-1.9074	2.6723	2.6694
Skewness	0.7329	0.3417	0.1922
Kurtosis	0.2437	0.6464	0.9453

* calculated using mm values
** calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0288	0.7382	0.4379
10	0.0159	0.4069	1.2973
16	0.0118	0.3026	1.7246
25	0.0082	0.2115	2.2412
50	0.0026	0.0659	3.9244
75	0.0006	0.0150	6.0559
84	0.0003	0.0074	7.0692
90	0.0001	0.0038	8.0461
95	0.0001	0.0017	9.2371

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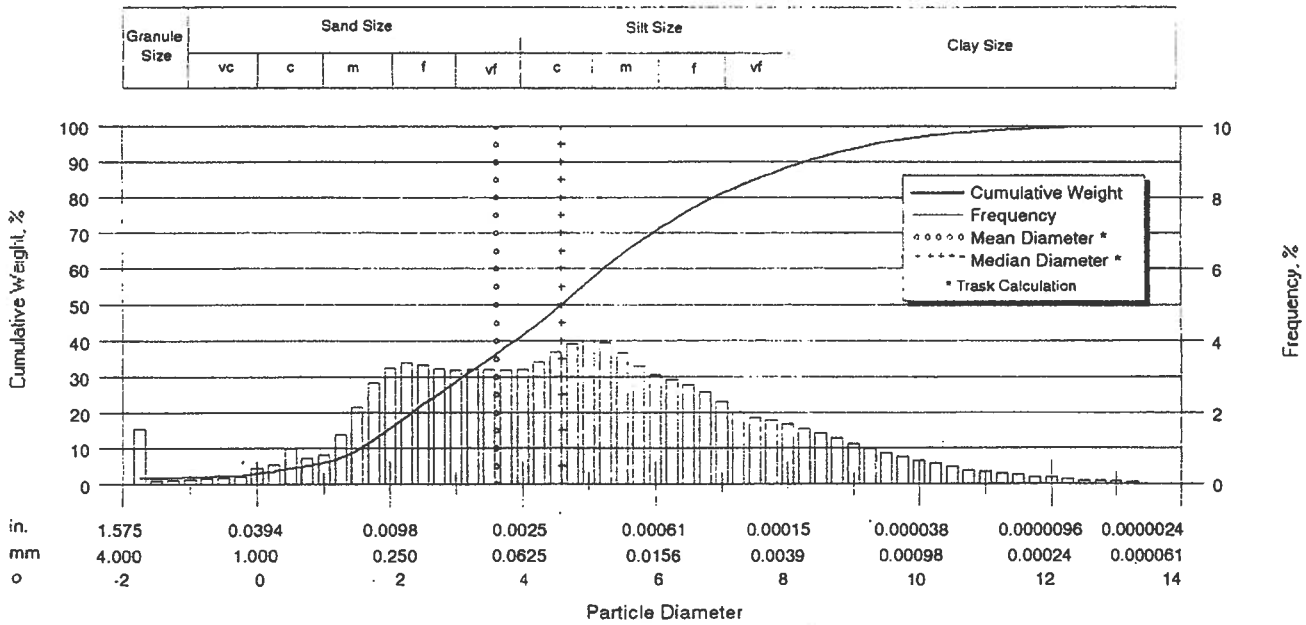
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B3-10	File Number	57111-95334
I.D.	954427-9	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	1.53	1.53
	8	0.0936	2.38	-1.25	0.20	1.73
V Coarse Sand	12	0.0662	1.68	-0.75	0.27	2.00
	16	0.0468	1.19	-0.25	0.38	2.39
Coarse Sand	20	0.0331	0.84	0.25	0.99	3.38
	25	0.0280	0.71	0.50	0.97	4.35
	30	0.0232	0.59	0.75	0.71	5.06
	35	0.0197	0.50	1.00	0.81	5.87
Medium Sand	40	0.0165	0.42	1.25	1.38	7.25
	45	0.0138	0.35	1.50	2.15	9.40
	50	0.0118	0.30	1.75	2.84	12.24
	60	0.0098	0.25	2.00	3.24	15.48
Fine Sand	70	0.0083	0.210	2.25	3.40	18.88
	80	0.0070	0.177	2.50	3.33	22.21
	100	0.0059	0.149	2.75	3.23	25.44
	120	0.0049	0.125	3.00	3.20	28.64
Very Fine Sand	140	0.0041	0.105	3.25	3.20	31.84
	170	0.0035	0.088	3.50	3.22	35.06
	200	0.0029	0.074	3.75	3.18	38.24
	230	0.0025	0.063	4.00	3.22	41.46
Silt	270	0.0021	0.053	4.25	3.41	44.87
	325	0.0017	0.044	4.50	3.71	48.58
	400	0.0015	0.037	4.75	3.89	52.47
	450	0.0012	0.031	5.00	3.99	56.46
	500	0.0010	0.025	5.32	5.01	61.47
	635	0.0008	0.020	5.64	4.50	65.97
		0.00061	0.0156	6.00	4.46	70.43
		0.00031	0.0078	7.00	10.56	80.99
		0.00015	0.0039	8.00	7.32	88.31
Clay		0.000079	0.0020	9.00	5.32	93.63
		0.000039	0.00098	10.0	3.25	96.88
		0.000019	0.00049	11.0	1.77	98.65
		0.0000094	0.00024	12.0	0.92	99.57
		0.0000047	0.00012	13.0	0.38	99.95
		0.0000039	0.00010	13.3	0.05	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0032	0.0015	0.0015
Mean, mm	0.0821	0.0382	0.0393
Mean, phi	3.6067	4.7091	4.6700
Median, in	0.0016	0.0016	0.0016
Median, mm	0.0415	0.0415	0.0415
Median, phi	4.5917	4.5917	4.5917
Standard Deviation, in	0.1397	0.0061	0.0062
Standard Deviation, mm	3.5815	0.1569	0.1600
Standard Deviation, phi	-1.8406	2.6722	2.6437
Skewness	1.0514	0.1680	0.0740
Kurtosis	0.2085	0.6149	0.9609

* calculated using mm values
* *calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0236	0.6048	0.7254
10	0.0133	0.3399	1.5567
16	0.0095	0.2437	2.0369
25	0.0059	0.1523	2.7150
50	0.0016	0.0415	4.5917
75	0.0005	0.0119	6.3961
84	0.0002	0.0060	7.3812
90	0.0001	0.0032	8.2768
95	0.0001	0.0015	9.3558

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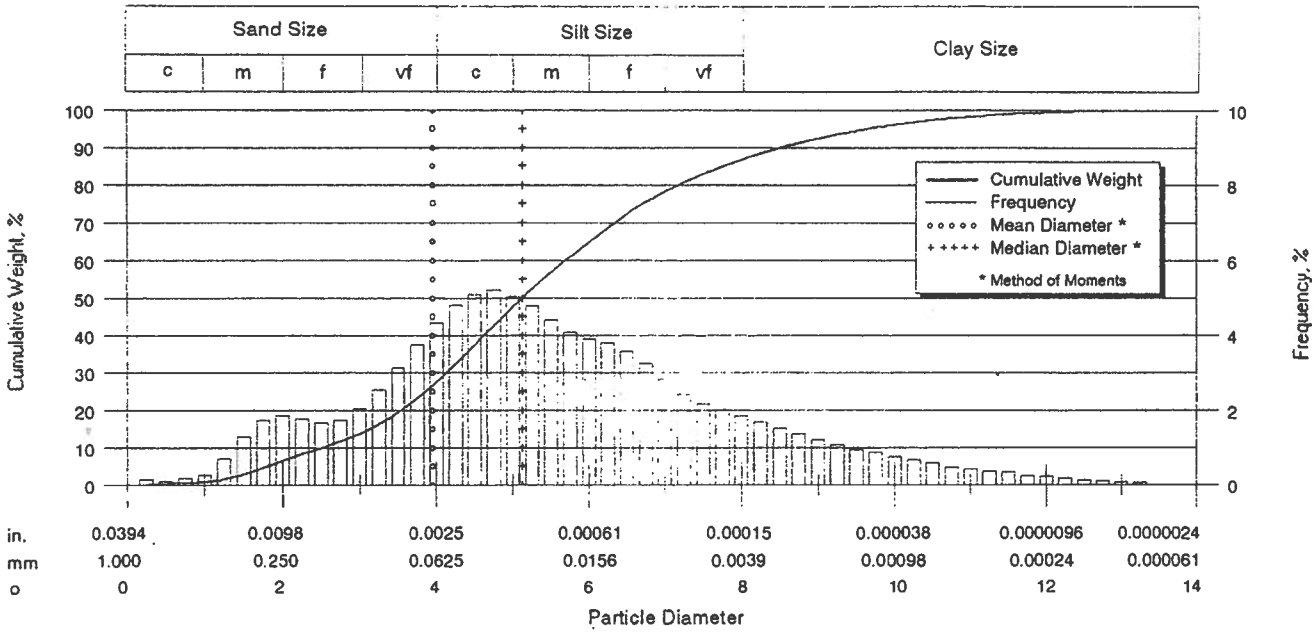
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B3-45	File Number	57111-95334
I.D.	954427-10	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.33	0.33
	25	0.0280	0.71	0.50	0.09	0.42
	30	0.0232	0.59	0.75	0.19	0.61
	35	0.0197	0.50	1.00	0.26	0.87
Medium Sand	40	0.0165	0.42	1.25	0.71	1.58
	45	0.0138	0.35	1.50	1.30	2.88
	50	0.0118	0.30	1.75	1.74	4.62
	60	0.0098	0.25	2.00	1.87	6.49
Fine Sand	70	0.0083	0.210	2.25	1.78	8.27
	80	0.0070	0.177	2.50	1.67	9.94
	100	0.0059	0.149	2.75	1.73	11.67
	120	0.0049	0.125	3.00	2.04	13.71
Very Fine Sand	140	0.0041	0.105	3.25	2.54	16.25
	170	0.0035	0.088	3.50	3.12	19.37
	200	0.0029	0.074	3.75	3.75	23.12
	230	0.0025	0.063	4.00	4.32	27.44
Silt	270	0.0021	0.053	4.25	4.80	32.24
	325	0.0017	0.044	4.50	5.13	37.37
	400	0.0015	0.037	4.75	5.18	42.55
	450	0.0012	0.031	5.00	5.04	47.59
	500	0.0010	0.025	5.32	6.06	53.65
	635	0.0008	0.020	5.64	5.46	59.11
		0.00061	0.0156	6.00	5.66	64.77
		0.00031	0.0078	7.00	13.42	78.19
		0.00015	0.0039	8.00	8.46	86.65
Clay		0.000079	0.0020	9.00	5.78	92.43
		0.000039	0.00098	10.0	3.66	96.09
		0.000019	0.00049	11.0	2.17	98.26
		0.0000094	0.00024	12.0	1.18	99.44
		0.0000047	0.00012	13.0	0.50	99.94
		0.0000039	0.00010	13.3	0.06	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0025	0.0010	0.0009	0.0010
Mean, mm	0.0649	0.0255	0.0231	0.0248
Mean, phi	3.9456	5.2916	5.4380	5.3334
Median, in	0.0011	0.0011	0.0011	0.0011
Median, mm	0.0287	0.0287	0.0287	0.0287
Median, phi	5.1243	5.1242	5.1242	5.1242
Std Deviation, in	0.0040	0.0156	0.0084	0.0079
Std Deviation, mm	0.1031	0.4008	0.2161	0.2038
Std Deviation, phi	3.2779	1.3189	2.2099	2.2947
Skewness	3.3970	0.9887	0.2723	0.1476
Kurtosis	15.2300	0.2375	0.7766	1.1264
Mode, mm	0.0426			
95% Confidence	0.0447			
Limits, mm	0.0851			
Variance, mm2	0.0106			
Coef. of Variance, %	158.80			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0112	0.2872	1.7998
10	0.0068	0.1755	2.5102
16	0.0042	0.1067	3.2280
25	0.0027	0.0687	3.8631
50	0.0011	0.0287	5.1242
75	0.0004	0.0095	6.7201
84	0.0002	0.0050	7.6479
90	0.0001	0.0027	8.5259
95	0.0000	0.0012	9.6520

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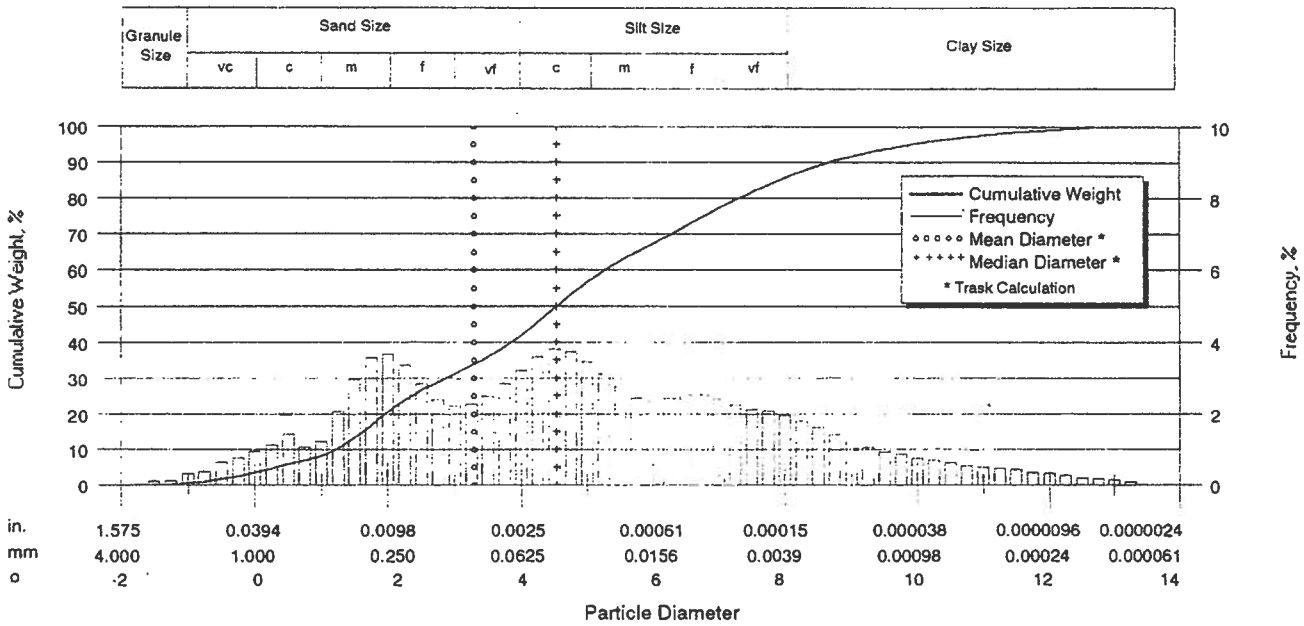
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B3-65	File Number	57111-95334
I.D.	954427-11	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	0.00	0.00
	8	0.0936	2.38	-1.25	0.23	0.23
V Coarse Sand	12	0.0662	1.68	-0.75	0.70	0.93
	16	0.0468	1.19	-0.25	1.40	2.33
	20	0.0331	0.84	0.25	2.06	4.39
Coarse Sand	25	0.0280	0.71	0.50	1.42	5.81
	30	0.0232	0.59	0.75	1.08	6.89
	35	0.0197	0.50	1.00	1.22	8.11
	40	0.0165	0.42	1.25	2.05	10.16
Medium Sand	45	0.0138	0.35	1.50	2.98	13.14
	50	0.0118	0.30	1.75	3.56	16.70
	60	0.0098	0.25	2.00	3.67	20.37
	70	0.0083	0.210	2.25	3.36	23.73
Fine Sand	80	0.0070	0.177	2.50	2.85	26.58
	100	0.0059	0.149	2.75	2.40	28.98
	120	0.0049	0.125	3.00	2.21	31.19
	140	0.0041	0.105	3.25	2.26	33.45
Very Fine Sand	170	0.0035	0.088	3.50	2.50	35.95
	200	0.0029	0.074	3.75	2.84	38.79
	230	0.0025	0.063	4.00	3.21	42.00
	270	0.0021	0.053	4.25	3.59	45.59
Silt	325	0.0017	0.044	4.50	3.83	49.42
	400	0.0015	0.037	4.75	3.73	53.15
	450	0.0012	0.031	5.00	3.46	56.61
	500	0.0010	0.025	5.32	3.93	60.54
	635	0.0008	0.020	5.64	3.36	63.90
		0.00061	0.0156	6.00	3.39	67.29
		0.00031	0.0078	7.00	9.93	77.22
		0.00015	0.0039	8.00	8.38	85.60
		0.000079	0.0020	9.00	6.02	91.62
Clay		0.000039	0.00098	10.0	3.58	95.20
		0.000019	0.00049	11.0	2.35	97.55
		0.0000094	0.00024	12.0	1.58	99.13
		0.0000047	0.00012	13.0	0.77	99.90
		0.0000039	0.00010	13.3	0.10	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0040	0.0015	0.0015
Mean, mm	0.1023	0.0372	0.0391
Mean, phi	3.2897	4.7478	4.6777
Median, in	0.0017	0.0017	0.0017
Median, mm	0.0431	0.0431	0.0431
Median, phi	4.5373	4.5373	4.5373
Standard Deviation, in	0.1801	0.0047	0.0049
Standard Deviation, mm	4.6169	0.1211	0.1268
Standard Deviation, phi	-2.2069	3.0457	2.9794
Skewness	0.9653	0.1909	0.0951
Kurtosis	0.2204	0.5782	0.8926

* calculated using mm values
* *calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0314	0.8054	0.3123
10	0.0166	0.4249	1.2347
16	0.0120	0.3073	1.7022
25	0.0076	0.1954	2.3558
50	0.0017	0.0431	4.5373
75	0.0004	0.0092	6.7697
84	0.0002	0.0045	7.7935
90	0.0001	0.0024	8.6768
95	0.0000	0.0010	9.9254

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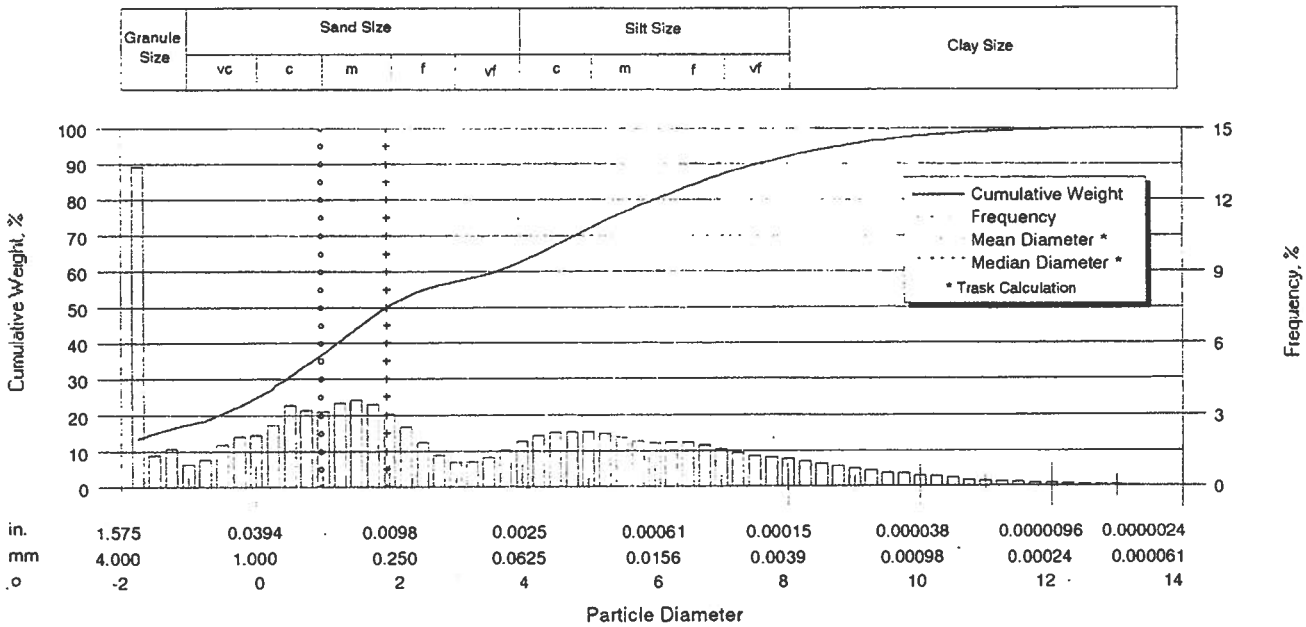
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B4-55	File Number	57111-95334
I.D.	954427-12	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Sieve and Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Granule	6	0.1324	3.36	-1.75	13.39	13.39
	8	0.0936	2.38	-1.25	2.93	16.32
V Coarse Sand	12	0.0662	1.68	-0.75	2.12	18.44
	16	0.0468	1.19	-0.25	3.91	22.35
	20	0.0331	0.84	0.25	4.76	27.11
Coarse Sand	25	0.0280	0.71	0.50	3.39	30.50
	30	0.0232	0.59	0.75	3.19	33.69
	35	0.0197	0.50	1.00	3.16	36.85
	40	0.0165	0.42	1.25	3.49	40.34
Medium Sand	45	0.0138	0.35	1.50	3.62	43.96
	50	0.0118	0.30	1.75	3.43	47.39
	60	0.0098	0.25	2.00	3.05	50.44
	70	0.0083	0.210	2.25	2.49	52.93
Fine Sand	80	0.0070	0.177	2.50	1.86	54.79
	100	0.0059	0.149	2.75	1.35	56.14
	120	0.0049	0.125	3.00	1.04	57.18
	140	0.0041	0.105	3.25	1.02	58.20
Very Fine Sand	170	0.0035	0.088	3.50	1.23	59.43
	200	0.0029	0.074	3.75	1.56	60.99
	230	0.0025	0.063	4.00	1.88	62.87
	270	0.0021	0.053	4.25	2.15	65.02
Silt	325	0.0017	0.044	4.50	2.28	67.30
	400	0.0015	0.037	4.75	2.29	69.59
	450	0.0012	0.031	5.00	2.29	71.88
	500	0.0010	0.025	5.32	2.80	74.68
	635	0.0008	0.020	5.64	2.53	77.21
		0.00061	0.0156	6.00	2.66	79.87
		0.00031	0.0078	7.00	6.98	86.85
		0.00015	0.0039	8.00	5.08	91.93
		0.000079	0.0020	9.00	3.62	95.55
Clay		0.000039	0.00098	10.0	2.21	97.76
		0.000019	0.00049	11.0	1.26	99.02
		0.0000094	0.00024	12.0	0.67	99.69
		0.0000047	0.00012	13.0	0.28	99.97
		0.0000039	0.00010	13.3	0.03	100.00

Sorting Statistics

Parameter	Trask*	Inman**	Folk**
Mean, in	0.0199	0.0063	0.0074
Mean, mm	0.5098	0.1621	0.1889
Mean, phi	0.9721	2.6254	2.4040
Median, in	0.0100	0.0100	0.0100
Median, mm	0.2568	0.2568	0.2568
Median, phi	1.9612	1.9612	1.9612
Standard Deviation, in	0.2492	0.0025	
Standard Deviation, mm	6.3901	0.0652	
Standard Deviation, phi	-2.6758	3.9398	
Skewness	0.3677		
Kurtosis			

* calculated using mm values
**calculated using phi values

Percentiles [weight, %]	Particle Diameter [in]	[mm]	[phi]
5	ERR 5	ERR 5	ERR 5
10	ERR 5	ERR 5	ERR 5
16	0.0970	2.4870	-1.3144
25	0.0388	0.9951	0.0070
50	0.0100	0.2568	1.9612
75	0.0010	0.0244	5.3587
84	0.0004	0.0106	6.5652
90	0.0002	0.0052	7.5895
95	0.0001	0.0022	8.8171

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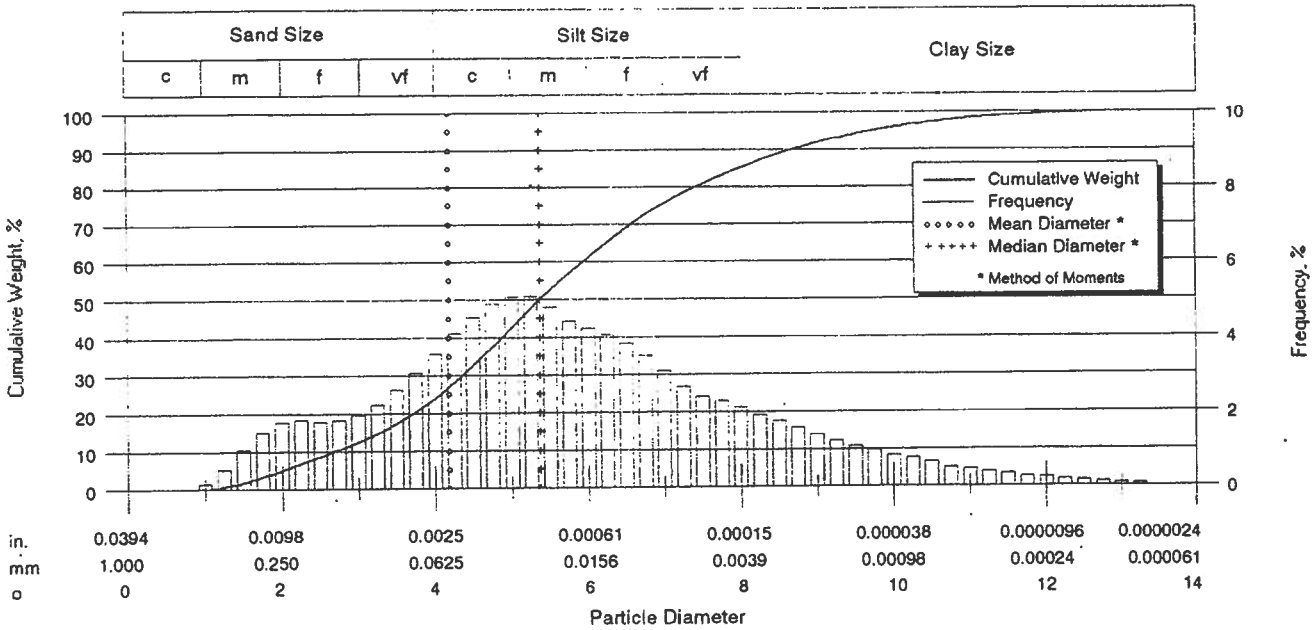
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	B4-80	File Number	57111-95334
I.D.	954427-13	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.00	0.00
	25	0.0280	0.71	0.50	0.00	0.00
	30	0.0232	0.59	0.75	0.01	0.01
	35	0.0197	0.50	1.00	0.14	0.15
Medium Sand	40	0.0165	0.42	1.25	0.52	0.67
	45	0.0138	0.35	1.50	1.05	1.72
	50	0.0118	0.30	1.75	1.50	3.22
	60	0.0098	0.25	2.00	1.77	4.99
Fine Sand	70	0.0083	0.210	2.25	1.83	6.82
	80	0.0070	0.177	2.50	1.80	8.62
	100	0.0059	0.149	2.75	1.81	10.43
	120	0.0049	0.125	3.00	1.96	12.39
Very Fine Sand	140	0.0041	0.105	3.25	2.23	14.62
	170	0.0035	0.088	3.50	2.62	17.24
	200	0.0029	0.074	3.75	3.06	20.30
	230	0.0025	0.063	4.00	3.57	23.87
Silt	270	0.0021	0.053	4.25	4.11	27.98
	325	0.0017	0.044	4.50	4.56	32.54
	400	0.0015	0.037	4.75	4.85	37.39
	450	0.0012	0.031	5.00	5.06	42.45
	500	0.0010	0.025	5.32	6.46	48.91
	635	0.0008	0.020	5.64	5.94	54.85
		0.00061	0.0156	6.00	6.13	60.98
		0.00031	0.0078	7.00	14.50	75.48
		0.00015	0.0039	8.00	9.49	84.97
Clay		0.000079	0.0020	9.00	6.64	91.61
		0.000039	0.00098	10.0	4.14	95.75
		0.000019	0.00049	11.0	2.39	98.14
		0.0000094	0.00024	12.0	1.26	99.40
		0.0000047	0.00012	13.0	0.54	99.94
		0.0000039	0.00010	13.3	0.06	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0021	0.0009	0.0008	0.0008
Mean, mm	0.0550	0.0219	0.0201	0.0214
Mean, phi	4.1836	5.5159	5.6354	5.5490
Median, in	0.0009	0.0009	0.0009	0.0009
Median, mm	0.0241	0.0241	0.0241	0.0241
Median, phi	5.3760	5.3764	5.3764	5.3764
Std Deviation, in	0.0032	0.0158	0.0082	0.0079
Std Deviation, mm	0.0822	0.4041	0.2104	0.2028
Std Deviation, phi	3.6042	1.3072	2.2487	2.3021
Skewness	2.6410	0.9805	0.2274	0.1234
Kurtosis	7.5020	0.2396	0.7283	1.1036
Mode, mm	0.0296			
95% Confidence	0.0389			
Limits, mm	0.0711			
Variance, mm2	0.0068			
Coef. of Variance, %	149.40			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0097	0.2498	2.0014
10	0.0060	0.1548	2.6912
16	0.0037	0.0956	3.3866
25	0.0023	0.0594	4.0727
50	0.0009	0.0241	5.3764
75	0.0003	0.0080	6.9591
84	0.0002	0.0042	7.8841
90	0.0001	0.0024	8.7136
95	0.0000	0.0011	9.7742

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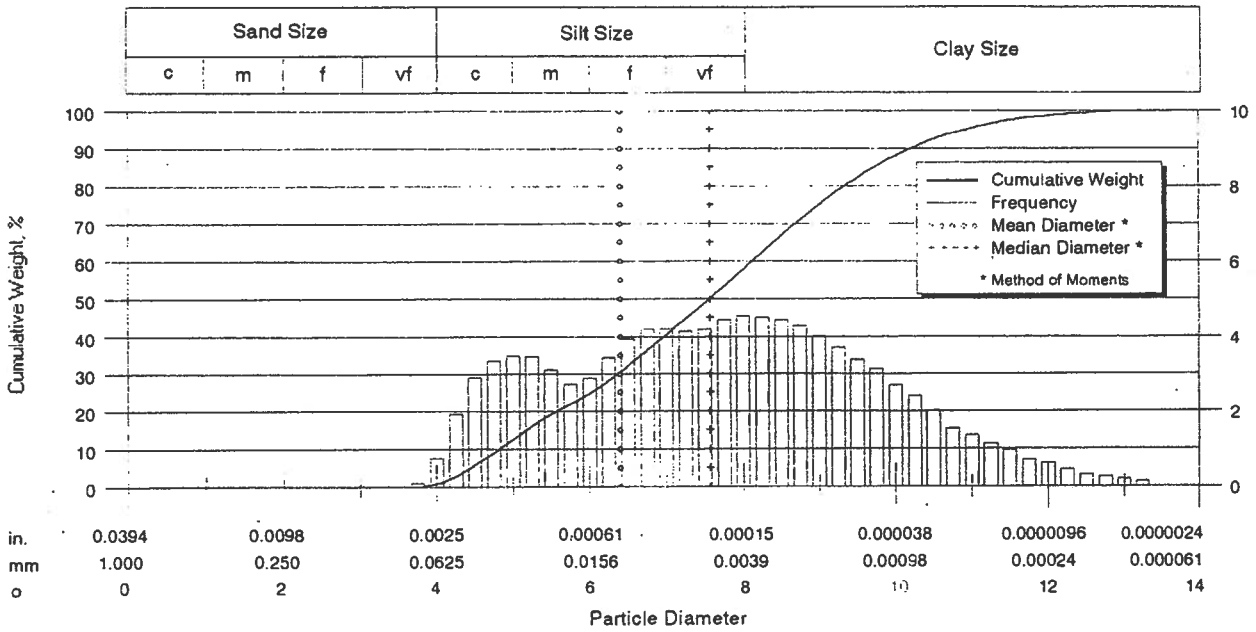
CORE LABORATORIES

Company	CORE LAB. - AURORA	Sample	M16-60-300	File Number	57111-95334
I.D.	954427-14	Proj.	Magma Florence	Date	11-OCT-95
County		State		Analysts	GC

Laser Particle Size Analysis



Particle Size Distribution

	[U.S. Sieve]	Diameter [in]	[mm]	[phi]	Weight, % [Inc.]	[Cum.]
Coarse Sand	20	0.0331	0.84	0.25	0.00	0.00
	25	0.0280	0.71	0.50	0.00	0.00
	30	0.0232	0.59	0.75	0.00	0.00
	35	0.0197	0.50	1.00	0.00	0.00
Medium Sand	40	0.0165	0.42	1.25	0.00	0.00
	45	0.0138	0.35	1.50	0.00	0.00
	50	0.0118	0.30	1.75	0.00	0.00
	60	0.0098	0.25	2.00	0.00	0.00
Fine Sand	70	0.0083	0.210	2.25	0.00	0.00
	80	0.0070	0.177	2.50	0.00	0.00
	100	0.0059	0.149	2.75	0.00	0.00
	120	0.0049	0.125	3.00	0.00	0.00
Very Fine Sand	140	0.0041	0.105	3.25	0.00	0.00
	170	0.0035	0.088	3.50	0.00	0.00
	200	0.0029	0.074	3.75	0.09	0.09
	230	0.0025	0.063	4.00	0.76	0.85
Silt	270	0.0021	0.053	4.25	1.91	2.76
	325	0.0017	0.044	4.50	2.92	5.68
	400	0.0015	0.037	4.75	3.33	9.01
	450	0.0012	0.031	5.00	3.50	12.51
	500	0.0010	0.025	5.32	4.38	16.89
	635	0.0008	0.020	5.64	3.74	20.63
		0.00061	0.0156	6.00	4.05	24.68
		0.00031	0.0078	7.00	15.78	40.46
		0.00015	0.0039	8.00	17.31	57.77
Clay		0.000079	0.0020	9.00	17.24	75.01
		0.000039	0.00098	10.0	12.88	87.89
		0.000019	0.00049	11.0	7.32	95.21
		0.0000094	0.00024	12.0	3.40	98.61
		0.0000047	0.00012	13.0	1.26	99.87
		0.0000039	0.00010	13.3	0.13	100.00

Sorting Statistics

Parameter	[Moment]	[Trask]	[Inman]	[Folk]
Mean, in	0.0005	0.0002	0.0002	0.0002
Mean, mm	0.0119	0.0055	0.0057	0.0056
Mean, phi	6.3990	7.5125	7.4508	7.4897
Median, in	0.0002	0.0002	0.0002	0.0002
Median, mm	0.0053	0.0053	0.0053	0.0053
Median, phi	7.5672	7.5674	7.5674	7.5674
Std Deviation, in	0.0006	0.0167	0.0085	0.0092
Std Deviation, mm	0.0147	0.4287	0.2178	0.2354
Std Deviation, phi	6.0841	1.2221	2.1988	2.0870
Skewness	1.7450	0.9469	0.0621	-0.0056
Kurtosis	2.4310	0.2755	0.4821	0.8983
Mode, mm	0.0036			
95% Confidence	0.0090			
Limits, mm	0.0147			
Variance, mm2	0.0002			
Coef. of Variance, %	124.40			

Percentiles [Weight, %]	Particle Diameter [in]	[mm]	[phi]
5	0.0018	0.0459	4.4450
10	0.0014	0.0354	4.8196
16	0.0010	0.0262	5.2520
25	0.0006	0.0154	6.0256
50	0.0002	0.0053	7.5674
75	0.0001	0.0020	8.9994
84	0.0000	0.0012	9.6496
90	0.0000	0.0008	10.2156
95	0.0000	0.0005	10.9629

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CORE LABORATORIES

SUMMARY OF HYDRAULIC CONDUCTIVITY
CORE LABORATORIES, AURORA
PROJECT NAME: MAGMA - FLORENCE

Sample I.D.	DEPTH, feet	Hydraulic Conductivity, md	Hydraulic Conductivity, cm/sec
P1 - 80 - 80	NA	32.2	2.76×10^{-5}
P2 - 90 - 45	NA	1.2	1.07×10^{-6}
B2 - 55	NA	0.618	5.30×10^{-7}
B3 - 45	NA	8.1	6.94×10^{-6}
B4 - 80	NA	0.613	5.26×10^{-7}
M16 - GU - 300	NA	0.0058	5.00×10^{-9}

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HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

Project Name	Claridge - Hanlon #91100A	***Project No.***	106200-19
Client Name	Geosystems Analysis, Inc.	***Date Received***	8/11/2011
Client Address		***Date Tested***	8/11/2011
		Date Issued	8/18/2011
Boring No.	CMP-11-03		
Sample Type	Undisturbed		
Sample Depth	283-288 feet		
Sample Description	Clay, very stiff, brown to red brown		

	Before	***After***	***Units***
Moisture Content, w	28.6	29.2	*%*
Dry Unit Weight, Dd	94.8	95.0	*pcf*
Height, L	1.81	1.80	*inches*
Diameter, d	3.19	3.19	*inches*
Degree of Saturation, Sr	97.2	99.5	*%*

Chamber Pressure:	83.3	**psi**
Applied Pressure (influent):	78.3	**psi**
Applied Pressure (effluent):	75.0	**psi**
Consolidation Pressure:	5	**psi**

Test Number		***Temp. Deg. C***	***Time (sec)***	***Influent Reading***	***Effluent Reading***	***Hydraulic Conductivity (cm/sec)*** **@ Test Temp.**	***Hydraulic Conductivity (cm/sec)*** **@ 20° C**	***Hydraulic Gradient h/L***
1	Start	22.4	0	7.60	19.85			
	Finish	22.2	59220	8.20	19.30	4.52E-09	4.3E-09	53.09
2	Start	22.2	59220	8.20	19.30			
	Finish	22.5	90480	8.50	19.00	4.49E-09	4.3E-09	52.96
3	Start	22.5	90480	8.50	19.00			
	Finish	22.6	140400	9.05	18.55	4.70E-09	4.4E-09	52.73
4	Start	22.6	140400	9.05	18.55			
	Finish	22.7	229140	10.00	17.70	4.79E-09	4.5E-09	52.33

Average Hydraulic Conductivity "k" (cm/sec) @ Test Temp.	4.6E-09	
Average Hydraulic Conductivity "k" (cm/sec) @ 20° C		**4.4E-09**

Assumed Specific Gravity, SG 2.75

Area of Tube (cm^2), a (Pipette) 0.9721

Permeant : Deaired Tap Water

Formulas:

Permeability (Falling Head-Rising Tailwater Test)

k = [(a*L/(2*A*t)] ln(ho/h1)

k = Hydraulic Conductivity (cm/sec)

a = Area of Tube (cm^2)

L = Height or Length of Sample (cm)

A = Area of Sample (cm^2)

t = Time of Test Interval (sec)

h_o = Height of Head at Start of Test Interval (cm)

h_1 = Height of Head at End of Test Interval (cm)

Degree of Saturation

Sr = w*SG/e Dd = (SG/1+e)Dw

Therefore:

Sr = (w*SG)/((SG*Dw/Dd)-1)

Sr = Degree of Saturation (%)

w = Moisture Content (%)

SG = Specific Gravity

e = Void Ratio

Dd =Dry Unit Weight (pcf)

Dw = Unit Weight of Water (62.4 pcf)

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HYDRAULIC CONDUCTIVITY TEST RESULTS (ASTM D5084)

Project Name	Claridge - Hanlon #91100A	***Job No.***	106200-19
Client Name	Geosystems Analysis, Inc.	***Date Received***	8/11/2011
Client Address		***Date Tested***	8/11/2011
		Date Issued	8/18/2011
Boring No.	CMP-11-03		
Sample Type	Undisturbed		
Sample Depth	283-288 feet		
Sample Description	Clay, very stiff, brown to red brown		

0.0

	Deviation from Average	Change in Influent(ml)	Change in Effluent (ml)	Ratio Effluent/Influent Change
Test1	0.98	0.58	-0.53	0.92
Test 2	0.97	0.29	-0.29	1.00
Test 3	1.02	0.53	-0.44	0.82
Test 4	1.04	0.92	-0.83	0.89
	ok if within 0.75-1.25			**ok if within 0.75-1.25**

1.0231881

0.022923341

HYDRAULIC CONDUCTIVITY TEST REPORT

ASTM D5084

Project Name	Claridge - Hanlon #91100A	***Project No.***	106200-19
Client Name	Geosystems Analysis, Inc.	***Date Received***	8/11/2011
Client Address		***Date Tested***	8/11/2011
		Date Issued	8/18/2011
Boring No.	CMP-11-03		
Sample Type	Undisturbed		
Sample Depth	292.5-297.5 feet		
Sample Description	Clay, very stiff, brown to red brown		

	Before	***After***	***Units***
Moisture Content, w	28.8	28.0	*%*
Dry Unit Weight, Dd	95.9	96.6	*pcf*
Height, L	1.95	1.95	*inches*
Diameter, d	3.16	3.16	*inches*
Degree of Saturation, Sr	100.4	99.0	*%*

Chamber Pressure:	83.5	**psi**
Applied Pressure (influent):	78.5	**psi**
Applied Pressure (effluent):	75.0	**psi**
Consolidation Pressure:	5	**psi**

Test Number		***Temp. Deg. C***	***Time (sec)***	***Influent Reading***	***Effluent Reading***	***Hydraulic Conductivity (cm/sec)*** **@ Test Temp.**	***Hydraulic Conductivity (cm/sec)*** **@ 20° C**	***Hydraulic Gradient h/L***
1	Start	22.4	0	7.60	19.70			
	Finish	22.2	59220	8.15	19.20	4.22E-09	4.0E-09	51.94
2	Start	22.2	59220	8.15	19.20			
	Finish	22.5	90480	8.50	18.85	5.35E-09	5.1E-09	51.80
3	Start	22.5	90480	8.50	18.85			
	Finish	22.6	140400	8.95	18.40	4.32E-09	4.1E-09	51.61
4	Start	22.6	140400	8.95	18.40			
	Finish	22.7	229140	9.80	17.60	4.48E-09	4.2E-09	51.27

Average Hydraulic Conductivity "k" (cm/sec) @ Test Temp.	4.6E-09	
Average Hydraulic Conductivity "k" (cm/sec) @ 20° C		**4.3E-09**

Assumed Specific Gravity, SG 2.75

Area of Tube (cm^2), a (Pipette) 0.9721

Permeant : Deaired Tap Water

Formulas:

Permeability (Falling Head-Rising Tailwater Test)

k = [(a*L/(2*A*t)] ln(ho/h1)

k = Hydraulic Conductivity (cm/sec)

a = Area of Tube (cm^2)

L = Height or Length of Sample (cm)

A = Area of Sample (cm^2)

t = Time of Test Interval (sec)

h_o = Height of Head at Start of Test Interval (cm)

h_1 = Height of Head at End of Test Interval (cm)

Degree of Saturation

Sr = w*SG/e Dd = (SG/1+e)Dw

Therefore:

Sr = (w*SG)/((SG*Dw/Dd)-1)

Sr = Degree of Saturation (%)

w = Moisture Content (%)

SG = Specific Gravity

e = Void Ratio

Dd =Dry Unit Weight (pcf)

Dw = Unit Weight of Water (62.4 pcf)

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HYDRAULIC CONDUCTIVITY TEST RESULTS (ASTM D5084)

Project Name	Claridge - Hanlon #91100A	***Job No.***	106200-19
Client Name	Geosystems Analysis, Inc.	***Date Received***	8/11/2011
Client Address		***Date Tested***	8/11/2011
		Date Issued	8/18/2011
Boring No.	CMP-11-03		
Sample Type	Undisturbed		
Sample Depth	292.5-297.5 feet		
Sample Description	Clay, very stiff, brown to red brown		

0.0

	Deviation from Average	Change in Influent(ml)	Change in Effluent (ml)	Ratio Effluent/Influent Change
Test1	0.92	0.53	-0.49	0.91
Test 2	1.16	0.34	-0.34	1.00
Test 3	0.94	0.44	-0.44	1.00
Test 4	0.98	0.83	-0.78	0.94
	ok if within 0.75-1.25			**ok if within 0.75-1.25**

1.0231881

0.022923341

EXHIBIT B-2

Data Report for Initial Interpretation of the Hydraulic Tests at the Florence Mine Site

APPENDIX E

CURRENT INVESTIGATION AQUIFER TEST ANALYSIS INFORMATION

Table E-1 Summary of Aquifer Test Field Program

Pumping Well	Observation Wells	Screened Interval (ft bgs)	Pump Rate (gpm)	Maximum Drawdown (ft)	Hydraulic Conductivity (ft/day)	Date Test Performed	Comments
PW7-1		540 - 880	38	109.0	0.2	6/16/95 to 6/22/95	Irrigation wells BIA-10B & WW-3 pumped during test.
	OB7-1	540 - 880		67.9	0.1		
	O3-GL	325 - 365		8.7	N/A		
	Corehole OB-1	Not Screened		6.3(3)	N/A		
P5-O		414 - 770	66	51.8	N/A	10/18/95 to 10/24/95	Irrigation wells BIA-10B & BIA-9 pumped during test.
	O5.1-O	674 - 832		29.5	N/A		
	O5.2-O	712 - 771		31.7	N/A		
P8.1-O		400 - 580	12	212.7	N/A	9/7/95 to 9/13/95	Irrigation well BIA-9 is pumped during test.
	P8.2-O	396 - 576		4.5	N/A		
	P8-GU	128 - 248		0.49	N/A		
	08-O	401 - 579		72.6	N/A		
	08-GU	133 - 251		0	N/A		
P8-GU		128 - 248	85	6.9	61.3	9/18/95 to 9/22/95	Irrigation wells BIA-10B & BIA-9 pumped during test.
	P8.1-O	400 - 580		9.2	N/A		
	P8.2-O	396 - 576		9.5	N/A		
	O8-O	401 - 579		8.9	N/A		
	O8-GU	133 - 251		6.9	N/A		
P12-O		440 - 940	64	35.5	0.4	6/1/95 to 6/8/95	Irrigation well WW-3 is pumped during test.
	O12-O	434 - 939		42.8	0.6		
	O12-GL	125 - 165		N/A(4)	N/A		
P13.1-O		772 - 1,449	46	93.1	N/A	10/9/95 to 10/16/95	No irrigation wells pumped during test.
	P13.2-O	781 - 1,379		19.2	N/A		
	P13-GL	690 - 760		0	N/A		
	O13-O	770 - 1,393		4.4	N/A		
P15-O		580 - 1,300	59	40.9	N/A	9/29/95 to 10/5/95	Irrigation wells BIA-10B & BIA-9 pumped during test.
	O15-O	632 - 1,296		22.4	N/A		
	O15-GL	421 - 481		1.3	N/A		

Table E-1 Summary of Aquifer Test Field Program

Pumping Well	Observation Wells	Screened Interval (ft bgs)	Pump Rate (gpm)	Maximum Drawdown (ft)	Hydraulic Conductivity (ft/day)	Date Test Performed	Comments
P19.1-O		402 - 600	24	155.2	0.3	7/3/95 to 7/6/95	Irrigation wells BIA-10B & WW-3 pumped during test.
	P19.2-O	404 - 602		25.7	0.2		
	019-O	410 - 608		16.9	0.2		
	019-GL	375 - 435		2.4	N/A		
	Corehole 138	Not Screened		0	N/A		
P28.1-O		395 - 495	30	7.9	7.7	8/15/95 to 8/21/95	Low pump rate test. No irrigation wells pumped during test.
	P28.2-O	398 - 497		5.4	N/A		
	P28-GL	279 - 309		1.03	N/A		
	028.1-O	394 - 494		4.7	N/A		
	028.2-S	454 - 494		3.2	N/A		
	028-GL	277 - 307		1.7	N/A		
P28.1-O		395 - 495	85	50.4	3.6	9/7/95 to 9/13/95	High pump rate test conducted. Irrigation well BIA-9 pumped during test.
	P28.2-O	398 - 497		28.3	2.7		
	P28-GL	279 - 309		7.1	N/A		
	028.1-O	394 - 494		22.8	N/A		
	028.2-S	454 - 494		14.2	N/A		
	028-GL	277 - 307		10.1	N/A		
P28-GL		279 - 309	75	115.2	8.3	9/18/95 to 9/28/95	Irrigation wells BIA-10B & BIA-9 pumped during test.
	P28.1-O	395 - 495		11.7	N/A		
	P28.2-O	398 - 497		11.6	N/A		
	O28.1-O	394 - 494		11.9	N/A		
	O28.2-S	454 - 494		12.2	N/A		
	O28-GL	277 - 307		18.8	25.5		
P28.2-O		398 - 497	80	33.8	3.1	10/2/95 to 10/5/95	Irrigation wells BIA-10B & BIA-9 pumped until 10/5/95.
	P28.1-O	395 - 495		2.3	N/A		
	P28-GL	279 - 309		8.7	N/A		
	O28.1-O	394 - 494		18.5	3.0		
	O28.2-S	454 - 494		15.4	N/A		
	O28-GL	277 - 307		11.9	N/A		

Table E-1 Summary of Aquifer Test Field Program

Pumping Well	Observation Wells	Screened Interval (ft bgs)	Pump Rate (gpm)	Maximum Drawdown (ft)	Hydraulic Conductivity (ft/day)	Date Test Performed	Comments
P39-O		471 - 826	55	108	0.3	5/19/95 to	No irrigation wells pumped during test.
	O39-O	474 - 890		23	0.3	5/21/95	
P49-O		808 - 1,222	40	298	N/A	10/11/95 to	No irrigation wells pumped during test.
	O49-O	812 - 1,227		091	N/A	10/16/95	
	O49-GL	661 - 721		0.47	N/A		
M2-GU		198 - 237	10	0.38	N/A	7/25/95 to	Short duration test[1]. Irrigation wells BIA-10B & England No. 3 pumped during test.
	M3-GL	298 - 338		0	N/A	7/26/95	
	M4-O	405 - 465		0	N/A		
	M5-S	516 - 576		0	N/A		
M3-GL		298 - 338	10	5.6	15.9	7/26/95 to	Short duration test[1]. Irrigation well England No. 3 pumped during test.
	M2-GU	198 - 237		0	N/A	7/27/95	
	M4-O	405 - 465		0.58	N/A		
	M5-S	516 - 576		0	N/A		
M4-O		405 - 465	15	190.4	0.6	7/28/95 to	Short duration test[1]. Irrigation well England No. 3 pumped during test.
	M2-GU	198 - 237		0.445	N/A	7/30/95	
	M3-GL	298 - 338		1.09	14.8		
	M5-S	516 - 576		0	N/A		
M10-GU		218 - 258	15	0.508	N/A	7/25/95 to	Short duration test[1]. Irrigation wells BIA-10B & England No.3 pumped during test.
	M11-GL	290 - 330		0.222	N/A	7/29/95	
	M12-O	420 - 480		0.318	N/A		
	M13-S	851 - 911		0	N/A		
M11-GL		290 - 330	15	16.7	N/A	7/29/95 to	Short duration test[1]. Irrigation well England No. 3 pumped during test.
	M10-GU	218 - 258		4.5	N/A	7/31/95	
	M12-O	420 - 480		4.6	N/A		
	M13-S	851 - 911		0	N/A		

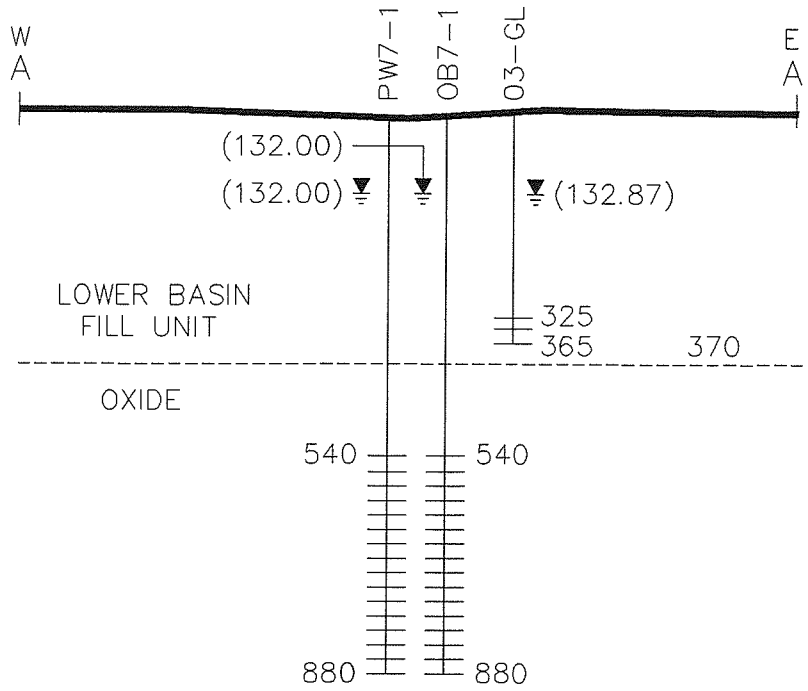
Table E-1 Summary of Aquifer Test Field Program

Pumping Well	Observation Wells	Screened Interval (ft bgs)	Pump Rate (gpm)	Maximum Drawdown (ft)	Hydraulic Conductivity (ft/day)	Date Test Performed	Comments
M12-O		420 - 480	14	19.5	N/A	7/31/95 to 8/2/95	Short duration test[1]. Irrigation wells BIA-10B & England No. 3 pumped during test.
	M10-GU	218 - 258		1.36	N/A		
	M11-GL	290 - 330		3.08	N/A		
	M13-S	851 - 911		0	N/A		
M18-GU		178 - 218	10	7.7	19.6	8/8/95 to 8/9/95	Short duration test[1].
	M1-GL	315 - 355		0	N/A		
M1-GL		315 - 355	10	5.4	17.3	8/11/95 to 8/12/95	Short duration test[1].
	M18-GU	178 - 218		0.157	N/A		
M15-GU		554 - 594	10	47.5	2.6	8/8/95 to 8/9/95	Short duration test[1].
	M14-GL	778 - 838		0	N/A		
M14-GL		778 - 838	10	30.1	1.7	8/11/95 to 8/12/95	Short duration test[1].
	M15-GU	554 - 594		1.56	N/A		
WW-3[2]		240 - 930	2000	N/A	N/A	8/23/95 to 8/29/95	Large scale aquifer test. No other irrigation well pumped during test.
	OB7-1	540 - 880		13.3	N/A		
	O3-GL	325 - 365		12.5	N/A		
	O12-O	434 - 939		23.2	N/A		
	O12-GL	125 - 165		29.9	N/A		
	P15-O	580 - 1,300		32.7	N/A		
	O15-O	632 - 1,296		26.7	N/A		
	O15-GL	421 - 481		7.4	N/A		
	O19-O	410 - 608		5.19	N/A		
	O19-GL	375 - 435		5.3	N/A		
	P28.1-O	395 - 495		2.1	N/A		
	P28.2-O	398 - 497		2.05	N/A		
	O28.1-O	394 - 494		2.06	N/A		
	028-GL	277 - 307		1.9	N/A		
	M14-GL	778 - 838		10.7	N/A		
	M15-GL	554 - 594		9.9	N/A		
	AIRSHAFT	Not Screened		5.0	N/A		

Table E-1 Summary of Aquifer Test Field Program

Pumping Well	Observation Wells	Screened Interval (ft bgs)	Pump Rate (gpm)	Maximum Drawdown (ft)	Hydraulic Conductivity (ft/day)	Date Test Performed	Comments
BIA-9[2]		80 - 494	2350	N/A	N/A	8/29/95 to 9/6/95	Large scale aquifer test. BIA-10B pumped during test.
	OB7-1	540 - 880		21.5	N/A		
	O3-GL	325 - 365		26.2	N/A		
	O12-O	434 - 939		10.3	N/A		
	O12-GL	125 - 165		10.2	N/A		
	P15-O	580 - 1,300		10.3	N/A		
	O15-O	632 - 1,296		5.3	N/A		
	O15-GL	421 - 481		4.7	N/A		
	O19-O	410 - 608		4.3	N/A		
	O19-GL	375 - 435		3.9	N/A		
	P28.1-O	395 - 495		4.1	N/A		
	P28.2-O	398 - 497		4.1	N/A		
	O28.1-O	394 - 494		4.3	N/A		
	028-GL	277 - 307		4.4	N/A		
	M14-GL	778 - 838		6.3	N/A		
	M15-GL	554 - 594		3.9	N/A		
	AIRSHAFT	Not Screened		11.6	N/A		

[1] Short duration tests performed at the monitoring well clusters. Each test was performed by pumping each well in the cluster for approximately 24 hours (Except sulfide wells).
[2] Regional tests performed using existing high discharge irrigation wells.
[3] Drawdown due to irrigation well not test pumping well.
[4] No information available, transducer malfunctioned.
ft bgs - feet below ground surface
ft/day - feet per day
gpm - gallons per minute
See section 2.3.5 (II) for discussion of aquifer tests.
Additional Aquifer test data is presented in Appendix E (II).



EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

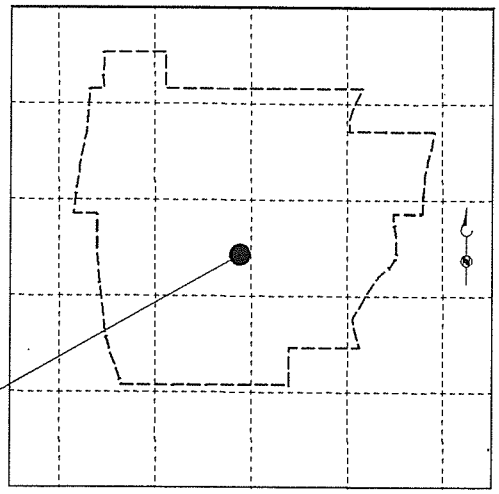
WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 880 — SCREENED INTERVAL

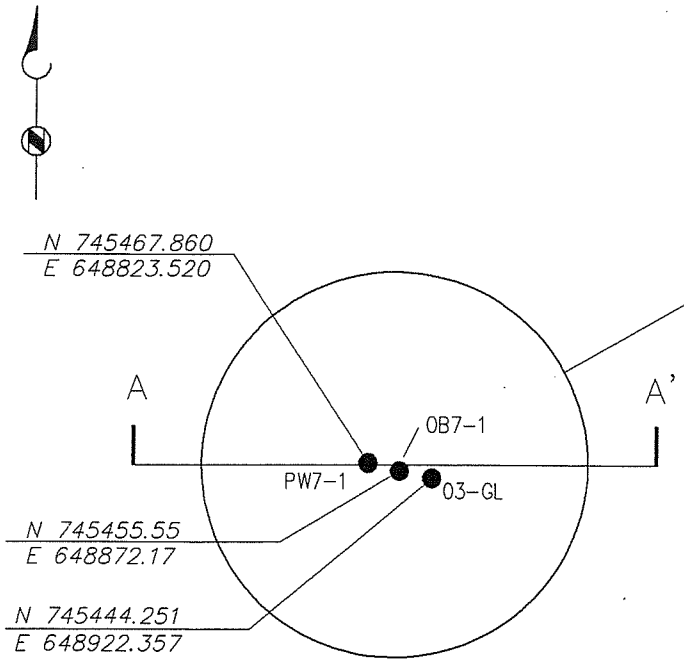
SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

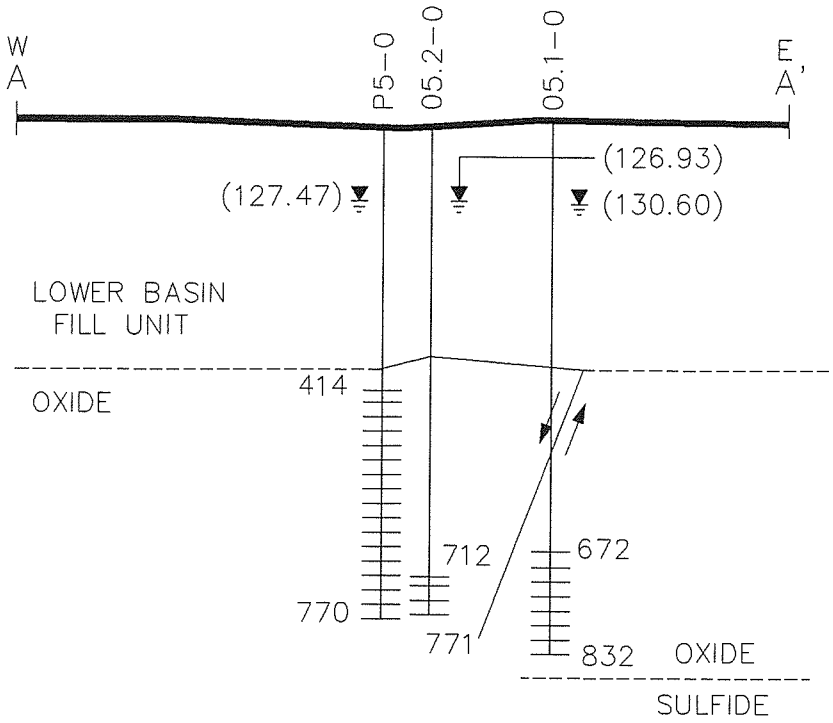
Figure E-1 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER NO. 3

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

E-1_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

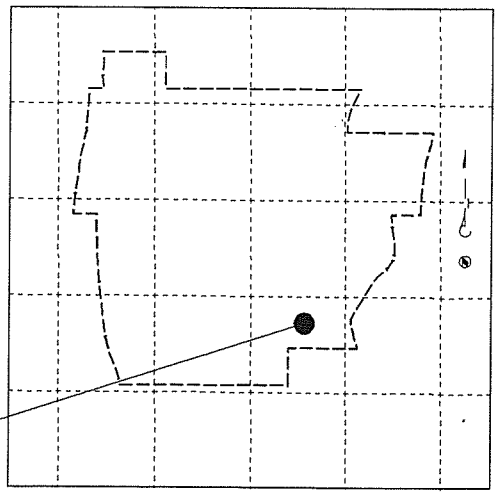
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

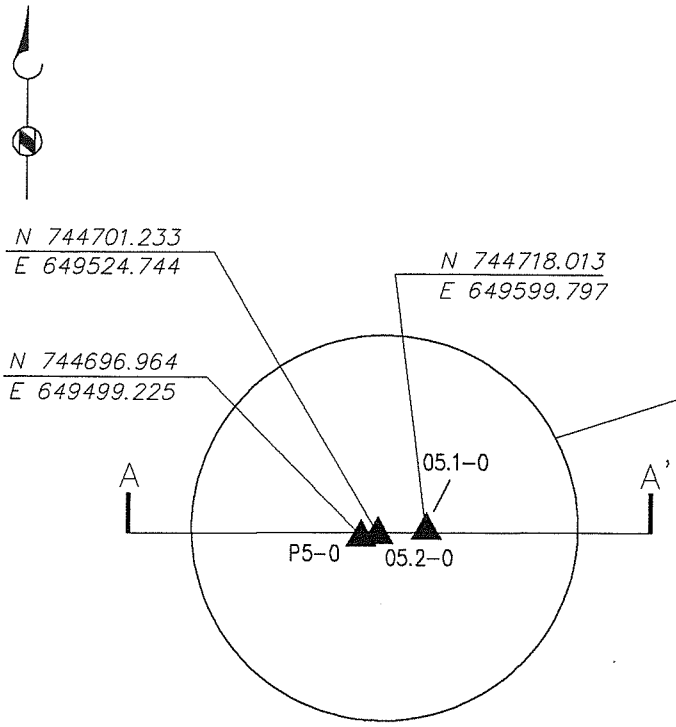
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 832 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

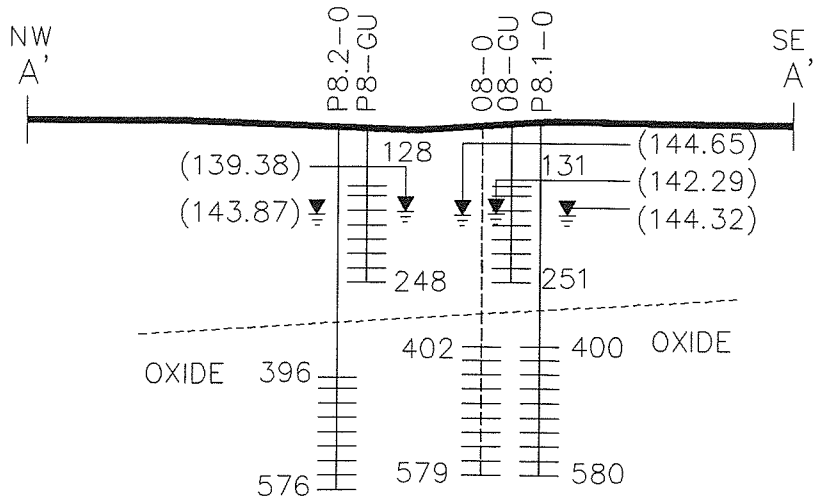
Figure E-2 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 5

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

E-2_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

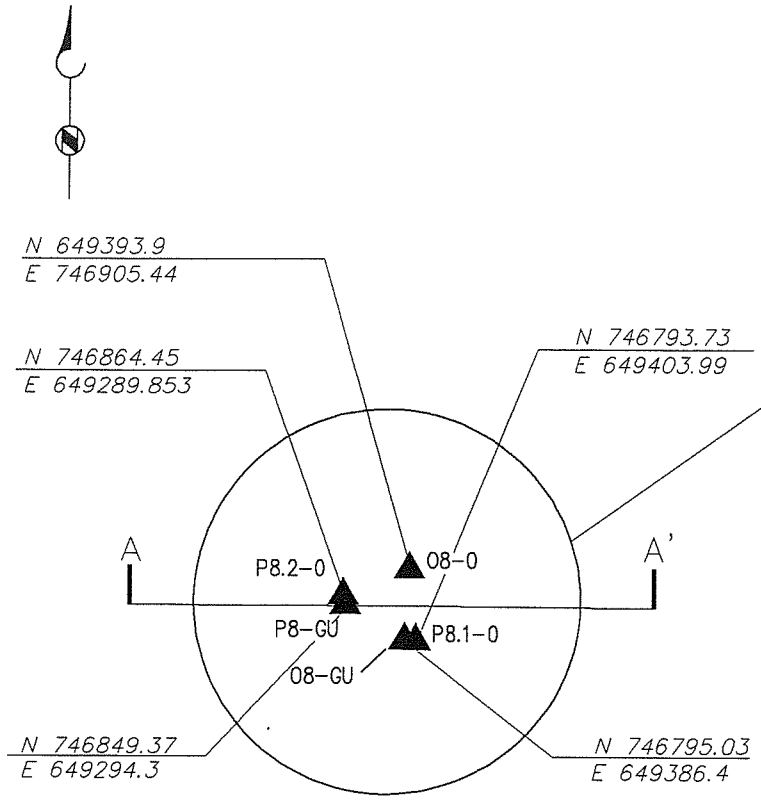
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES
(AQUIFER COMPONENT SCREEN)

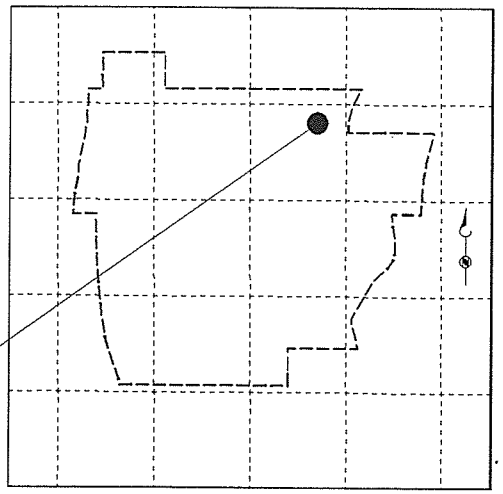
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 550 — SCREENED INTERVAL



WELL PLAN VIEW

Approximate Scale: 1"= 300'



WELL LOCATION MAP

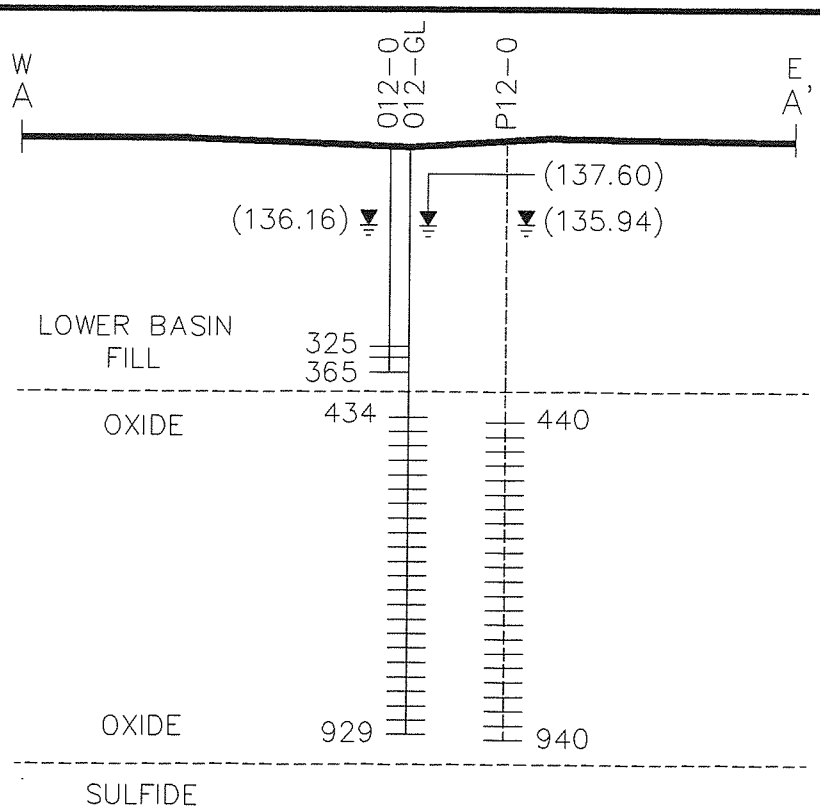
Approximate Scale: 1"= 2000'

Figure E-3 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 8

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

E-3_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

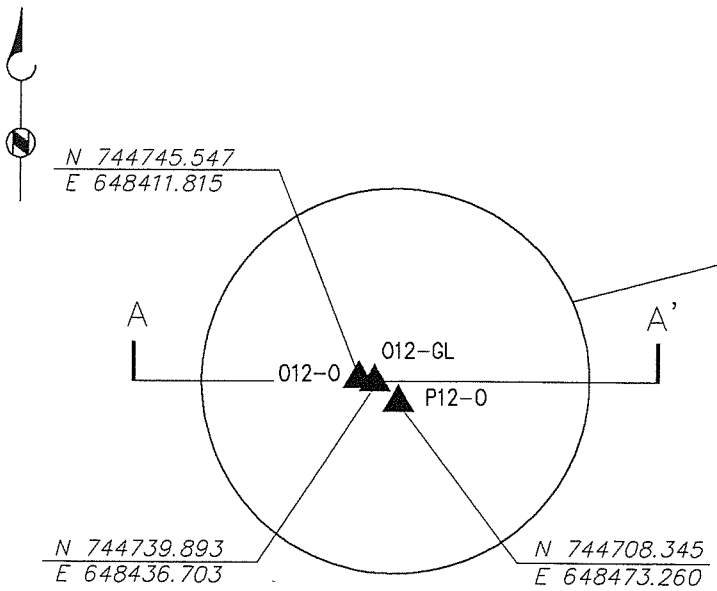
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

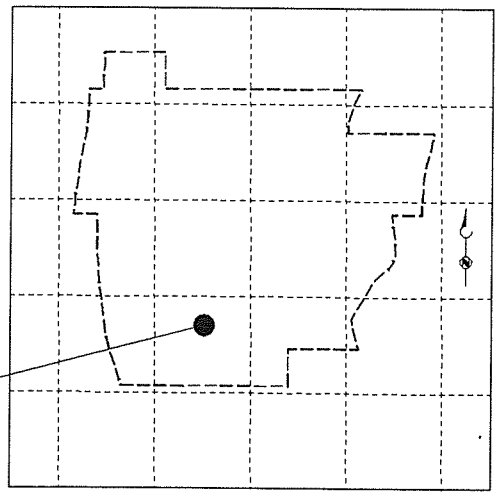
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 940 — SCREENED INTERVAL



WELL PLAN VIEW

Approximate Scale: 1"= 300'



WELL LOCATION MAP

Approximate Scale: 1"= 2000'

Figure E-4 (II)

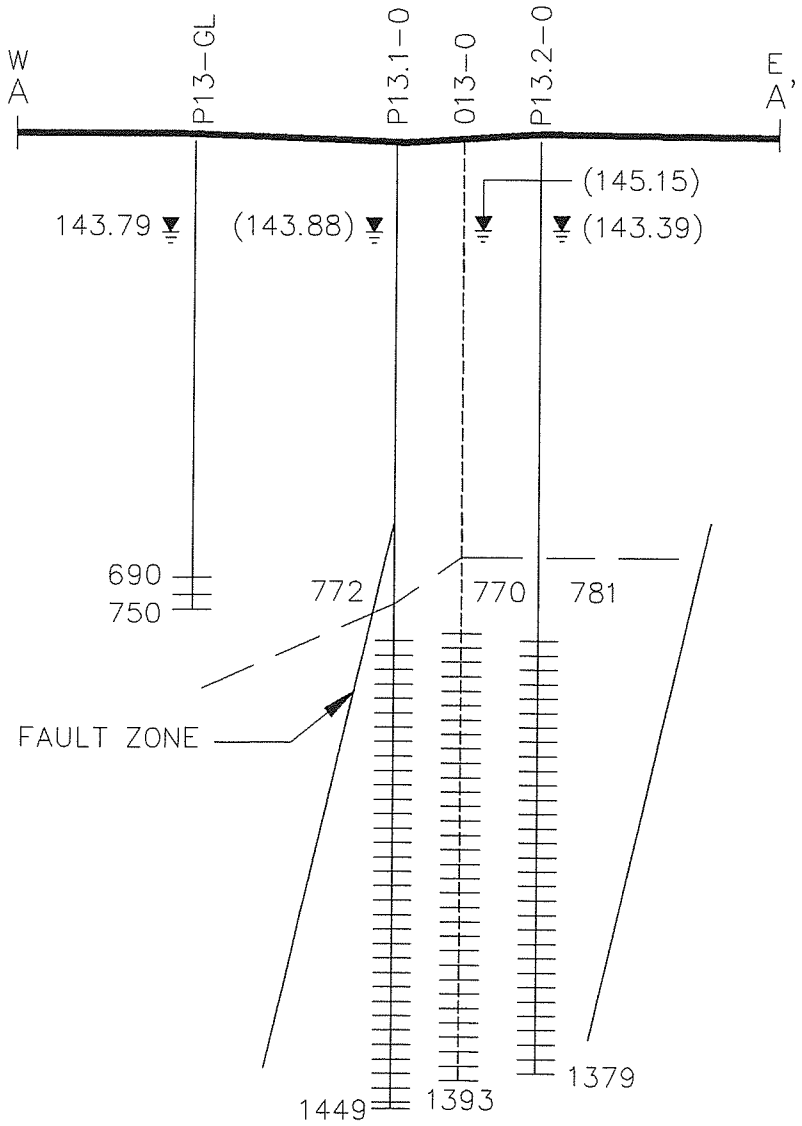
LOCATION SUMMARY AQUIFER TEST CLUSTER 12

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-4_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 600'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

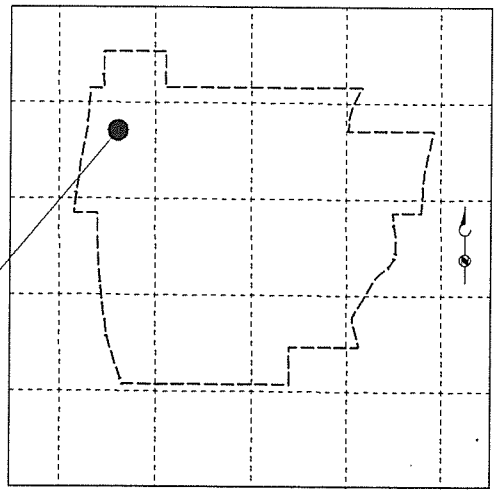
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

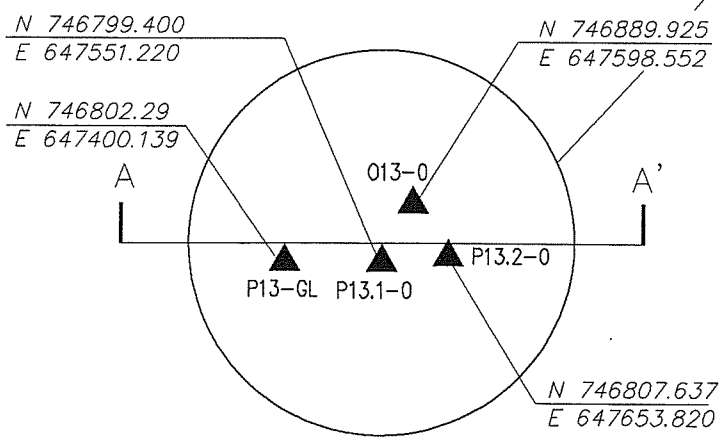
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 1450 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

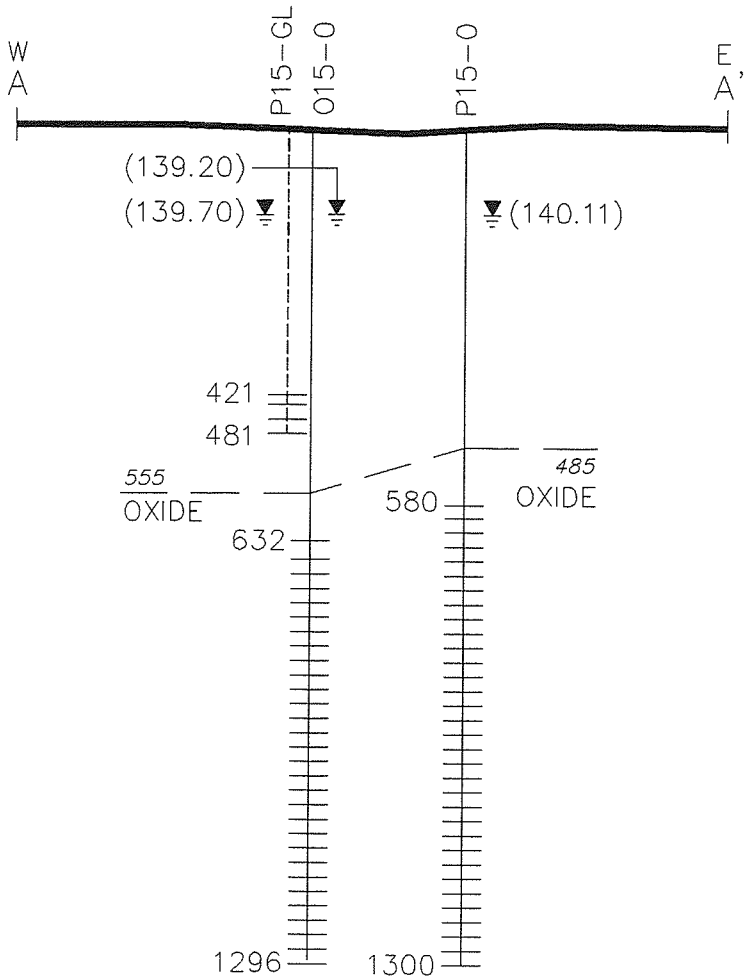
Approximate Scale: 1"= 300'

Figure E-5 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 13

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

E-5_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

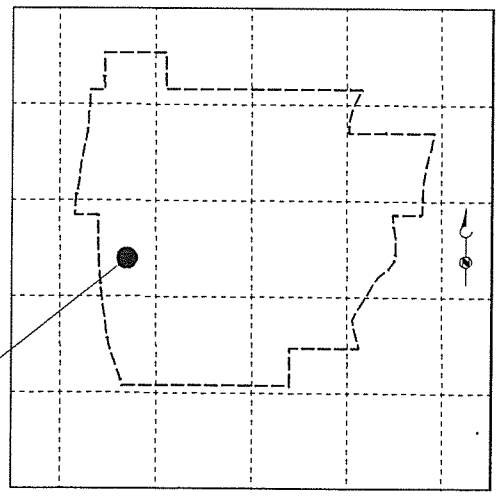
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

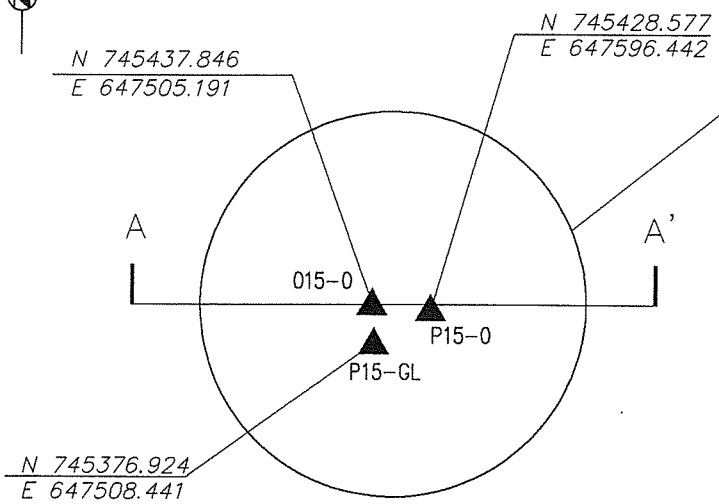
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 610 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

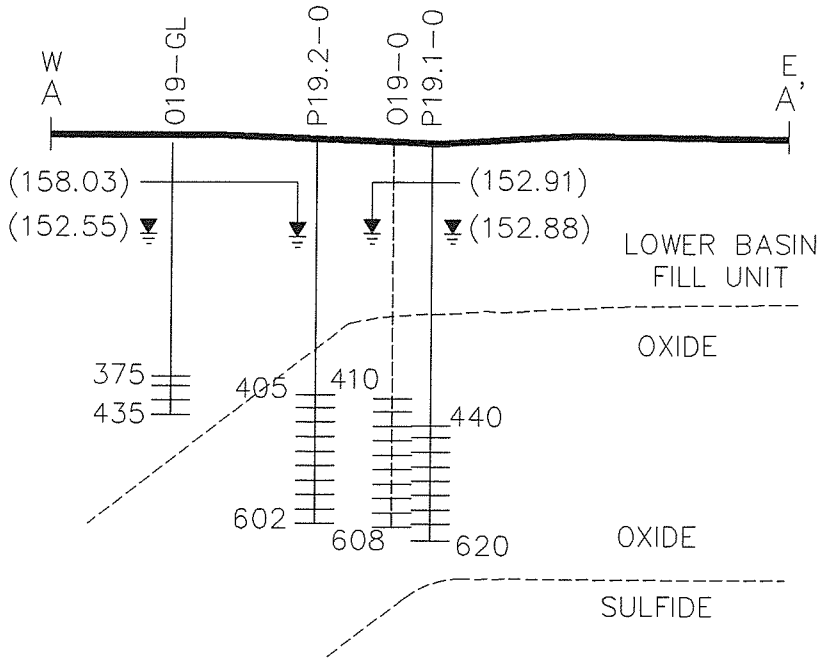
BROWN AND CALDWELL

Figure E-6 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 15

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-6_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

WELL PREFIXES

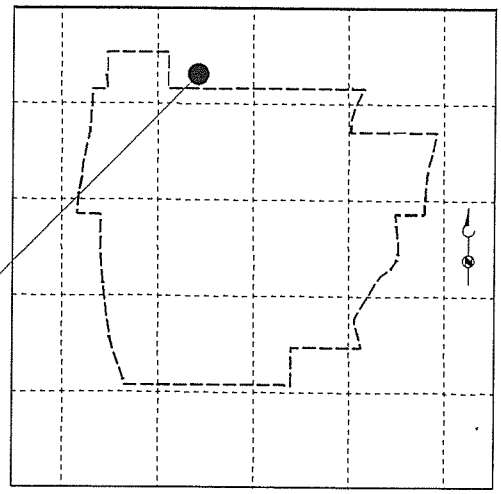
PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES
(AQUIFER COMPONENT SCREEN)

BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

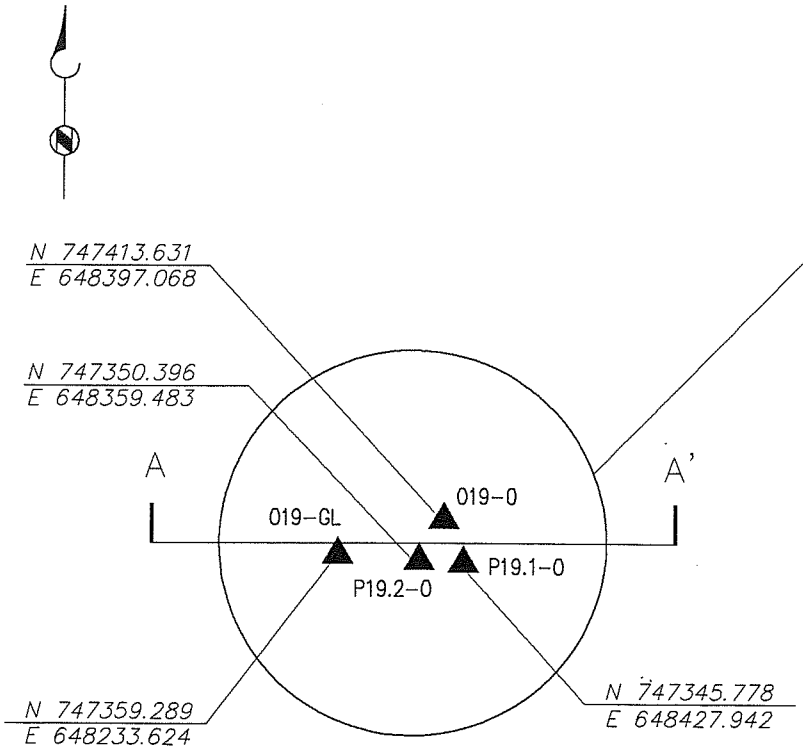
FEET BELOW GROUND SURFACE — 610

SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

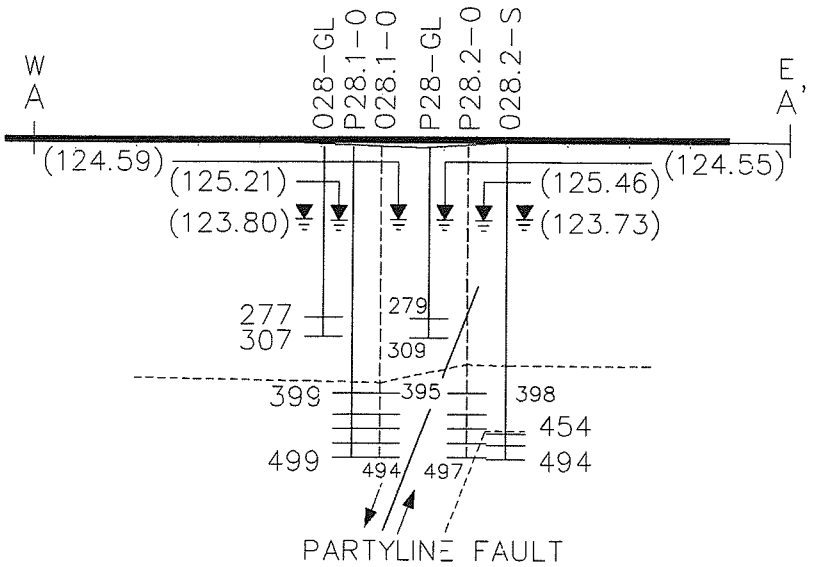
Approximate Scale: 1"= 300'

Figure E-7 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 19

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

E-7.2 12-01-95 DanH



NOTE:
WELLS 028.1-0 AND P28.2-0 ARE SCREENED ACROSS FAULT ZONE.

SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

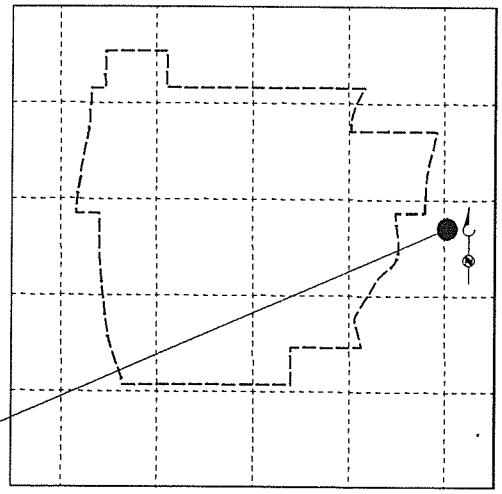
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

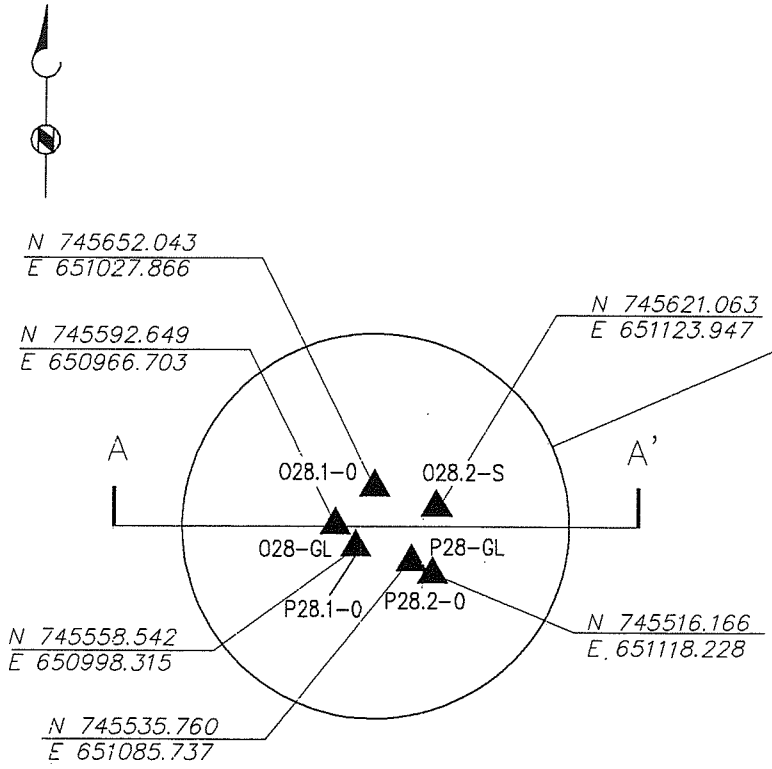
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 494 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

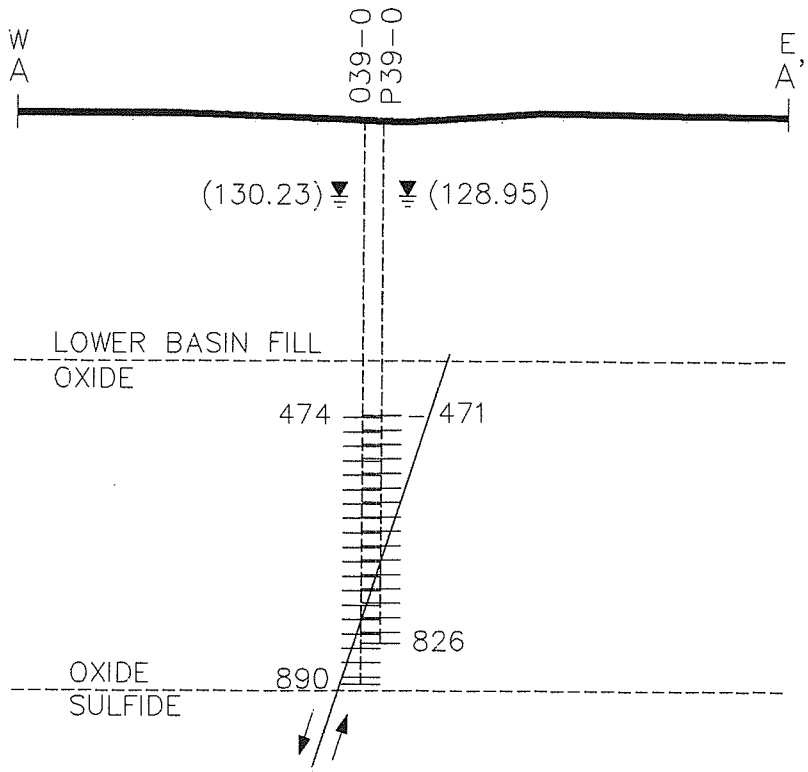
BROWN AND CALDWELL

Figure E-8 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 28

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-8_2 12-01-95 DanH



EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

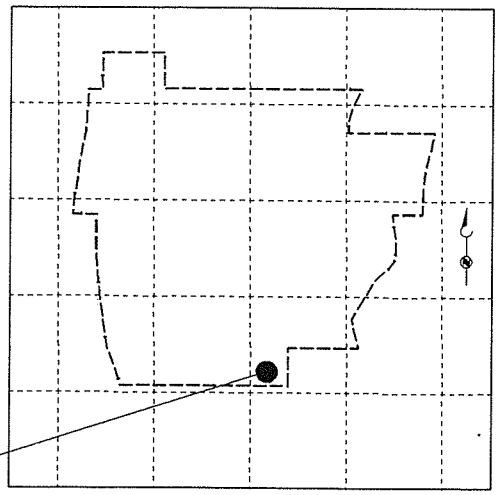
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 610

SCREENED INTERVAL

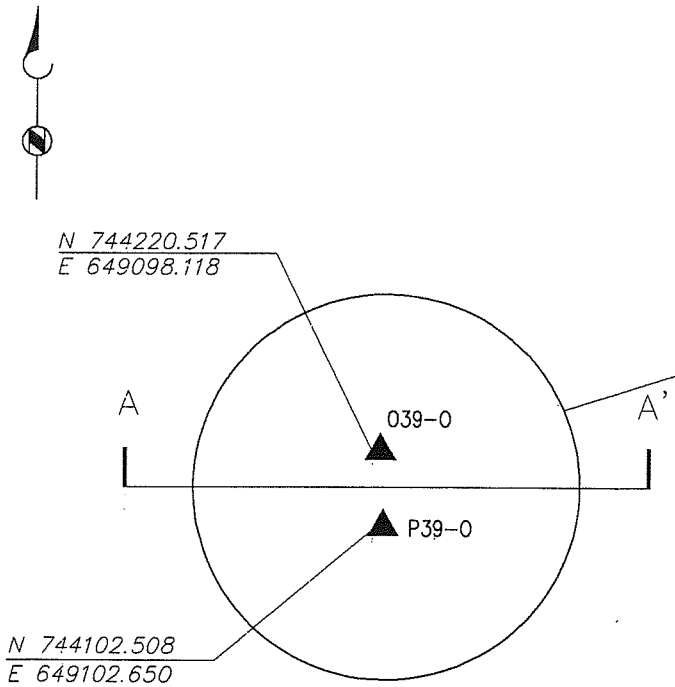
SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

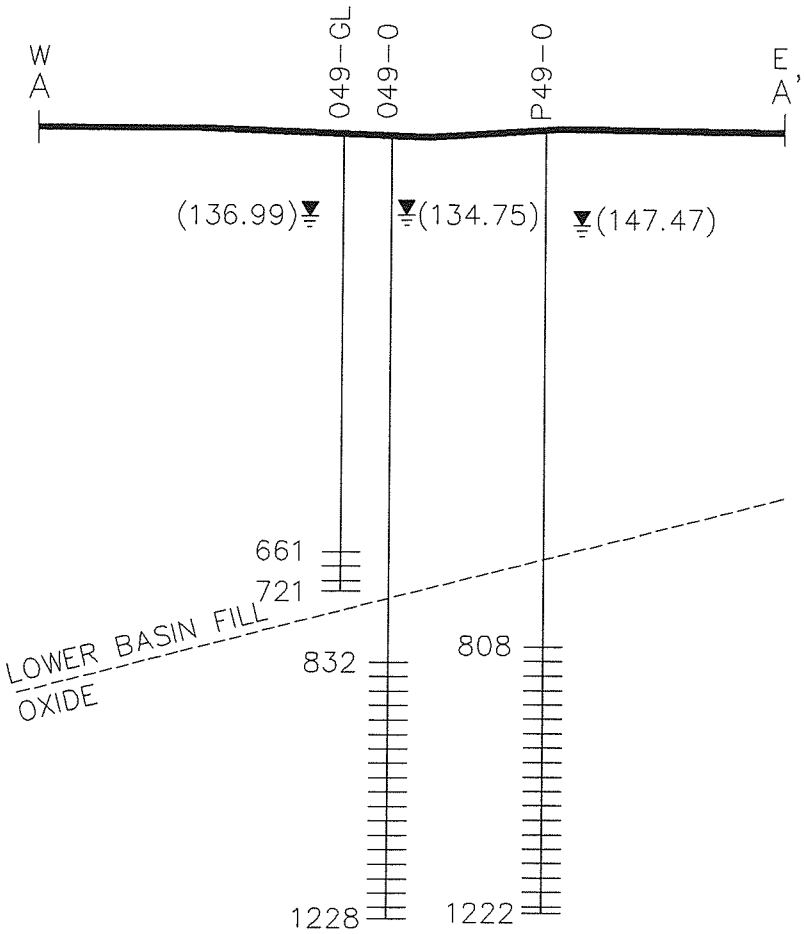
Approximate Scale: 1"= 300'

Figure E-9 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 39

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

E-9_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

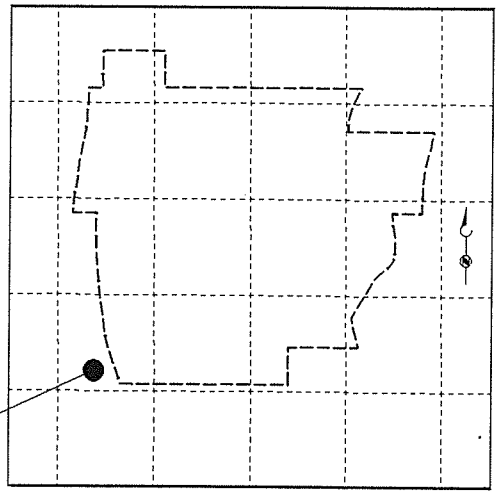
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

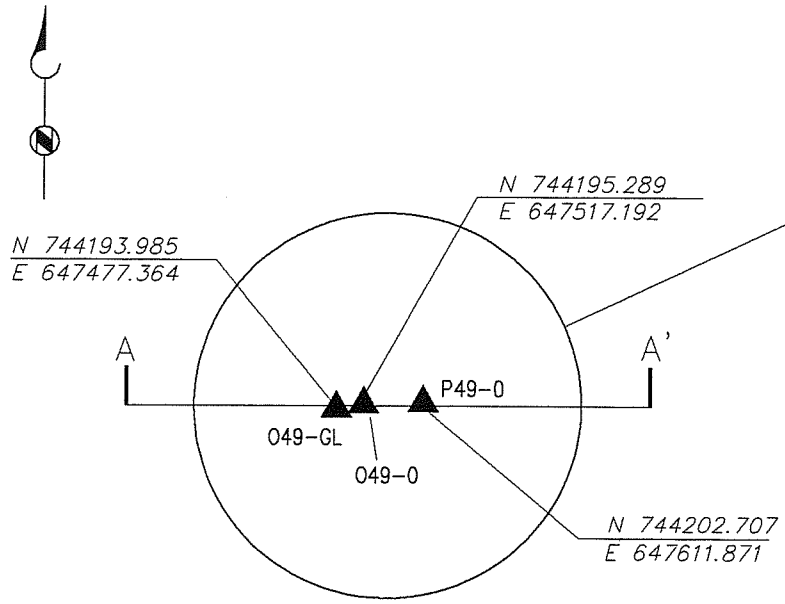
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 890 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

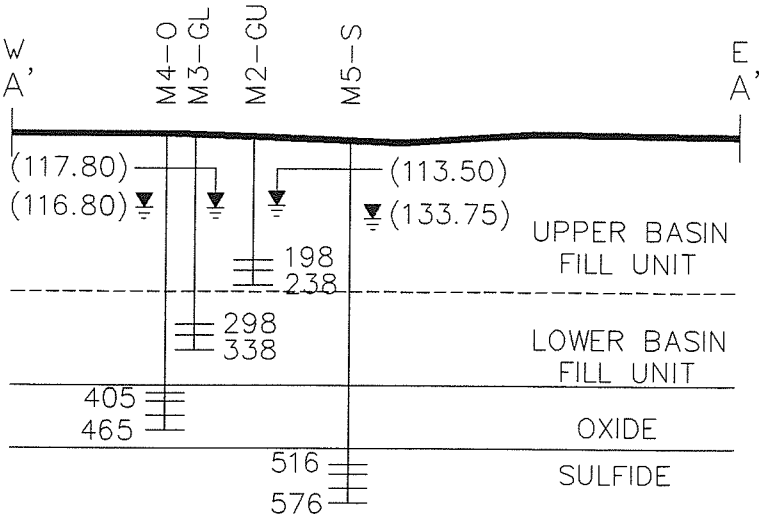
Approximate Scale: 1"= 300'

Figure E-10 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 49

BROWN AND CALDWELL

MAGMA
MAGMA COPPER COMPANY
Florence, Arizona

E-10_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

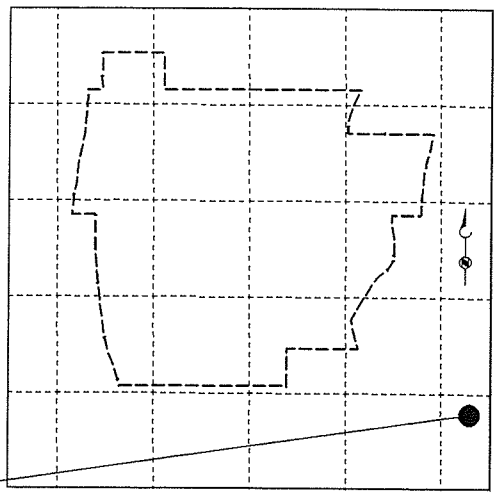
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	□

WELL SUFFIXES
(AQUIFER COMPONENT SCREEN)

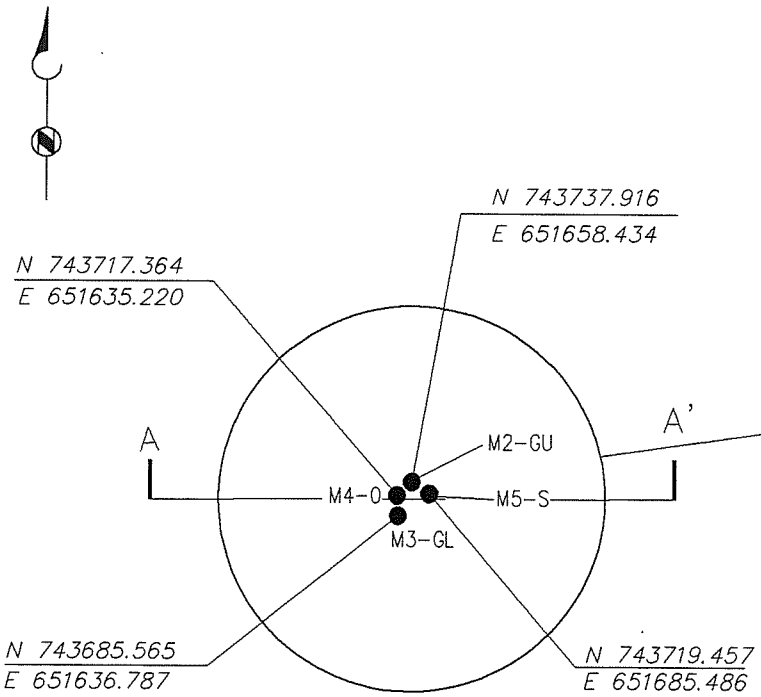
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	□
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 576 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

Figure E-11 (II)

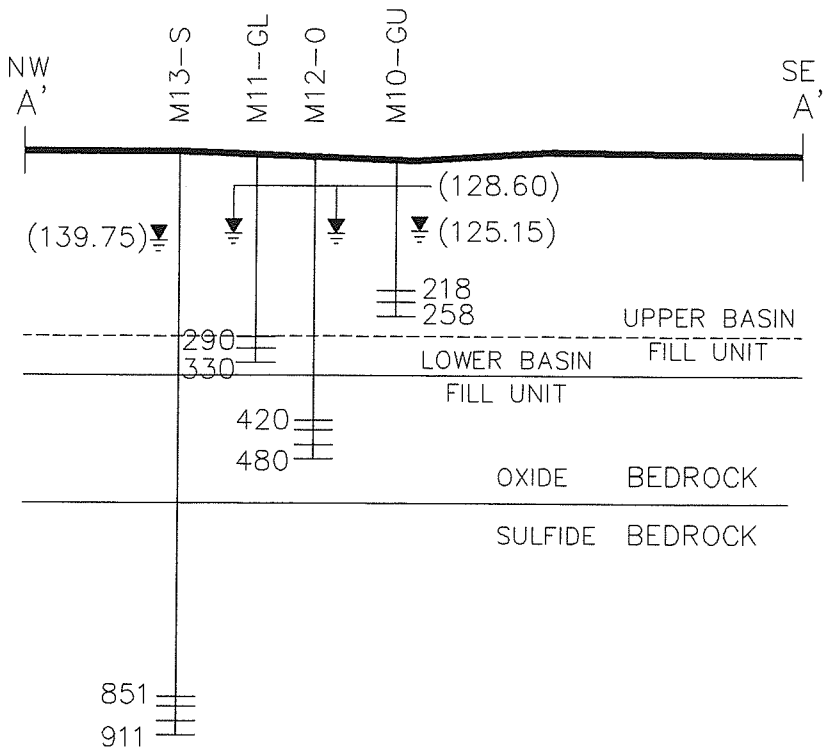
LOCATION SUMMARY SOUTHEAST MONITORING WELL CLUSTER

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

BROWN AND CALDWELL

E-11_2 12-01-95 DanH



SIMPLIFIED NORTHWEST-SOUTHEAST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

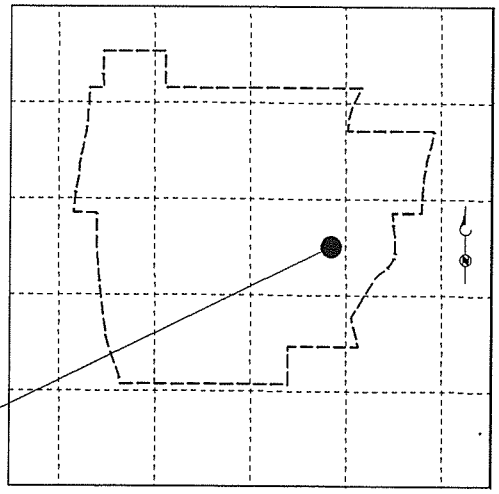
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

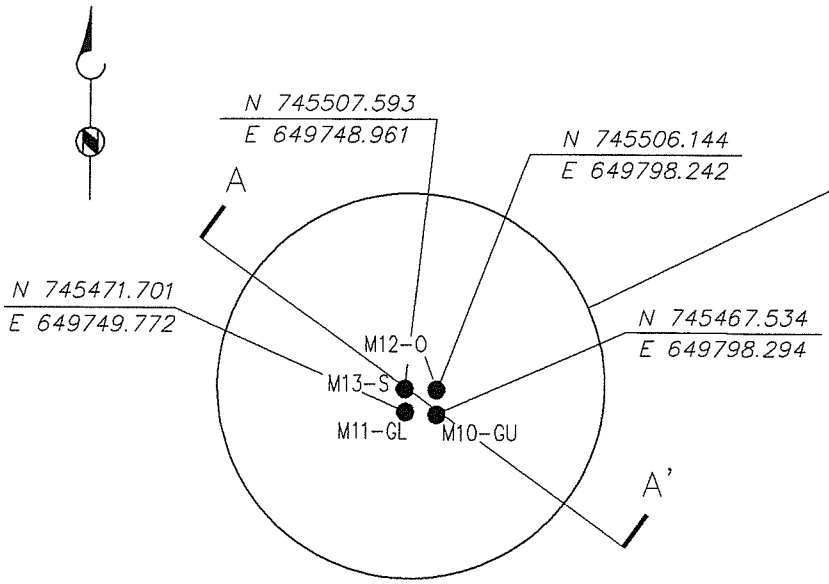
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 480 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

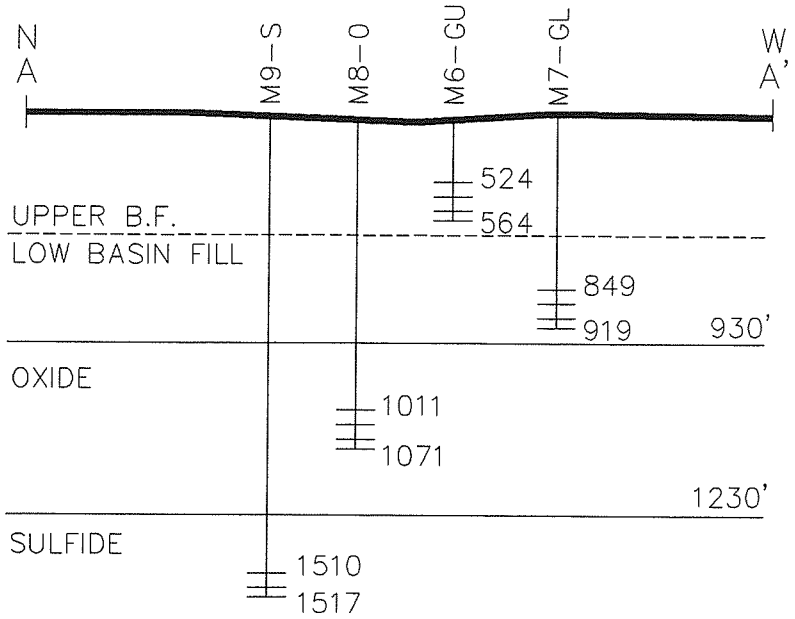
Figure E-12 (II)
LOCATION SUMMARY MIDDLE MONITORING WELL CLUSTER

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-12_2 12-01-95 DanH



SIMPLIFIED NORTH-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

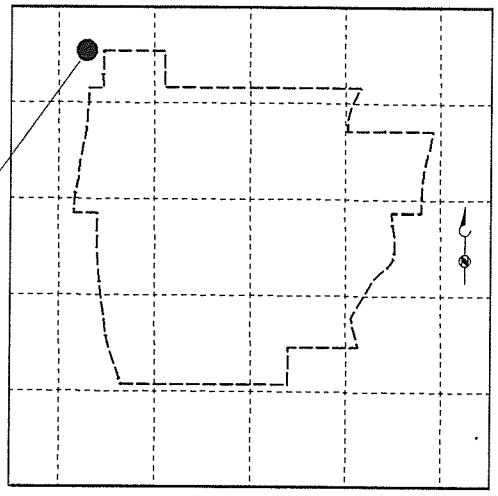
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

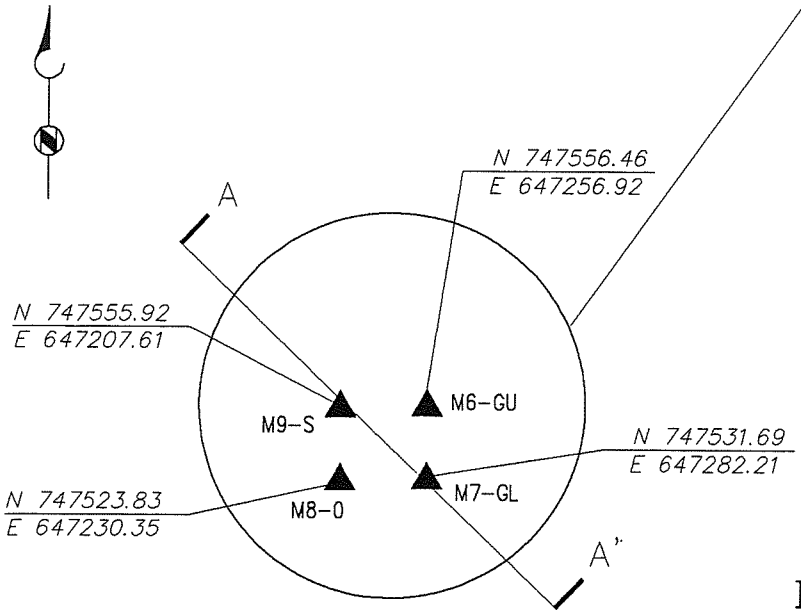
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 890 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

BROWN AND CALDWELL

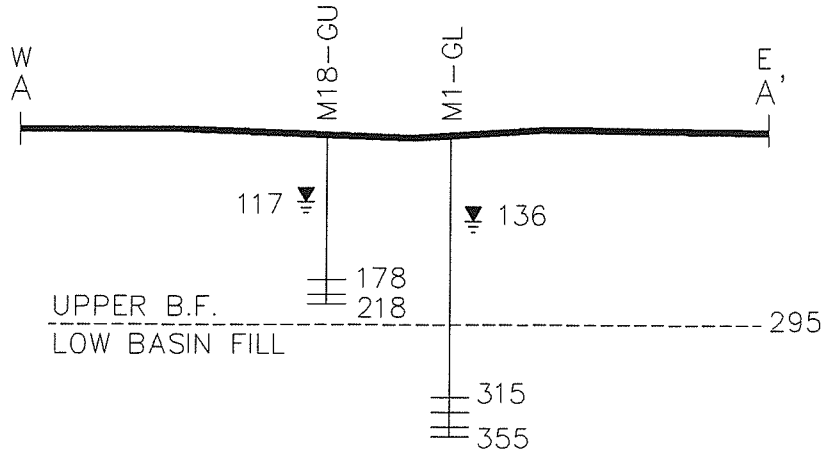
Figure E-13 (II)

LOCATION SUMMARY NORTHWEST MONITORING WELL CLUSTER

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-13_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

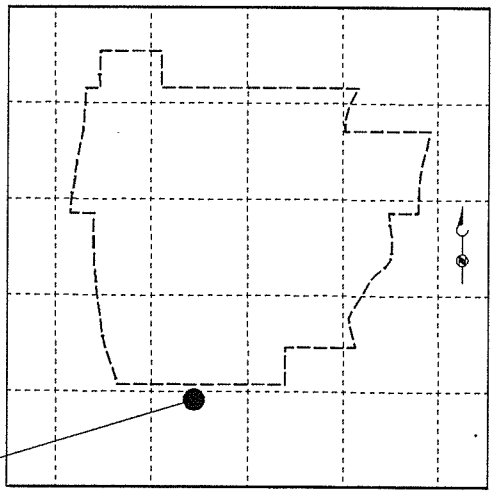
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

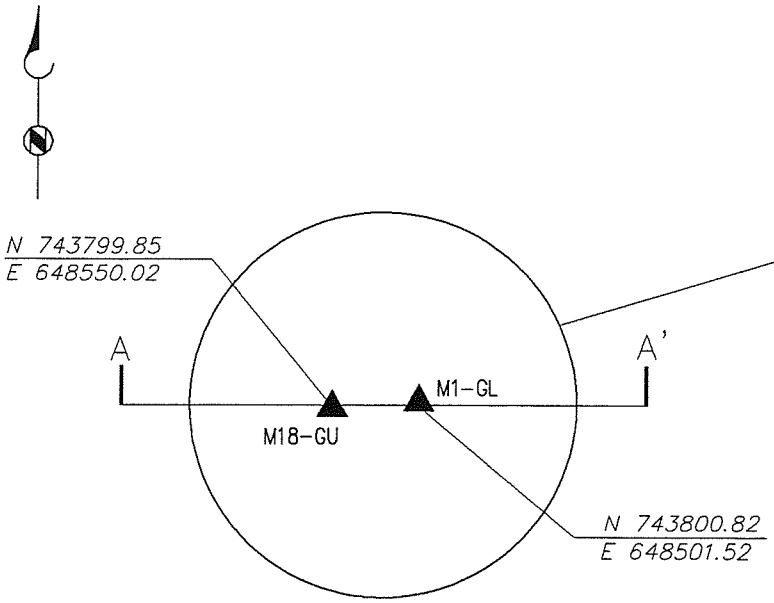
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 890 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

Figure E-14 (II)

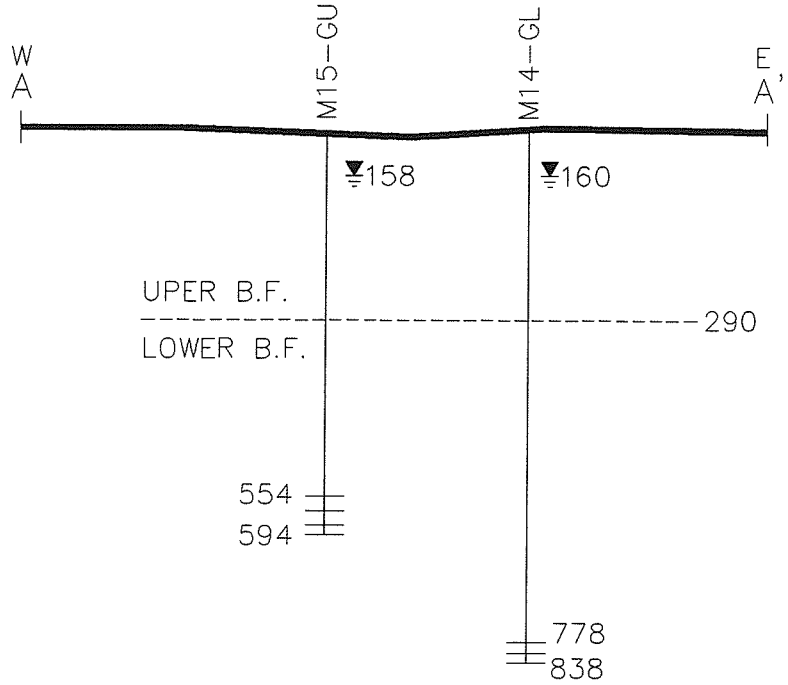
LOCATION SUMMARY MONITORING WELL CLUSTER 1 & 18

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-14_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIOMETRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

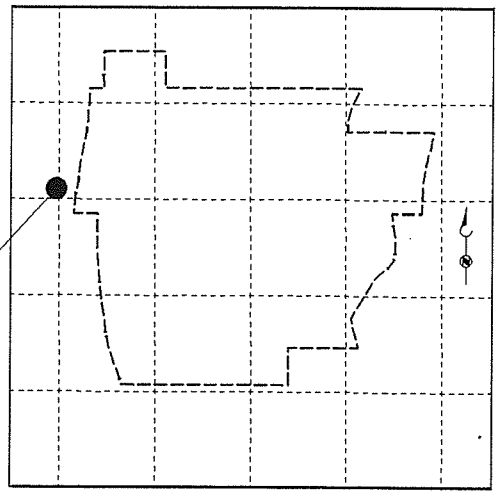
WELL PREFIXES

PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES (AQUIFER COMPONENT SCREEN)

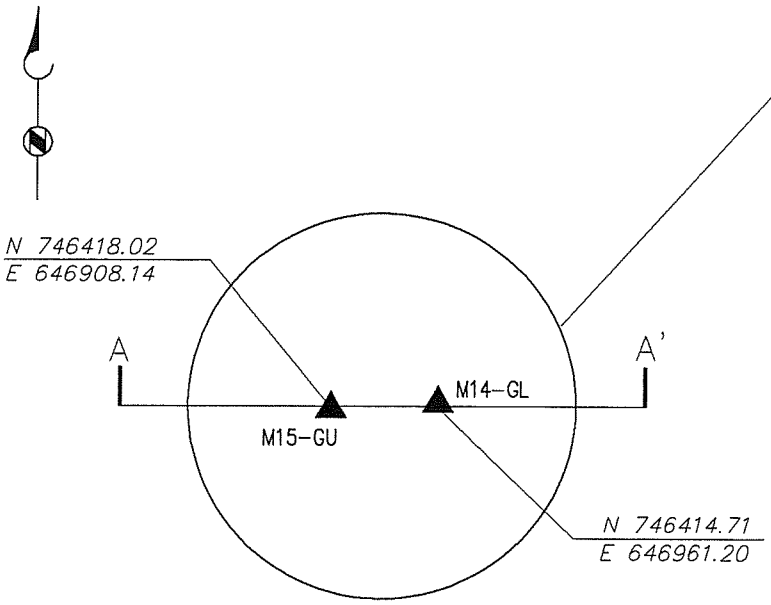
BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

FEET BELOW GROUND SURFACE — 890 — SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

Figure E-15 (II)

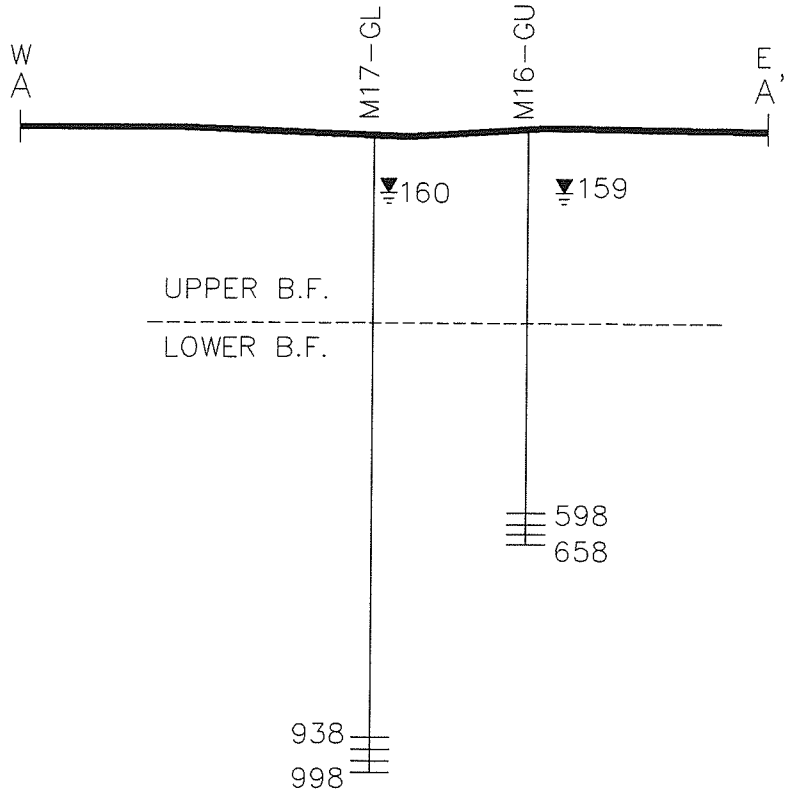
LOCATION SUMMARY MONITORING WELL CLUSTER 14 & 15

BROWN AND CALDWELL

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-15_2 12-01-95 DanH



SIMPLIFIED EAST-WEST CROSS SECTION

Approximate Scale: Vertical : 1"= 300'
Horizontal: 1"= 150'

EXPLANATION

POTENTIAMENTRIC SURFACE (151.00)

(SHOWN IN FEET BELOW GROUND SURFACE)

WELL PREFIXES

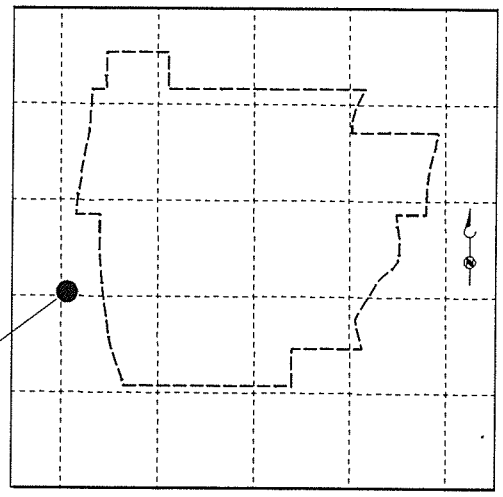
PUMPED WELL	P
MONITOR WELL	M
OBSERVATION WELL	O

WELL SUFFIXES
(AQUIFER COMPONENT SCREEN)

BASIN FILL	GU
BASIN FILL	GL
OXIDE BEDROCK	O
SULFIDE BEDROCK	S

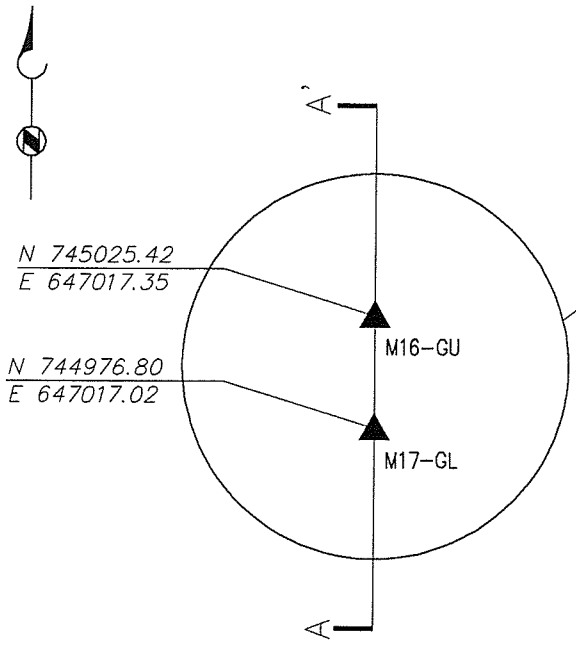
FEET BELOW GROUND SURFACE — 890

SCREENED INTERVAL



WELL LOCATION MAP

Approximate Scale: 1"= 2000'



WELL PLAN VIEW

Approximate Scale: 1"= 300'

BROWN AND CALDWELL

Figure E-16 (II)
LOCATION SUMMARY
AQUIFER TEST
CLUSTER 16/17

MAGMA

MAGMA COPPER COMPANY
Florence, Arizona

E-16_2 12-01-95 DanH

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Data Report for Initial Interpretation of the Hydraulic Tests at the Florence Mine Site

for

Magma Copper Company Aquifer Protection Permit Florence In Situ Leaching Project

Prepared for:

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2 Copies - Golder Associates

November 1995

Golder Associates

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1.0 INTRODUCTION

This report presents the results of the interpretation of hydraulic tests in the area of Magma Copper Company's (Magma) proposed in-situ mining project near Florence, Arizona. The purpose of this report is to provide a technical basis for hydraulic parameter estimation for site characterization in support of state and federal environmental review and permitting requirements.

This report has been prepared as a technical appendix to the Aquifer Protection Permit (APP) Application document prepared by Brown and Caldwell (1995). As such, only hydrogeologic information pertinent to test data interpretation is discussed in this report. The interested reader is directed to the above reference for additional detail.

The analyses presented in this report are based on standard methods developed in the oil and gas industry. These methods are applied to data collected and provided by Brown and Caldwell. Interpretation of the field data is performed with the FLOWDIM™ software of Golder Associates.

This report is divided into three major sections. Chapter 2 presents the mathematical foundation for the well test analysis. A brief discussion of each test and application of this theory to the aquifer test at the Florence Site is presented in Chapter 3. Tables and graphical representation of these analyses are provided in Appendixes A through C. The field data used in these analyses are included in electronic format in the attached diskette.

1.1 Background

Magma has undertaken field studies to characterize the hydrogeologic conditions near its proposed in-situ mining site in the Poston Butte porphyry copper deposit. The proposed mine site is located in the Basin and Range Physiographic Province of southern Arizona, in the Eloy Sub-basin of the Pinal Active Management Area (AMA), and is about 1 mile southwest of Poston Butte and 2 miles

northwest of the Town of Florence, Arizona.

The rock units in the study area range in age from Precambrian to Quaternary. The floodplain alluvium is Quaternary in age and consists mainly of unconsolidated silt, sand, gravel and boulders. The Cenozoic basin fill deposits have been divided into three major units; the Upper (UBFU), Middle (MBFU) and the Lower (LBFU) Basin Fill Units. The UBFU is composed of unconsolidated to weakly cemented, interbedded clay, silt, sand gravel and boulders. The thickness of the UBFU ranges from 200 to about 500 feet in the vicinity of the mine site. The MBFU is a discontinuous layer composed by silt and clay that varies in thickness from zero to about 80 feet. Weakly to moderately cemented sand, silt and clay constitute the lower unit (LBFU). The thickness of this latter unit varies from less than 50 feet on the east to about 800 feet to the west of the mine site. The bedrock complex consists of quartz monzonite and granodiorite porphyry, and diabase, basalt and other volcanic rocks.

Magma has retained Brown and Caldwell of Phoenix, Arizona to prepare the APP application for the Florence in-situ project. As part of this APP-site characterization effort, Brown and Caldwell has installed forty six (46) monitoring wells and seventeen (17) test wells around the site. Eight (8) of these wells are completed within the UBF Unit, seventeen (17) within the LBF Unit and thirty eight (38) within the bedrock complex. To date, Brown and Caldwell has conducted twenty five (25) aquifer tests which include monitoring wells as well as test boreholes. Magma requested that Golder Associates assist Brown and Caldwell with the design and interpretation of the hydraulic tests required as part of the APP process. Nineteen (19) aquifer test locations were selected for interpretation. These locations cover the range of typical hydrogeologic conditions observed at the site. The following sections present an overview of the theory and methods of interpretation, and the analytical results for a portion of these aquifer tests.

2.0 THEORY AND METHODS OF INTERPRETATION

Well testing provides a means of acquiring knowledge of the properties of hydrogeological formations. In the process of a well test, a known signal (usually a change in flow rate) is applied to the formation and the resulting output signal or response is measured (usually in terms of a change in pressure). Well test interpretation is therefore an inverse problem in that the formation parameters are inferred by comparing a simulated model response to the measured response. The formation parameters are derived by adjusting the flow model parameters to obtain a simulation response that matches the measured data. Clearly, there can be significant ambiguity and non-uniqueness involved in this process, as more than one flow model with different physical assumptions and attributes may match the data. In most situations this can be minimized by careful validation of the selected model using other data.

The overall methodology for the detailed well test analysis of the Florence Project data was as follows:

- the data set was divided into its major components, such as the drawdown period and the shut-in or recovery period;
- appropriate parts were then analyzed separately, with different methods of analysis for flow periods and shut-in periods;
- the analyses of the different periods were checked for consistency.

2.1 Analysis of Recovery Period

The analysis of recovery (shut-in) periods is usually based on the assumption that the shut-in period corresponds to an event of zero flow rate following a fixed period of known finite, constant flow

rate. If the flow rate prior to the shut-in period is variable, then this flow history can be included in the analysis by using the superposition of a number of different but constant flow rates of different durations.

The next step in an hydraulic test analysis involves the selection of an appropriate flow model. these models are generally divided into three basic components.

- inner boundary conditions (i.e., wellbore storage and skin effects, and fracture flow effects);
- formation flow component (i.e., homogeneous formation, dual porosity, and composite model);.
- outer boundary conditions (i.e., infinite extent condition, no flow or constant pressure conditions).

In practice, recognition of a suitable model is performed using diagnostic plots. The data are plotted in different coordinate systems (such as, log-log plots, semi-log Horner plots, etc.) to help the analyst identify the appropriate model from the shape of the data. One key diagnostic plot is the derivative plot where the derivative of the pressure with respect to the natural logarithm of elapsed time is plotted against the log of time. The pressure derivative is extremely sensitive to the shape of the pressure data and as such constitutes the most useful tool for diagnostic purposes. For example, a horizontal line on a derivative plot (presented in a log-log scale) indicates infinite-acting radial flow behavior.

Data from shut-in periods are examined in both log-log and semi-log diagnostic plots. This approach allows the analyst to review the characteristics of the shut-in period. For example, when the effects of the pre-test injection/extraction flows during drilling are significant, the shut-in pressure data reach a peak before starting to decline at late time. This form of data is referred to as a 'rollover' and

can be easily diagnosed on the log-log and semi-log plots. The log-log and the semi-log diagnostic plots are also used to fit selected portions of the shut-in data with appropriate straight lines and obtain initial estimates of formation parameters.

After the flow model has been selected, the quality of the fit of the data with the model response (called 'type curves') is adjusted by using automated regression methods. During this stage of the analysis, the entire data from the selected shut-in period is considered. However, during the final regression stages, emphasis is always placed on the fit of the type curves to specific portions of the data. Judgment of the relative goodness of fit to specific portions of the shut-in data comprises one of the most important aspects of the automated data fitting procedure. Once a suitable and consistent fit of the data is obtained to the type curves, the fit is reviewed for final refinement. The entire measured data set from the shut-in period generated using the best flow model parameters derived from the shut-in analysis is displayed in a cartesian plot.

After the flow model has been selected and a consistent set of analysis results obtained, a sensitivity analysis could be conducted. This exercise is designed to quantify the likely uncertainty in the estimated hydraulic conductivity. When carried out, it helps to determine the range of the parameter within which a reasonably good fit is retained between the model response and the data. The ranges of this parameter therefore reflect uncertainty in the analysis.

2.2 Analysis of Drawdown Period

If a sufficient hydraulic head change is achieved during the drawdown period, the available data were analyzed as a constant discharge test. Otherwise, the data were not use in the interpretation.

In an analysis of the main flow period, the source signal is assumed to be in the form of an instantaneous pressure change from undisturbed in-situ conditions. The data for this flow period is the measured hydraulic head decrease during the test resulting from fluid extraction from the

formation. The analysis used a simple set of type curves which correspond to a single interpretation model :

- inner boundary condition: wellbore storage and skin;
- formation: homogeneous; and
- outer boundary condition: infinite lateral extent.

Only one of two parameter sets can be determined from this analysis: hydraulic conductivity and wellbore skin (the static water level being an input parameter for this analysis) or hydraulic conductivity and storativity. The best fit of the data to the type curves therefore corresponds to finding the optimum set of the two output parameters.

The following section (Section 2.3) describes the general theory underlying hydraulic test analysis. Section 2.4 presents the governing equations and related assumptions. The parameters for various flow models are discussed in Section 2.5. Section 2.6 outlines general methods that are applied to the analysis of hydraulic tests. The reader interested in the specific methodology of detailed test interpretation is therefore directed to Section 2.6.

2.3 Theoretical Background

The purpose of this discussion is to provide a summary of the mathematical and physical background of the aspects of well test analysis that are relevant to the Florence Site. The presentation is divided into three parts:

Part one defines the basic rock and fluid parameters used in the analysis of transient well tests (Section 2.3.1). The second part presents the 'diffusion equation' that governs the flow in porous

media, identifies its underlying assumptions, and describes some special solutions (Section 2.4). Data analyses of Florence hydraulic tests are based on various solutions of the diffusion equation. Finally, the third part describes the interpretation models that have been applied to analyze the Florence hydraulic test data (Section 2.6).

Aspects of theoretical well testing have been documented in numerous papers and textbooks, both in the petroleum engineering and the groundwater literature. The interested reader is directed to the following summarizing references: Kruseman and de Ridder (1991) and Dawson and Istok (1991) for theoretical aspects of pump test analyses written mainly for the 'hydrogeology audience' and Earlougher (1977), Streltsova (1988), Horne (1990) and Sabet (1991) targeted mainly at the 'petroleum formation evaluation audience.'

2.3.1 Rock and Fluid Properties

2.3.1.1 Porosity and Compressibility

Fluid properties such as water compressibility, density, viscosity, and in some cases the thermal expansion coefficient, have to be estimated prior to analysis of the test data. Formation compressibility and porosity must be known (or a reasonable value assumed) in order to analyze transient tests and to obtain estimates for the skin coefficient.

Rock porosity, ϕ, is defined as the ratio of the void volume to the total bulk volume. For analysis of fluid movement the effective porosity of the rock is used. It represents the interconnected volume of pores available for fluid transport. For the Florence hydraulic tests, it was assumed that the average porosity of the Oxide and unconsolidated alluvial sediments is 0.05 and 0.10 respectively. Fractured reservoir rocks can be represented as comprising of two overlapping continua with different porosities. One is the intergranular matrix porosity and the other is the porosity created by the void spaces of fractures. These two types of porosity are called primary and secondary porosity

respectively. The total porosity (or total effective porosity) of the double-porosity system is the sum of the primary and secondary porosities. Laboratory measurements on various types of fractured rock have shown that the fracture porosity is usually significantly less than the matrix porosity (von Golf-Racht, 1982)

The isothermal compressibility of water (and rock) is generally defined as:

$$c = \frac{1}{V}\frac{dV}{dP}\Big|_T \qquad 2.1$$

where the derivative is taken under the condition of constant temperature. In Eq. 2.1, V is the total volume of a given mass of material, and dV is the instantaneous change in volume induced by an instantaneous change in pressure dP.

The total compressibility of the rock-fluid system with 100% water saturation is made up of two components;

$$c_T = c_W + c_R \qquad 2.2$$

where:

c_T	=	total compressibility	Pa^{-1}
c_W	=	compressibility of water	Pa^{-1}
c_R	=	compressibility of rock	Pa^{-1}

Total compressibility was assumed equal to 5.4×10^{-4} Pa^{-1} for the analyses of the aquifer tests at the Florence site. Water compressibility data are readily available as a function of salinity, temperature and pressure. The correct estimation of the rock compressibility, however, is difficult. Data in the

literature cited in Belanger et al. (1989) give a possible range of the fractured rock compressibility as 2.0×10^{-9} kPa^{-1} to 2.0×10^{-5} kPa^{-1}.

Specific storage, S_S, of a saturated confined aquifer is defined as the volume of water that a unit volume of aquifer releases from storage under a unit decline in hydraulic head. This parameter depends directly on the ϕc_T product (Earlougher, 1977):

$$S_S = \phi c_T (\rho g) \qquad m^{-1} \qquad 2.3$$

where:

ρ	=	density of water	kg/m^3
g	=	acceleration of gravity	ms^{-2}.

2.3.1.2 Wellbore Storage

Another form of compressibility, of the fluid inside the borehole, is wellbore storage. During a hydraulic test, wellbore storage causes the downhole flow rate to change more slowly than the surface flow rate. The borehole storage is equal to the change in the volume of fluid in the wellbore, per unit change in the downhole pressure. The wellbore storage coefficient is defined by

$$C = \frac{\Delta V}{\Delta P} \qquad m^3 Pa^{-1} \qquad 2.4$$

noting that ΔV refers to the change in volume of fluid inside the wellbore, and ΔP refers to the change in the downhole (borehole) pressure.

In a wellbore with a changing fluid level (for example during a constant rate pumping period) the wellbore storage coefficient is given by:

$$C = \frac{\pi r_t^2}{\rho g} \qquad 2.5$$

where:

πr_t^2	=	volume of tubing per unit length
ρg	=	change in pressure per unit length

When the fluid level is fixed (for example during a shut-in period) the wellbore storage coefficient is given by

$$C = \pi r_W^2 h c_{WW} = V_W c_{WW} \qquad 2.6$$

where V_W is the test section volume (h is the test section length and r_W the wellbore radius) and c_{WW} is the compressibility of the water in the wellbore. The wellbore storage coefficient varies by orders of magnitude depending on the mode of storage within a test. For example, assuming ρg = 10 kPa/m, h = 50 m, r_W = 0.079 m, r_t = 0.035 m and c_{WW} = 4 x10^{-7} kPa^{-1}, values of C from equations 2.5 and 2.6 are calculated to be 3.8 x10^{-4} m^3/kPa and 3.9 x10^{-7} m^3/kPa, respectively.

2.3.1.3 Permeability and Hydraulic Conductivity

The estimation of hydraulic conductivity was the primary objective of the aquifer testing at the Florence site. This parameter is related to both the fluid and fluid transmitting characteristics of the formation. This relationship can be illustrated through the well-known Darcy equation:

$$q = -K \frac{dH}{dL} \qquad 2.7$$

where:

q	=	Darcy flux	ms^{-1},
K	=	hydraulic conductivity	ms^{-1},
dH/dL	=	hydraulic gradient	*unitless*,
H	=	hydraulic head	*m*,
L	=	length or distance	*m*.

The Darcy flux assumes that flow occurs over the entire flow area. In other words, it is a macroscopic velocity. Darcy's law holds only for laminar flow.

The same equation can be expressed in terms of intrinsic permeability (k) which represents the conductance that the rock offers to fluid flow:

$$q = -\frac{k}{\mu}\frac{dP}{dL} \qquad 2.8$$

where:

P	=	pressure	*Pa*,
μ	=	dynamic viscosity	*Pa-s*,
k	=	intrinsic permeability	m^2.

Intrinsic permeability is defined for a single fluid flowing through the rock and represents a transmissive property of only the rock system. Equating Eq. 2.8 with Eq. 2.7 and including the head-

pressure correlation, results in an equation relating hydraulic conductivity and intrinsic permeability:

$$K = \frac{k}{\mu} \rho g \qquad 2.9$$

2.3.1.4 Hydraulic Head

The hydraulic head is expressed in terms of the pressure (P) and an elevation (Z) relative to a known datum. It can be thought of as a column of fluid of length H with a specific density ρ, assuming an atmospheric pressure of P_{atm}, and acceleration of gravity g,

$$H = \frac{P - P_{atm}}{\rho g} - Z \qquad 2.10$$

2.4 Assumptions and Governing Equation

The general well test analysis approach is based on solutions to the diffusion equation (also known, in the petroleum literature, as the diffusivity equation) for various sets of initial and boundary conditions. There are two common ways of presenting these solutions:

a) Hydraulic head, hydraulic conductivity and storage, or

b) Pressure, permeability, porosity, compressibility and fluid viscosity.

When expressed in terms of pressure, the diffusion equation is (see, for example, Lee, 1982):

$$\frac{\partial^2 P}{\partial r^2} + \frac{1}{r}\frac{\partial P}{\partial r} = \frac{\phi \mu c_t}{k}\frac{\partial P}{\partial t} \qquad 2.11$$

where:

r	=	radial distance	*m*,
t	=	time	*s*.

This equation is a linear parabolic partial differential equation, that is derived using the following assumptions (Horne, 1990):

a) Darcy's Law applies;
b) Porosity, permeability, viscosity and rock compressibility are constant;
c) Fluid compressibility is small and constant;
d) Pressure gradients in the formation are small;
e) Flow is single phase;
f) Gravity and thermal effects are negligible;
g) Permeability is isotropic; and
h) Only horizontal radial flow is considered.

The solutions of the diffusion equation are usually given in terms of dimensionless parameters. The dimensionless variables lead to both a simplification and generalization of the mathematics (Dake, 1978). Moreover, with dimensionless variables, the solutions are invariant in form, irrespective of the units system used. The dimensionless pressure, P_D, is a solution to Eq. 2.11 for specific initial and boundary conditions. In the case of the constant surface flow rate (q), the pressure at any point in the formation penetrated by the well is described by the generalized solution below (Earlougher, 1977):

$$P_i - P(r,t) = \frac{qB\mu}{2\pi kh}[P_D(t_D, r_D, C_D, \omega, \lambda, ...) + s] \qquad 2.12$$

where B is the formation volume factor, equal to a volume of fluid at well pressure and temperature normalized to standard surface conditions (B is considered to be unity during the analyses of the Florence data). The variables t_D and r_D are the dimensionless time and radius, respectively; C_D is the dimensionless wellbore storage. The other parameters are defined in the Nomenclature section (Section 6.0).

The physical pressure drop is equal to a dimensionless pressure drop times a scaling factor. The scaling factor depends only on flow rate and reservoir properties. The concept applies in general, even for complex situations. It is this generality that makes the dimensionless solution approach useful. P_D is a function of time, location, system geometry and other variables (Earlougher, 1977).

The dimensionless time, t_D, in Eq. 2.12 is defined by:

$$t_D = \frac{kt}{\phi \mu c_t r_W^2} \qquad 2.13$$

where r_W is the radius of the well. The definitions for the dimensionless radius and the dimensionless wellbore storage are:

$$r_D = \frac{r}{r_W} \qquad 2.14$$

and,

$$C_D = \frac{C}{2\pi \phi c_t r_W^2 h} \qquad 2.15$$

Equations 2.13 through 2.15 are expressed in a consistent set of units. In the simple case of steady state radial flow, P_D is equal to ln (r_e/r_w), where r_e is the radius of the circular constant pressure boundary, and Eq. 2.12 becomes the well known steady-state radial form of Darcy's Equation (Earlougher, 1977), or the Thiem Equation (see Section 2.1.1 of Kruseman and de Ridder, 1991). For transient flow, P_D is always a function of dimensionless time (Eq. 2.13), dimensionless radius (Eq. 2.14), and other parameters related to the flow geometry (Earlougher, 1977). Dimensionless pressure can be applied easily, and results in simple general equations that apply to any sort of reservoir properties. It is easily adapted to mathematical manipulation and superposition so that more complex systems can be considered.

In order to account for tests that do not have a constant flow rate (the assumption used to derive Eq. 2.12), the superposition technique is applied. This approach makes it possible to describe a variable rate event (including a shut-in, which is an event with a zero surface flow rate) using a number of constant rate events. The variable rate superposition has been described in detail in well testing literature (Earlougher, 1977; Lee, 1982; Horne, 1990).

The principle of superposition holds for systems that can be described mathematically as 'linear systems' (Horne, 1990). Since most well test solutions are derived from linear diffusive flow equations with linear boundary conditions, the principle of superposition is applicable for most of the standard response functions. The superposition theorem simply states that the sum of individual solutions of a linear flow equation is also a solution of that equation (Drake, 1978). For a variable rate event, the principle of superposition in time can be used to describe the flow response, using a series of constant rate solutions. If a variable rate event is separated (discretized) into 'n' constant rate flow periods, a solution for the nth flow period can be found by solving the diffusivity equation for each flow rate individually and superposing the solutions according to the following equation (Gringarten, 1979; Bourdet et al., 1989):

$$P_D = \sum_{i=1}^{n-1} \frac{q_i - q_{i-1}}{q_{n-1} - q_n} [P_D(\sum_{j=1}^{n-1} \Delta t_{jD}) - P_D(\sum_{j=1}^{n-1} \Delta t_{jD} + \Delta t_D)] + P_D(\Delta t_D) \qquad 2.16$$

where each of the 'n' flow periods has a flow rate of q_i ($q_i \geq 0$) and a duration of Δt_i with Δt being the elapsed time in the 'n^{th}' flow sequence. The subscript 'D' for the time refers to dimensionless time, which is proportional to real time and is given by Eq 2.13.

2.5 Interpretation Models

Type curve matching for pumping test data was first introduced by Theis (1935) for interpreting crosshole responses in homogeneous aquifers. Since then, type curve matching has become one of the most common tools in the interpretation of well test data, both in petroleum and groundwater areas. A type curve is a graphical representation of the theoretical response during a test of an interpretation model that represents the well and the formation being tested. A type curve is therefore specific to the type of test for a given flow system. The type curve analysis of well test data essentially consists of selecting a type curve that can adequately describe the actual response of the wellbore and the formation during the test.

Type curves, therefore, include the entire dynamic behavior of an interpretation model during a test; in other words, type curves include all the individual 'flow regimes' of an interpretation model. 'Flow regimes' are but characteristic features for the various components of an interpretation model. The individual components of an interpretation model dominate the well test response at different times. These responses are broadly divided into three groups: early time, middle time, and late time (Earlougher, 1977).

As a given test starts, the pressure transients generated by the test move away from the generator (ie. the source/sink well) and into the formation. At early time, the pressure signals are dominated by features in the flow system close to the source - such as wellbore storage and skin, presence of

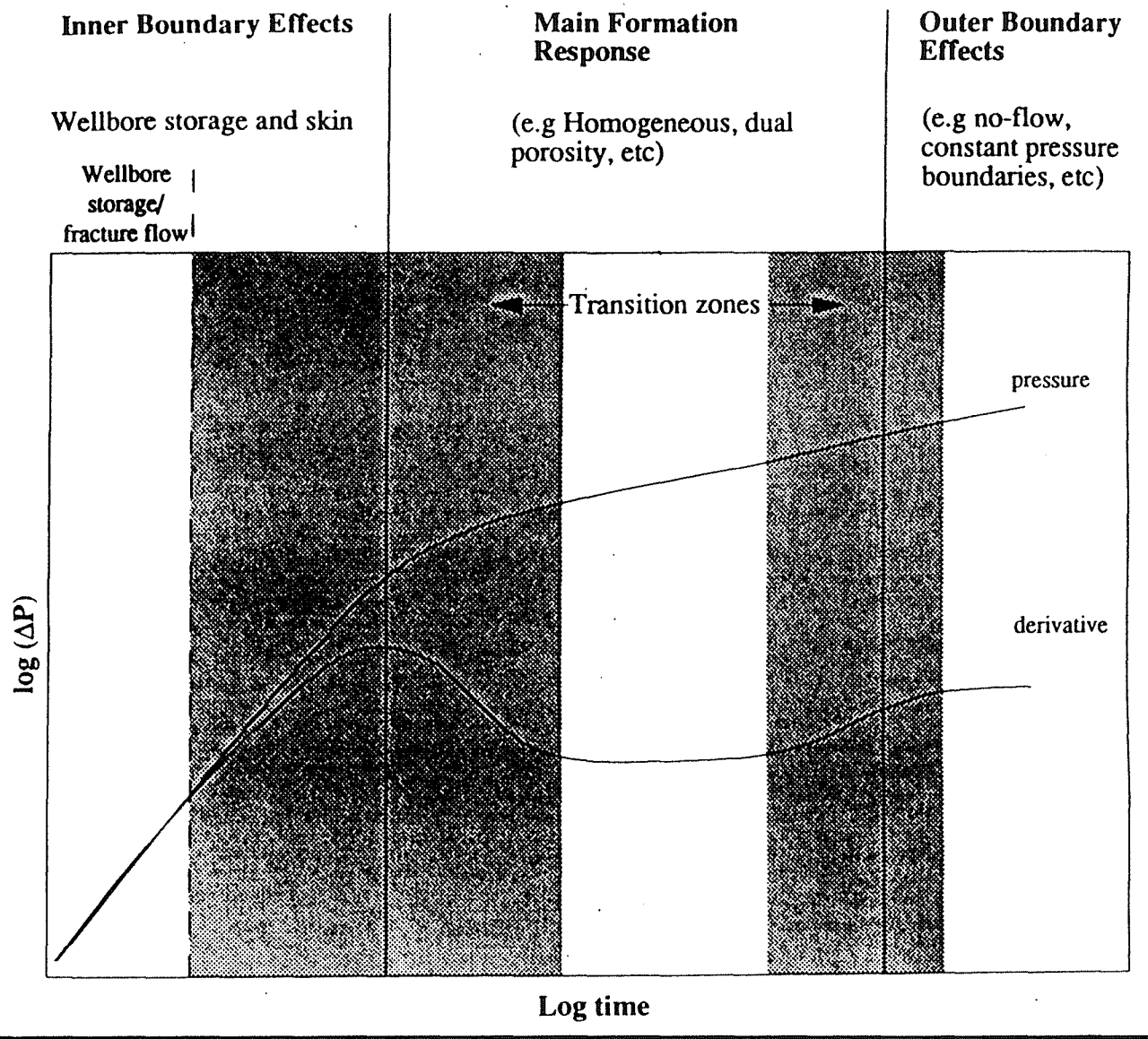
fractures intersecting the source, etc. As the test progresses, the pressure transients move farther away from the source and the test section pressure response reflects the transmission of pressure through each of the significant features in the flow system in succession. The development of the individual flow regimes in the pressure responses does not occur in discreet steps but are separated by 'transition periods' in which the influences of parameters characterizing the two regimes are combined. After the early time effects are over, the pressure response is indicative of larger scale conditions in the formation. During this phase of the pressure response, features such as double porosity, homogeneous behavior, etc. dominate the pressure response. As the test duration increases, the pressure response reflects the formation conditions farther away from the borehole and features such as boundary effects may affect the pressure response. Until the boundary effects are 'seen' by the pressure signals, the formation effectively responds as if it were of 'infinite lateral extent'.

Type curves combine all the flow regimes, including the transition periods, for specific interpretation models. Well test interpretation models are used to define the complete theoretical flow system and the characteristics of the interpretation models are divided into these distinct periods:

1. Inner Boundary (wellbore storage, fracture flow etc.);
2. Formation Flow Behavior (homogeneity, dual porosity etc.); and
3. Outer Boundary (infinite acting, constant pressure etc.).

These periods are illustrated in Figure 1 for pressure and pressure derivative curves. The first period represents the inner boundary condition of the interpretation model and governs the early time response of the model. The formation flow behavior is the flow regime when the pressure response at the pumping well is dominated by formation flow parameters. The outer boundary condition, as the name implies, characterizes the late-time effects.

In an idealized data set the pressure or pressure derivative will have a recognizable shape which can be related to what is happening in the formation. When analyzing well test data it is now common practice to plot the pressure derivative (derivative of pressure change with respect to the natural



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Magma Florence			Golder Associates Tucson, Arizona		TITLE FIGURE 1
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logarithm of time) in addition to the pressure because it is easier to recognize the characteristic shapes of the test periods on the pressure derivative (Bourdet et al, 1983; Bourdet et al, 1989). Examination of pressure derivative plots allows the analyst to determine the extent of each of the three periods and, from diagnostic curve shapes, identify different types of formation response and boundary effects. The following interpretation models are available in Golder's FLOWDIM™ code:

Inner Boundary Conditions:

a) Wellbore storage and skin;

b) Infinite conductivity or uniform flux fracture; and

b) Finite conductivity fracture.

Formation Flow Behavior:

a) Homogeneous -standard 'porous medium' flow;

b) Dual porosity -fractures in a less permeable matrix; and

c) Fractional Dimension -fracture controlled flow with "imperfect" connections.

Outer Boundary Conditions:

I) Single boundary -constant pressure or no flow.

The following sections discuss only the interpretation models and parameters, which are applied to the analyses of the Florence data. The models are:

- Inner Boundary -Wellbore storage and Skin, and Fractures;
- Formation Flow -Homogeneous and Dual Porosity; and
- Outer Boundary -Infinite Acting.

Different sets of constitutive parameters are used to represent each of the components of the well test interpretation models. The parameters are:

C:	wellbore storage;
h:	total thickness of the formation (equals the test section length, for a 'fully penetrating well' assumption);
k:	formation permeability;
k_f:	fracture permeability in a double porosity system;
k_{fw}:	permeability of finite conductivity fracture;
s:	skin factor;
w:	fracture width;
x_f:	fracture half length;
ω:	interporosity storativity ratio; and
λ:	interporosity flow coefficient.

These components of the interpretation models are described in the following sections.

2.5.1 Inner Boundary

2.5.1.1 Wellbore Storage and Skin

The wellbore storage effect prevents the downhole flow rate from instantaneously following the surface flow rate in the case of constant rate tests. This affects the early-time transient pressure response to a considerable extent. The wellbore storage effect can mask the formation response in tests of very low permeability formations. Wellbore storage is characterized by a wellbore storage constant, C, which is the change in wellbore fluid volume with pressure. For a well filled with a single phase fluid occupying a fixed volume V_W, this constant is given by Eq. 2.6. For a well with a changing liquid level (open tubing flow) the wellbore storage constant is given by Eq. 2.5.

To account for the wellbore storage effect in the solutions of Eq. 2.11, a dimensionless wellbore storage constant C_D was introduced (Eq. 2.15) and P_D becomes a function of t_D, C_D and s, together

with other system parameters.

It is important to note that the compressibility on Eq. 2.6 is that of the fluid in the wellbore. In fractured formations, the actual wellbore storage values can exceed those computed with Eq. 2.6 because part of the storage is due to the volume of fractures in communication with the wellbore. The difference can be a factor of 10 to 100 depending on borehole conditions (Ostrowski and Kloska, 1989). Other effects, such as tool compliance or tool induced injections, can also increase the apparent wellbore storage and cause the wellbore storage constant to be higher than calculated.

Another important dimensionless variable is the skin factor (s) which quantifies the near-borehole flow conditions. Skin factors estimated from transient testing include all features that affect the efficiency of fluid flow into the wellbore. The skin factor represents a steady sate dimensionless pressure drop at the well face in addition to the normal transient pressure drop in the formation. The additional pressure drop is assumed to occur in an infinitesimally thin "skin zone" (van Everdingen, 1953). The additional pressure drop can be the result of local permeability alteration (for example, caused by plugging of flow paths by fines in the drilling fluid, etc.). This pressure drop could also be caused by deviation from purely 2-D radial flow near the well (for example, caused by a fracture near the well giving rise to more linear than cylindrical symmetry flow at early time); this is also called 'pseudo-skin' (Earlougher, 1977). The skin factor is related to this additional pressure drop by the following equation (Earlougher, 1977):

$$s = \frac{2\pi kh}{qB\mu} \Delta P_s \qquad 2.17$$

where Δp_s, is the additional pressure drop in the skin zone. A more physically realistic concept of skin is obtained by assuming that the skin effect is due to an altered zone of radius r_S with a skin zone hydraulic conductivity (K_S); for such a case the skin effect can be calculated from the following equation (Earlougher, 1977):

$$s = [\frac{K}{K_s} - 1] \ln[\frac{r_s}{r_W}] \quad (unitless) \qquad 2.18$$

It can be seen from this equation that when the skin zone hydraulic conductivity (K_S) is higher than the formation hydraulic conductivity (K) the skin effect is negative. There is clearly a practical limit to how large the magnitude of skin can become; for the Florence tests, skin coefficients typically vary between -7.5 and 12.0.

Pseudo-skins result from situations such as partial penetration of the water bearing formations, turbulent flow, multiphase effects, and fractures intersecting the wellbore. The important difference between mechanical skins and pseudo-skins is that the pseudo-skins penetrate the formation, creating transient pressure drops that become stable only some time after the beginning of flow in the well (Dowell Schlumberger, 1985). The total skin effect is the combination of the mechanical and all pseudo-skins.

2.5.1.2 Fracture Flow

When the borehole penetrates a single fracture, the early time pressure response is determined by wellbore storage and the flow behavior within the fracture. Two different kinds of fractures are considered, an infinite conductivity fracture and a finite conductivity fracture. In both these models, the flow is assumed to take place from the formation to the fracture and from the fracture into the wellbore. For the infinite conductivity fracture, a negligible pressure drop is assumed to occur within the fracture itself. For this model, the flow goes through two flow regimes:

a) Linear flow towards the fracture from the formation, and then
b) A global radial flow in the formation.

These two successive flow regimes are also shown by a 'uniform flux' fracture (Earlougher, 1977;

Horne, 1990). A uniform flux fracture is a fully penetrating vertical fracture with a uniform flow into the fracture along its length. Both the infinite conductivity and the uniform flux fracture models are based on the following assumption:

a) There is no wellbore storage;
b) The fracture is vertical and fully penetrating;
c) Pressure within the fracture and the borehole is the same at all points;
d) The fracture is characterized by a half-length (x_f); and
e) The fracture is in a homogeneous aquifer.

Analysis using these models yields an estimate of:

x_f = Fracture half-length

In a finite conductivity fracture model, pressure drop is allowed to take place within the fracture. For a finite conductivity fracture, the flow goes through three regimes:

a) Linear flow within the fracture;
b) Linear flow toward the fracture and within the fracture (bilinear flow); and
c) Global radial flow.

In this case, the flow is determined by the fracture half length as in the case of the infinite conductivity fracture and also by the product of fracture permeability and fracture width. Fracture permeability is not a parameter for the case of an infinite conductivity fracture model, since it is considered to be infinitely large. Analysis with the finite conductivity vertical fracture yields estimates for:

x_f = Fracture half-length

k_{fw} = Fracture permeability

None of the Florence tests analyzed so far have shown a response that could be associated to either of these models. In other words, all of the tests analyzed to date have hydraulic responses typical of porous media flow.

2.5.2 Formation Flow Behavior

Many theoretical models have been developed to describe the flow of fluids through different types of formations in the subsurface. Flow models have been developed to account for a multitude of heterogeneous formation behaviors. These models have increased in complexity in line with the increased computational and graphical display powers of desktop computers. To discuss all the models and combinations of models currently available is beyond the scope of this report. Therefore, only the models that are or might be potentially useful for the analyses of the Florence data are discussed here, namely; homogeneous and dual porosity flow models.

2.5.2.1 Homogeneous

The homogeneous model is the simplest formation flow model. It describes flow through the pore spaces of a homogeneous isotropic formation. Analysis with this model in FLOWDIM™ yields estimates of:

k = permeability; and
s = skin.

This flow model is typically combined with the wellbore storage and skin (Inner boundary) and infinite acting (Outer boundary) models to produce the theoretical model of the simplest formation

response.

2.5.2.2 Dual Porosity

A different method of analysis is applied to fractured formations in which flow occurs through both the matrix and through a network of fractures. To analyze tests conducted in these formations, a dual porosity flow model was developed by Warren and Root (1963). They showed that a model which included two fracture related parameters, in addition to permeability and skin, could be used to describe the pressure-time behavior of a fractured formation. These additional parameters represent the storativity ratio of the fractures and the matrix, and the ratio of the matrix permeability to the fracture permeability. It should be noted that the dual porosity model may also be used to represent flow in a fracture system, where relatively low conductivity and less well connected 'background fractures' can be equated with the 'matrix' and more dominant transmissive features with the 'fractures.'

The dual porosity models available in the well testing literature are characterized by the way flow in the more permeable flow conduits (i.e., the fractures) interacts with that in the less permeable flow medium (i.e. the matrix). There are two types of dual porosity models available within FLOWDIM™ depending on the different types of interporosity flow:

a) Restricted Interporosity Flow: In this model there is a skin between the more permeable medium (the fissures) and the less permeable medium (the matrix blocks) which restricts flow; and

b) Unrestricted Interporosity Flow: In this model there is no impediment to flow between the two media and the less permeable medium is assumed to be shaped either like slabs or spheres.

Analysis using the dual porosity model in FLOWDIM™ yields estimates of:

k_f	=	permeability of the more permeable medium;
s	=	skin factor of the well;
s_f	=	skin factor between fissures and the matrix;
ω	=	interporosity storativity ratio; and
λ	=	interporosity flow coefficient.

The definitions of permeability and skin are similar to those in Section 2.3.1.3 and 2.5.1.1. The modifications necessary to fit them into the dual porosity model are noted below. The first of the parameters specific to the dual porosity model, interporosity storativity ratio 'ω', is defined by:

$$\omega = \frac{(\phi c_t)_f}{(\phi c_t)_f + (\phi c_t)_m} \qquad 2.19$$

This relationship characterizes the relative storage capacity of the two media, fracture and matrix (characterized by subscripts 'f' and 'm' respectively). The interporosity flow coefficient 'λ', characterizes the ability of the matrix to flow into the fractures and is defined by:

$$\lambda = \alpha \frac{k_m}{k_f} r_w^2 \qquad 2.20$$

where α is a geometrical factor which depends on the shape of the matrix block. For spherical matrix blocks of radius r_m,

$$\alpha = \frac{15}{r_m^2} \qquad 2.21$$

and for horizontal slab matrix blocks of thickness h_m.

$$\alpha = \frac{12}{h_m^2} \qquad 2.22$$

The theory of the Warren and Root model (Warren and Root, 1963) is extensively discussed in the well test literature (Earlougher, 1977; Streltsova, 1988; Horne, 1990; Sabet, 1991). Therefore, only practical aspects and the physical meaning of the dual-porosity flow parameters are discussed below.

The interporosity storativity ratio, ω, represents the ratio between storage capacity of the fracture network and the total storage capacity of the formation. A value of ω close to zero corresponds to a formation with a very small fracture storage capacity; $\omega = 1$ represents a reservoir with a single dominant flow medium. Small values of ω (<0.1) typically reflect the small storage capacity of fractures relative to the much larger storage capacity of the rock matrix.

The interporosity flow coefficient, λ, represents the dimensionless interporosity flow capacity which depends, primarily, on the ratio of the matrix permeability to the fracture permeability, k_m/k_f. For a given block shape factor α, small λ values correspond to a large contrast between fracture and matrix block permeability. A permeability ratio equal to 1 represents a single porosity (homogeneous) reservoir.

Alternatively, if k_m/k_f is known (e.g. k_m from laboratory tests and k_f from hydraulic testing), it is possible to estimate the characteristics of the fractures. High α values mean large contact surface and consequently smaller matrix blocks (high fracture density). A low value of α corresponds to a smaller contact surface, large matrix blocks and consequently low fracture density.

To date, none of the Florence hydraulic test responses have shown a dual-porosity behavior.

2.5.3 Outer Boundary

2.5.3.1 Infinite Lateral Extent

The model that simulates an infinite acting formation response requires no additional parameters. In this model there is no outer boundary response different from the formation flow response.

2.6 Well Test Analysis

Pressure transient testing has been a subject of extensive work both in the field of groundwater hydrogeology and in the oil industry for the past forty years. Over this period better measuring devices have become available, providing more reliable field data and this, together with the advent of powerful desktop computers, has given rise to the development of more sophisticated interpretation techniques.

In general, transient well tests can be separated into three basic types based on the nature of the source signal:

a) constant rate;
b) constant pressure; and
c) slug and pulse tests.

For constant rate and constant pressure tests, the surface rate and the surface pressure, respectively, are kept constant during the testing period. A slug test is initiated by an instantaneous pressure change (withdraw or injection) and then the groundwater is allowed to flow to the open borehole and to return to initial conditions. A pulse test is very similar to a slug test, the only difference is that the interval is shut-in so that the fluid volume is kept constant. The hydraulic tests conducted at the Florence site are constant rate type tests.

Depending on the type of test, different analysis methods have been developed and documented in numerous papers and manuals. The interested reader is directed to the following summarizing references: Earlougher (1977), Gringarten (1979), Lee (1982), and Bourdet et al. (1983 and 1989) for the analysis of constant rate tests, including multi-rate and shut-in tests; Grisak et al. (1985) for the analysis of wellbore storage dominated pulse and slug, where practical and theoretical aspects of testing in low permeability formations are also discussed; and Pickens et al. (1987) present some interesting practical considerations on interpretation of hydraulic tests in low permeability formations. For detailed descriptions of the various well test analysis methods currently in use, the interested reader is referred to the following additional references: Streltsova (1988), Sabet (1991) and Dawson and Istok (1991).

The purpose of this section is to present some aspects of the test analysis methods that are found to be important for interpretation of the Florence test data. The only tests that will be described in detail are the constant rate tests since these are the type of tests used at the Florence site.

The principles governing the test analysis can be considered as a special pattern recognition problem (Gringarten, 1986). In a well test, a known signal (e.g. pumping rate) is applied to an unknown system and the response of that system (e.g. the change in water pressure) is measured during the test. This type of problem is known as the 'inverse problem.' Its solution involves finding a well defined theoretical system, whose response to the same input signal is as close as possible to that of the actual flow system. Normally this solution is not unique, but with reasonable assumptions and information from other sources like geophysical and geological data, in most cases it is possible to give at least a confined range of solutions.

2.6.1 Constant Rate Tests

The analysis methods for a constant rate test can be divided into two general classes:

a) Straight line analysis methods; and

b) Type curve matching.

After plotting the data in specific coordinate systems, straight lines can be fitted to specific segments of the data set and reservoir parameters determined from the slope and intercept of these lines. This approach requires the data to be divided into discrete sections representing the near wellbore, formation, and outer boundary responses. Each section is then analyzed separately.

The type curve matching approach considers the data as a continuous record. In this approach the data is matched to type curves that represent pressure response models for different combinations of formation and boundary conditions. The type curves are represented in terms of the dimensionless parameters which were introduced in Section 2.4. The formation parameters are calculated from the match points between the measured data and the type curves. These two methods are discussed in more detail in the sections that follow.

2.6.2 Straight Line Analysis Methods

A commonly used method of obtaining reservoir parameters is by straight line analysis. In this approach, pressure data is plotted on specialized plots, e.g. versus log(t), and straight lines fitted to specific portions of the data are used to derive formation parameters. The theory behind straight line methods, especially semilog Horner and MDH has been extensively described in the literature (Earlougher, 1977). Therefore only the application of this method will be discussed here.

Straight lines fitted to the early time portion of the data can be used to obtain estimates of the wellbore storage (pressure versus time or log pressure versus log time) or near well fracture flow parameters (pressure vs. $t^{1/2}$ or $t^{1/4}$). Straight line fits to semilog plots (pressure versus log time), or log (Horner time) can be used to obtain estimates of wellbore storage, skin, permeability and initial pressure; Horner time is defined later in this section. Straight lines fitted to multiple periods of

pseudo radial flow can also be used to identify a dual porosity response and estimate the appropriate flow parameters (λ and ω, see nomenclature).

Straight line analysis methods can also be applied to data presented on log-log plots. A horizontal line fitted to a pseudo radial flow portion of the pressure derivative will provide an estimate of the formation permeability, similar to the Horner approach. Distances to outer boundaries and the existence of multiple boundaries can also be estimated by fitting lines to the log-log plot.

The necessary condition for application of the straight line approach to determine initial hydraulic head and hydraulic conductivity is that the aquifer must be 'infinite acting.' This means that the pressure response must extend beyond the influence of wellbore storage and skin effects and into a period of pseudo-radial flow. In the case of heterogeneous behavior, the total system response must be obtained for the method to be applied. When these conditions are met, the basic reservoir parameters (e.g. hydraulic conductivity) can be derived. The straight line method was in many cases not applicable to the Florence test data, even for the estimation of basic formation parameters, because many of the hydraulic tests are strongly affected by pumping in nearby irrigation wells, rendering the pseudo-radial flow period difficult to identify.

Nonetheless, the basic ideas of the straight line analysis are presented here for the benefit of the reader. A special application of this method is the case of the analysis of a shut-in period after a constant rate flow period. According to the superposition principle, the solution for this case is (Horne, 1990):

$$P_D = P_D[t_{pD} + \Delta t_D] - P_D[\Delta t_D] \qquad 2.23$$

where t_{pD} is the dimensionless flow period duration and Δt_D is the dimensionless elapsed time from the start of the shut-in. The dimensionless pressure (P_D) and the dimensionless time are defined in Section 2.5.2. For infinite acting radial flow during both the flow period and the shut-in, Eq. 2.23

leads to the following solution for the source well in a homogeneous reservoir:

$$P(\Delta t) = P_i - \frac{qB\mu}{4\pi kh} \ln \frac{t_P + \Delta t}{\Delta t} \qquad 2.24$$

Therefore when the pressure is plotted against the natural logarithm of $(t_P + \Delta t)/\Delta t$, where t_P is the flow period duration and Δt is the shut-in time, the data will show a straight line with a slope of

$$m = \frac{qB\mu}{4\pi kh} \qquad 2.25$$

during a period of infinite acting radial flow. The pressure axis intercept represents the initial formation pressure (P_i) or equivalently the static water level. Such a plot is known as a Horner plot and $(t_P + \Delta t)/\Delta t$ is referred to as Horner time which is a dimensionless quantity. For a multiple rate transient test this method can be generalized by plotting (Gringarten et al., 1980):

$$P(\Delta t) \ vs. \ \frac{1}{|q_{n-1} - q_n|} [\sum_{i=1}^{n-1} (q_i - q_{i-1}) \log [\sum_{j=1}^{n-1} \Delta t_j + \Delta t] - (q_{n-1} - q_n) \log \Delta t] \qquad 2.26$$

where Δt_j is the duration of each constant rate event. In Eq, 2.26 the time/rate function is referred to as the superposition function, and the plot is known as a generalized Horner plot.

2.6.3 Type Curve Matching and Automatic Regression

A transient well test generally comprises an input impulse (e.g. a change in flow rate) which is imposed on the test interval, and the recorded response (e.g. a change in pressure). The nature and

shape of the response is governed by test geometry parameters (interval volume, flow rate, etc.), fluid parameters (viscosity, compressibility, etc), and formation flow parameters (permeability, porosity, etc.). Some of these are known directly or can be measured either in-situ during the test or in laboratory tests. However, some of the parameters which control the formation response cannot be measured directly and must be inferred from the test response. An analytical mathematical model of the dependence of the formation response on the formation flow parameters can be developed and solved. Then by matching the measured test response to the model response it can be inferred that the model parameters have the same values as the actual reservoir parameters. This process is known as 'Type Curve Matching.'

2.6.4 Theory of Type Curve Matching

We will consider the single constant rate case to present the basic theory of type curve matching. For a constant rate case, the dimensionless pressure is defined as (Horne, 1990):

$$P_D = \frac{2\pi kh}{qB\mu}(P_i - P) = A\,\Delta P \qquad 2.27$$

where A is a function of k, h, q, B, and μ.

Re-arranging Eq.'s 2.13 and 2.27, we get:

$$\frac{t_D}{C_D} = B\left(\frac{\Delta t}{C}\right) \qquad 2.28$$

where B is a function of k, h, and μ. Or in logarithmic terms:

$$Log P_D = Log \Delta P + Log A \qquad 2.29$$

$$Log(\frac{t_D}{C_D}) = Log \Delta t + Log(\frac{B}{C}) \qquad 2.30$$

The combination of the dimensionless time and wellbore storage is a way to reduce the number of independent variables and make the type curves easier to distinguish from each other. Since, by definition, the dimensionless pressure and time/storage are linear functions of actual pressure and time, the log of actual pressure change will differ from the log of the dimensionless pressure drop by a constant amount. The same is also true for the log of actual time. Thus when the appropriate interpretation model has been selected, the actual pressure vs. (time) curve and the theoretical curve P_D vs. (T_D/C_D) have identical shapes, but are shifted with respect to one and other when plotted on the same log-log scale.

The objective of this type curve analysis is to evaluate the amount of shift between the two sets of curves. When the actual data is matched to the theoretical curve on the log-log axes, a match point is selected and the reservoir parameters obtained by rearranging and substituting P_D and ΔP, and (T_D/c_D) and Δt into the above equations as follows:

$$[\frac{P_D}{\Delta P}]\, matchpoint = A \Rightarrow permeability \qquad 2.31$$

$$[\frac{t_D/C_D}{\Delta t}]\, matchpoint = (B/C) + permeability \Rightarrow wellbore\ storage \qquad 2.32$$

Originally P_D was plotted versus t_D on a series of distinct curves for welbore storage/skin and infinite acting radial flow (Agarwal et al., 1970). Manipulation of the dimensionless pressure equation, created a combined storage and skin variable, C_De^{2s} that could be used to generate a series of type curves (Gringarten, 1979) for different C_De^{2s} values. The skin factor is obtained by substitution of the calculated dimensionless storage into the C_De^{2s} value obtained from the type curve that gives the best match, and the corresponding C_De^{2s} appropriate to that curve. Other type curves have been developed for fractured reservoirs (see, for example, Bourdet and Gringarten, 1980) and for formations with composite behavior.

For further details of the theoretical aspects of type curve matching, the interested reader is referred to Gringarten (1987), Chapter 4 of Sabet (1991), and Section 3.3 of Earlougher (1977).

2.6.5 Dimensionless Type Curves

The solutions to the analytical models can be expressed as a series of dimensionless variables (Section 2.5.1). These dimensionless variables are important because they simplify the formation response models by representing the transient test parameters in terms of model parameters which remain fixed during the test, thus reducing the total number of unknowns which need to be considered. They also have the additional advantage of providing model solutions that are independent of units. The definition of these dimensionless variables assumes that the test parameters (flow rate, interval volume), the fluid parameters (viscosity, compressibility), and the reservoir parameters (permeability, compressibility, porosity, and reservoir thickness) all remain constant throughout the test.

Theoretical models of reservoir behavior can be presented as a family of dimensionless type curves, expressed in terms of dimensionless pressure (P_D), that are a function of t_D and other dimensionless variables. Each curve in the family is characterized by dimensionless variables that depend on the particular model. These parameters are defined as the product of a measured parameter (e.g. pressure

or time change) and parameters characterizing the reservoir (porosity, permeability, etc.).

The type curves used for the analysis of a pumped withdrawal test in a formation are called drawdown type curves and are defined as:

$$P_D = P_D[(\Delta t)_D] \qquad 2.33$$

The actual data for type curve analysis are defined as:

$$\Delta P = P_i - P(\Delta t) \qquad 2.34$$

The change in pressure (ΔP) is plotted against the change in time (Δt) where Δt is the elapsed time since the start of the pumping sequence, and ΔP is the corresponding pressure reading.

Interpretation models can be obtained by a combination of the appropriate component (inner boundary, formation behavior, and outer boundary) models which have been developed. Their dimensionless solutions are superposed (in space and time) to obtain the type curves required for analysis. Type curves have been published for most of the common reservoir configurations (e.g. homogeneous, dual porosity, etc).

The drawdown type curves are not strictly valid for analyzing flow periods (drawdowns or build-ups) after the first drawdown. For each drawdown type curve there exists a 'family' of build-up type curves that depend on the production period, t_p. The corresponding theoretical build-up type curve is obtained from the appropriate drawdown curve by superposition as follows (Gringarten et al., 1980):

$$(P_D)_{BU} = P_D(T_{pD}) - P_D(t_{pD} + \Delta t_D) + P_D(\Delta t_D) \qquad 2.35$$

The build-up type curves must be calculated for each test, because they depend upon the test conditions. For a multi rate (MR) flow test the type curve can be expressed by Eq. 2.16 in Section 2.5.

2.6.6 Derivative Type Curves

A relatively recent innovation (Bourdet et al., 1983), made much easier with the introduction of computer aided techniques, is to plot the derivative of P_D with respect to ln (t_D/C_D) on the same axes as the P_D vs. T_D/C_D. The derivative is useful as a diagnostic plot when trying to determine the different flow regimes that may occur during the test. The advantage of the derivative plot is that it is able to display in a single graph many separate characteristics that would otherwise require different plots.

During pure wellbore storage (Earlougher, 1977) showed that:

$$P_D = \frac{t_D}{C} \qquad 2.36$$

then taking the derivative

$$\frac{dP_D}{d(\frac{t_D}{C_D})} = P_D' = 1 \qquad 2.37$$

During infinite acting radial flow (which does not show a characteristic response on a log-log scale) in a homogeneous formation (Bourdet et al., 1983):

$$P_D = 0.5[\ln(\frac{t_D}{C_D}) + 0.80907 + \ln(C_D e^{2}s)] \qquad 2.38$$

then taking the derivative

$$\frac{dP_D}{d(\frac{t_D}{C_D})} = P_D' = 0.5/(\frac{t_D}{C_D}) \qquad 2.39$$

Therefore, both at early and late times, all P_D' behaviors are identical and independent of the C_De^{2s} values. At early time, all the curves merge into a straight line corresponding to $P_D' = 1$. At late time the curves merge into a single straight line of slope = -1, corresponding to $P_D' = 0.5/(t_D/C_D)$. Between these two asymptotes, each of the C_De^{2s} curves exhibit a specific shape. It is more useful however, to plot the type curves as P_D' (t_D/C_D) versus (t_D/C_D). This is a better choice of axes because the pressure and time axes are now consistent with the dimensioless pressure axes described earlier.

At early time, the type curves follow a unit slope log-log straight line. When infinite acting radial flow is reached, the derivative curves become horizontal at P_D' $(t_D/C_D) = 0.5$. Between these two asymptotes, the type curves and derivatives are distinctly different for the combined 'family' of C_de^{2s} curves. This makes it easier to correctly identify the correct C_de^{2s} curve corresponding to the data. The derivative shape also provides an improved diagnostic tool for other formation models such as dual porosity, composite, fracture flow, and outer boundary responses.

Modern well test analysis has been greatly enhanced by the introduction of the pressure derivative type curves. The advent of computer aided interpretation has made calculation of the derivative of real data relatively straightforward. The advantage of the derivative plot is that it is able to display in a single graph many separate characteristics of the flow system that would otherwise require different plots (Horne, 1990). The power of the pressure derivative arises from the fact that it magnifies the differences in shapes between the various flow regimes that can be present during a

given flow period, thereby enhancing the diagnostic capabilities of the analyst by a significant amount (Gringarten, 1986).

The interpretation method implemented in FLOWDIM, a Golder Associates proprietary software, takes full advantage of the derivative approach as discussed above. Test interpretation of the aquifer tests in the Florence study area were conducted using this software. The following section presents a brief discussion of the interpretation of each test.

3.0 TEST INTERPRETATION RESULTS

This section provides a brief description of the conditions during each aquifer test, general comments on the quality of the data, and results from the analytical interpretation. One critical piece of information during any hydraulic test program is the location of nearby active wells and their pumping rates and duration of pumping periods. In the case of the Florence aquifer tests, a precise discharge rate history for nearby agricultural wells is, in general, not available. Complete interpretation of the affected aquifer tests is not possible without this information, and the resulting estimated hydraulic conductivity may be inaccurate.

In some cases, boundary effects and abrupt changes in the pumped well discharge rate complicated the interpretation of the drawdown and recovery data, not to mention the effect of nearby agricultural wells. To the extent permitted by the data, an attempt was made to discern amongst effects produced by geological controls and those produced by the cycling of nearby agricultural wells. Information about the hydraulic tests conducted to date is summarized in Table 1 (See Appendix A). Also shown in this table are the name designations of the wells participating in a given test, starting and ending date of the test, and available information regarding geologic formation, screen location, drawdown and discharge data.

Table 2 (See Appendix A) presents a summary of the hydraulic conductivity estimates resulting from our interpretation. Also included in this table is the name of the formation penetrated by the particular well(s), and comments and qualifiers on the conductivity estimates. The available data are classified into three different categories; fair, acceptable and good. A fair data set is one that is interpretable but the estimated hydraulic conductivity should be used with caution. An acceptable data set represents a test with some uncertainty and usually results in an underestimate of the formation hydraulic parameters. A good data set results in a hydraulic conductivity that is deemed as a close representation of the formation conductivity.

The following table is considered useful for the understanding of subsequent section ans is therefore

included in the text. The table provides an abbreviated summary of the estimate hydraulic

Well Identification	Active/Observation	K (feet/day)
Basin Fill Deposits		
M1-GL	Active	17.3
M3-GL	Active	15.9
M14-GL	Active	1.7
M14-GL3d	Active	0.1
M15-GU	Active	2.6
M18-GL	Active	19.6
P28-GL	Active	8.3
O28-GL	Observation (P28-GL)	23.2
M3-GL	Observation (M4-O)	14.8
P8-GU	Active	61.3
Oxide		
M4-O	Active	0.6
PW2-1	Active	1.4
PW4-1	Active	3.8
PW7-1	Active	0.2
OB7-1	Observation (PW7-1)	0.1
P12-O	Active	0.4
O12-O	Observation (P12-O)	0.6
P19.1-O	Active	0.3
P19-O	Observation (P19.1-O)	0.2
P19.2-O	Observation (P19.1-O)	0.2
P19.1-O3d	Active	1.00E-02
P19-O3d	Observation (P19.1-O)	2.39E-04
P19.2-O3d	Observation (P19.1-O)	1.99E-04
P39-O	Active	0.3
O39-O	Observation (P39-O)	0.3
P28.1-O	Active	7.7
P28.1-O (2)	Active	3.6
P28.2 -O	Observation (P28.1-O)	2.7
P28.2-O	Active	3.1
O28.1-O	Observation (P28.2-O)	3.0
P13.1-O	Active	0.3
P49-O3d	Active/Recovery Data	7.75E-03
P15-O	Active	0.5

conductivity presented in Table 2 in Appendix A. This abbreviated table divides wells into those testing the Basin Fill Units, and those testing the mineralized bedrock.

As seen from this table, the hydraulic conductivity for the Basin Fill Units vary from 1.7 to 61.3 feet per day (ft/day), whereas that for the quartz monzonite and the granodiorite porphyry vary from 0.1 to 7.7 ft/day (with exception of the 3-D analyses). The maximum conductivity value for the Basin Fill units was derived from a test in the Upper Unit. The smaller variation in the hydraulic conductivity suggest a greater degree of heterogeneity than that of the mineralized bedrock.

Appendix A contains a summary sheet for each test interpretation, including a calculation of hydraulic conductivity in feet per minute (ft/min), feet/day (ft/day), meter per second (m/sec), and centimeter per second (cm/sec), as well as the estimated value of the skin factor. Appendix B presents the log-log plots of the type curve selected for the analysis, and observed drawdown versus time. Appendix C includes report forms from the FLOWDIM interpretation for each test. This form contains the well name, type of test, and date of the test. Well geometry information, such as well radius, interval length, formation tested, total depth, as well as discharge rate and test duration are also included in this form. In addition, this form presents also the model assumptions and numerical values for hydraulic parameters.

The following paragraphs offer a cursory description of test conditions and hydraulic conductivity estimates for each test. The first few tests are discussed in detail to provide the reader with a basis for understanding the remaining tests presented in Appendix A through C. Detailed discussion for unique and interesting tests is given as warranted by test response.

Aquifer Test on M1-GL

This constant rate test involved a single well with a discharge of 10 gallons per minute (gpm). Well M1-GL is a monitoring borehole completed within the lower basin fill unit (LBFU). Nearby agricultural wells BIA-9 and BIA-10B were reported to be active during the test. The test response shows a slight "recovery" of the hydraulic head during the test. This effect is responsible for the decrease in drawdown (circles) in the late time data presented in Figure 1B in Appendix B. Final

recovery of the hydraulic head resulted in a water elevation higher than the elevation reported at the beginning of the test; indicating that the observed hydraulic head response is a superposition of more than one stress on the aquifer (namely; the transient effects from wells BIA-9 and BIA-10B).

The log-log plot presented in Figure 1B shows both the drawdown data and its derivative with respect to the natural log of time (triangles) versus time, and the dimensionless type curve that was selected for interpretation of this test. In this particular case the selected type curve corresponds to a two-dimensional (notice the asymptotic approach to $p_D' = 0.5$), homogeneous flow model, with a $C_D e^{2s}$ parameter equal to 2×10^{8} . This value, in turn, results in a skin coefficient of 3.3 (see summary interpretation in Figure 1A in Appendix A) indicating some possible formation clogging near the well face. Figure 1B shows the transient effects produced by nearby pumping, and that the match between the data and the type curve is poor. The pressure derivative of the data shows a large amount of random variation in late time, making it difficult to better assess the hydraulic parameters. The hydraulic conductivity estimate is 17.3 ft/day. It is our opinion that this conductivity value most likely overestimates the actual conductivity of the formation in that the observed drawdown appears to be affected by a recovery trend that limits its final magnitude. The effect of nearby pumping (recovery) may be responsible for the extremely small estimate of the storage coefficient (8.4×10^{-9}).

Aquifer Test on M3-GL

Aquifer test on monitoring well M3-GL (Figure 14B) involved wells M2-GU, M4-O and M5-S as observation points. Average discharge from M3-GL during this test was reported at 10 gpm. Well M3-GL is completed in the Lower Basin Fill Unit, while M2-GU and M4-O are completed in the Upper Basin Fill Unit (UBFU) and the oxide unit, respectively. Irrigation Well ENGLAND #3 was on during the test but no information regarding its pumping rate is available. Observation wells M2-GU and M5-S showed recovery 100 minutes into the test. The hydraulic response for wells M2-GU and M4-O is minimal and quite erratic. This small response between M2-GU and M3-GL may indicate a limited hydraulic connection between the lower and Upper Basin Fill Unit in this area of

the site. After shut in of well M3-GL, observation wells M2-GU and M4-O showed a slight recovery and then began to drop off again which may be the result of cycling of agricultural pumping. The hydraulic response of well M5-S appears completely independent of pumping on well M3-GL. Due to the above conditions, the hydraulic responses from the observation wells were considered not suitable for interpretation.

Data interpretation for this test was accomplished by means of a 2-D, homogeneous model (as indicated by the approach of the derivative of $p_D = 0.5$) with a C_De^{2s} parameter equal to 1×10^{6} (Figure 14B). The skin parameter was estimated to be 1.16 (Figure 14A); indicating slight formation clogging near the well face. The overall fit of the drawdown data and the selected type curve is relatively good up to about 10 hours into the test. However, the pressure derivative data deviates sharply from the type curve just after about 0.1 hour into the test. The estimated hydraulic conductivity for the Lower Basin Fill Unit is 15.9 ft/day with a storage coefficient of 3×10^{-7}. The deviation of the data from the derivative and this small storage coefficient may be an effect produced by pumping from ENGLAND #3 well.

Aquifer Test on M14-GL

Well M14-GL was tested under a constant discharge of about 10 gpm. This well is completed within the Lower Basin Fill Unit (LBFU). Well M15-GU, in the Upper Basin Fill Unit, serves as an observation well. Irrigation Wells BIA-9 and BIA-10B were on during the test but no information is available regarding their pumping rate history. Additionally, M1-GL was pumping during testing. Very little drawdown was seen in the observation well (M15-GU). However, a sharp increase in hydraulic head was observed at about 1,000 minutes after pumping in M14-GL ceased. Recovery in the pumping well went beyond initial reported static water level. It is suspected that one or both of the pumping agricultural wells may be responsible for these effects. Field data from the observation well was not considered suitable for interpretation.

Two interpretation models were applied to the drawdown data from well M14-GL. First, a 2-D, homogeneous model (Figure 3A) was used to match the field data. It was seen (Figure 3B) that only the early data (t < 50 min) closely approximated both the pressure and pressure derivative of the 2-D type curve. At later times, the derivative of the field data deviated sharply from the type curve. As discussed in Section 2.6, this type of deviation is characteristic of a 3-D flow regime. Analyses of these data using a 3-D model (Figures 4A and 4B) shows that the overall fit to both pressure and pressure derivative improved significantly. Given the relatively short length of the screened interval as compared to the thickness of the Lower Basin Fill Unit in that location, it is not surprising that the test response suggests 3-D flow (typical of a partially penetrating well). Hydraulic conductivity estimates from these two different models are reported in Table 2 as well as in Figures 3C and 4C. The resulting conductivity estimates are 1.7 and 0.1 ft/day for the 2-D and 3-D models respectively. Although the 3-D type-curve better represents this field data, it is recommended, for the sake of conservatism, that numerical simulation of flow and transport be conducted with the larger hydraulic conductivity estimate. As will be discussed later for some of the other tests, 3-D conductivity estimates are typically smaller than corresponding 2-D estimates.

Aquifer Test on M15-GU

This constant rate test involved a single pumping well (M15-GU) discharging at 10 gpm from the upper consolidated unit (UBFU) and one observation well (M14-GL) which was completed in the Lower Basin Fill Unit (LBFU). Irrigation Wells BIA-9 and BIA-10B were on during the test but no information is available regarding their pumping rate history. The pumping well recovery rose above the static water level. It may be that one or both of the irrigation wells were shut off during testing, causing these effects. Due to the above effects the data form the observation well were not considered suitable for interpretation. Only the data for M15-GU was analyzed.

The selected type curve for the pumping well data (M15-GU) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 10 (see Figure 5C). This value, in turn, results in a skin

coefficient of 6.6 indicating (Figure 5A), perhaps, some formation clogging near the well face. As shown in the log-log plot (Figure 5B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 2.6 ft/day. The estimate for the storage coefficient is 1.1×10^{-11} which is clearly too small and another indication of the difficulty involved in modeling marginal data.

Aquifer Test on M18-GU

This constant rate test involved a single pumping well (M18-GU) with a discharge of 10 gpm from the Upper Basin Fill Unit (UBFU). This was a short duration test with no observation wells. The data set is fair for interpretation.

The selected type curve for the pumping well data (M18-GU) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 1.0×10^{15} . This value, in turn, results in a skin coefficient of 11.4 (Figure 6A) indicating significant formation clogging near the well face. As shown in the log-log plot (Figure 6B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 19.6 ft/day. The estimate for the storage coefficient is 8.7×10^{-16} which is clearly much too small and another indication of only a fair data set.

Aquifer Test on P39-O

This constant rate test involved a single pumping well (P39-O) with a discharge of 55 gpm pumping from the oxide zone. It had a single observation well (O39-O) which was also completed in the oxide zone. The data appears to be good and suitable for analysis.

The selected type curve for the pumping well data (P39-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 100. This value, in turn, results in a skin coefficient of -1.8 (Figure 7A). As shown in the log-log plot (Figure 7B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 0.3 ft/day and the estimate for the storage coefficient is 9.6×10^{-4}.

The selected type curve for the observation well data (O39-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0. As shown in this log-log plot (Figure 8B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 0.3 ft/day and the estimate for the storage coefficient is 4.3×10^{-4} (Figure 8C).

Aquifer Test on PW7-1

This constant rate test involved a single pumping well (PW7-1) with a discharge of 38 gpm from the oxide zone. Observation wells OB7-1 and OB-1 are also completed in the oxide zone. Observation well O3-GL straddles the interface between the basin fill deposits and the oxide. Irrigation wells BIA-10B and WW-3 were on during testing and appear to have had some effect on the data as shown by early recovery in these wells. However, data sets from PW7-1 and OB7-1 appear acceptable and suitable for analysis.

The selected type curve for the pumping well data (PW7-1) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 100. This value, in turn, results in a skin coefficient of -2.1 (Figure 17A) which indicates enhanced hydraulic conductivity near the well. As shown in the log-log plot (Figure 17B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is good. The hydraulic conductivity estimate is 0.2 ft/day and the estimate for the storage coefficient is 1.8×10^{-3} (Figure 17C).

The selected type curve for the observation well data (OB7-1) corresponds to a 2-D, homogeneous

flow model. As shown in this log-log plot (Figure 9B), and due to the transient effects produced by nearby pumping, the match between the data and the type curve is fair. The hydraulic conductivity estimate is 0.1 ft/day and the estimate for the storage coefficient is 1.3×10^{-4} (Figure 9C).

Aquifer Test on P12-O

This constant rate test involved a single pumping well (P12-O) with a discharge of 64 gpm from the oxide zone. Observation well O12-O was also completed in the oxide zone whereas observation well O12-GL was completed within the LBFU. The data appear to show multiple pumping well effects. Drawdown increased at approximately 500 minutes into the test, recovery was observed at 3,000 minutes, additional drawdown was seen at 7,000 minutes, and more recovery was observed at approximately 9,000 minutes. Large drawdown variations were also recorded the observation wells. Due to the above effects, this test is considered marginal for interpretation, and only the first 3,000 minutes of data from wells P12-O and O12-O were used.

The selected type curve for the pumping well data (P12-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 3.0. This value, in turn, results in a skin coefficient of -4.3 which indicates enhanced hydraulic conductivity near the well. This enhanced conductivity could be natural, as resulting from nearby fractures, or it could be due to the drilling and well development process. As shown in the log-log plot (Figure 19B), the match between the data and the type curve is fair. The hydraulic conductivity estimate is 0.4 ft/day and the estimate for the storage coefficient is 4.2×10^{-1}.

The selected type curve for observation well data (O12-O) corresponds to a 2-D, homogeneous flow model. As shown in this log-log plot (Figure 10B), the match between the data and the type curve is fair. The hydraulic conductivity estimate is 0.6 ft/day and the estimate for the storage coefficient is 2.2×10^{-3}.

Aquifer Test on P28-GL

This constant rate test involved a single pumping well (P28-GL) with a discharge of 75 gpm from the Lower Basin Fill Unit (LBFU). Observation well O28-GL was completed in the Lower Basin Fill Unit (LBFU) and observation wells P28.1-O, P28.2-O and O28.1-O were completed in the oxide zone. Observation well O28.2-S was completed in the sulfide zone. Irrigation Wells BIA-9 and BIA-10B were on during the test but no information is available regarding their pumping rate history. Additionally ENGLAND #3 and WW-3 were on briefly for sampling toward the beginning of the test, and P8-GU was also pumping during this test. The test results appear good and suitable for analysis, however, only data from P28-O and O29-GL were interpreted.

The selected type curve for the pumping well data (P28-GL) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 1.0×10^{6} . This value, in turn, results in a skin coefficient of 1.3 which may indicate some formation damage near the well face. As shown in the log-log plot (Figure 29B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is good. The hydraulic conductivity estimate is 8.3 ft/day and the estimate for the storage coefficient is 3.4×10^{-7}.

The selected type curve for the observation well data (O28-GL) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0. As shown in this log-log plot (Figure 11B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is fair. The hydraulic conductivity estimate is 23.2 ft/day. The estimate for the storage coefficient is 2.7×10^{-5}.

Aquifer Test on P28.2-O

This constant rate test involved a single pumping well (P28.2-O) with a discharge of 77 gpm pumping from the oxide zone. Observation wells P28-GL and O28-GL were completed in the Lower

Basin Fill Unit (LBFU), observation well O28.1-O and P28.1-O were completed in the oxide zone. and observation well O28.2-S was completed in the sulfide zone. Irrigation Wells BIA-9 and BIA10-B were on during the test but no information is available regarding their pumping rate history. These wells did affect the data in all observation wells as evidenced by decrease in the drawdown at later time in all observation wells. Also, the recovery in the pumping well went beyond static water level, indicating that the observations in the pumping well are not ideal for interpretation. However, overall, the test is judged to be acceptable for interpretation.

The selected type curve for the pumping well data (P28.2-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 10. This value, in turn, results in a skin coefficient of -6.5 which indicates enhanced hydraulic conductivity near the well. This enhanced conductivity could result from nearby fractures, or it could be due to the drilling and well development process. As shown in the log-log plot (Figure 33B), and due to the transient effects produced by nearby pumping, the match between the data and the type curve is only fair. The hydraulic conductivity estimate is 3.1 ft/day. The estimate for the storage coefficient turns out to be 3.8 which is clearly unreasonable (S is a dimensionless quantity smaller than one). This unreasonable storage coefficient estimate results, most likely, from a data set affected by pumping from wells BIA-9 and BIA 10-B. The resulting storativity estimates are, therefore, not reliable.

The selected type curve for the observation well data (O28.1-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0. As shown in this log-log plot (Figure 12B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is acceptable. The hydraulic conductivity estimate is 3.0 ft/day. The estimate for the storage coefficient is 1.1×10^{-3} (a much better result than was obtained from the pumping well).

Aquifer Test on PW2-1

This constant rate test involved a single pumping well (PW2-1) and one observation well OB2-1,

both on the oxide unit. Only the drawdown data for PW2-1 was analyzed; however, the observation well data appear suitable for analysis.

The selected type curve for the pumping well data (PW2-1) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0×10^8. The estimated skin coefficient is 4.3 indicating, perhaps, some formation clogging near the well face. As shown in the log-log plot (Figure 13B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 1.4 ft/day. Interestingly, the estimated storage coefficient (3.2×10^{-9}) seems too small compared to that computed for other tests on the oxide unit.

Aquifer Test on PW4-1 (Test 1)

This constant rate test involved a single pumping well (PW4-1) and one observation well OB4-1. Only the drawdown data for PW4-1 was analyzed; however, the observation data appear to be good and suitable for analysis.

The selected type curve for the pumping well data (PW4-1) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0×10^8 which results in a skin coefficient of 4.6 indicating (Figure 15A), perhaps, some formation clogging near the well face. As shown in the log-log plot (Figure 15B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 3.8 ft/day, however the estimate for the storage coefficient seems to small (2.5×10^{-9}).

Aquifer Test on M4-O

The aquifer test on monitoring well M4-O involved wells M2-GU, M3-GL and M5-S as observation points. Average discharge from M4-O during this test was reported at 15 gpm. Irrigation Well

ENGLAND #3 was on during the test but no information is available regarding its pumping rate history. Little or no drawdown was seen in any of the observation wells. However, at about 550 minutes into the test, the hydraulic head in all the wells shows a sharp decrease. After turning the pump off in well M4-O, the observation wells in the unconsolidated unit showed some partial recovery and then, at about 1,900 minutes, show a sharp drawdown. The hydraulic connection between the oxide unit and the overlain unconsolidated units seems limited at this location. Observation well M5-S (completed in the sulfide unit) did not show any drawdown, but instead recovered throughout the test indicating a very limited connection to the oxide unit. Due to these conditions, the test response from the observation wells M2-GU and M5-S was not considered suitable for interpretation.

FLOWDIM interpretation for the pumping well results in a fair match (Figure 16B) between the homogeneous 2-D model ($C_De^{2s} = 2 \times 10^8$) and the field data. The hydraulic conductivity estimate is 0.6 ft/day, with a skin factor of 3.8. The hydraulic conductivity is, however, deemed an underestimation of the actual formation conductivity due to the effect of pumping well ENGLAND #3.

Interpretation of observation well M3-GL used a 2-D model and resulted in a permeability estimate of 14.8 ft/day, and storativity of 8.8×10^{-2}. The match to the selected type curve is presented in Figure 2B.

Aquifer Test on P8-GU

This aquifer test involved a single pumping well (P8-GU) with a discharge of 85 gpm from the Upper Basin Fill Unit (UBFU). Four observations wells (P8.1-O, P8.2-O, O8-O, and O8-GL) were monitored. Irrigation wells BIA-9 and BIA-10B were on during the test but no information is available regarding their pumping rate history. Additionally, irrigation well WW-3 was turned on briefly for sampling toward the beginning of testing, and P28-GL was also pumped during testing. These wells did affect the measurements in the observation wells as evidenced by their lack of

recovery when the pumping in P8-GU was stopped at about 3200 minutes into the test. Also, the recovery in the pumping well did not reach static water level, indicating that the observations in the pumping well are only fair for interpretation.

Field data interpretation was attempted with a type curve for the drawdown data (P8-GU) corresponding to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 1.0×10^6. This value, in turn, results in a skin coefficient of 0.9 indicating, perhaps, only minor formation clogging near the well face. As shown in the log-log plot (Figure 18B), the match between the data and the type curve is fair. The hydraulic conductivity estimate is 61.3 ft/day and the estimate for the storage coefficient is 3.2×10^{-6}.

Aquifer Test on P13.1-O

This constant rate test involved a single pumping well (P13.1-O) with a discharge of 46 gpm. All irrigation wells are reported to be off during the test. Observation well P13-GL data shows some irregularity, but the pumping well and observation well P13.2-O appear suitable for analysis. Observation well O13-O showed no response during this test.

The selected type curve corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 1×10^6. This value, in turn, results in a skin coefficient of -3.4 which indicates enhanced hydraulic conductivity near the well. This enhanced conductivity could be the result of natural fractures or it might be due to the drilling and well development process. As shown in the log-log plot (Figure 20B), there is a good match between the data and the type curve so results of this test are judged to be good. The hydraulic conductivity estimate is 0.3 ft/day which is a typical value for the oxide zone and the storage coefficient estimate is 4.7×10^{-7}.

The hydraulic response for observation well P13.2-O shows a strong 3-D component (Figure 21B). Analyses of these data result in a hydraulic conductivity of 1.3×10^{-1} ft/day and a storativity of 7.0

$x10^{-7}$.

Aquifer Test on P15-O

This constant rate test involved a single pumping well (P15-O) with a discharge of 60 gpm. However, irrigation Wells BIA-9 and BIA-10B were on during the test but no information is available regarding their pumping rates. These wells did affect observation wells (P15-GL and O15-O) as evidenced by the sudden change in drawdown near the end of the test. The sudden change in drawdown is superimposed upon the drawdown due to P15-O and is difficult to separate. These irregularities indicate that the observation wells are not suitable for interpretation. The pumping well is suitable, however.

The selected type curve corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 1×10^2. This value, in turn, results in a skin coefficient of -5.0 which indicates enhanced hydraulic conductivity near the well. As shown in the log-log plot (Figure 22B), there is a fair match between the data and the type curve so results of this test are judged to be acceptable when considering the complications introduced by additional pumping wells (BIA-9 and BIA-10B). The hydraulic conductivity estimate is 0.5 ft/day which is a typical value for the oxide zone and the storage coefficient estimate is 1.3×10^{-2}.

Aquifer Test on P19.1-O

This constant rate test involved a single pumping well (P19.1-O) with a discharge of 24 gpm pumping from the oxide zone. Observation wells P19-O and P19.2-O were also completed in the oxide zone. Two additional observations wells were also monitored during this test (O19-GL and well 138). The data from these two wells were strongly affected by pumping in irrigation wells BIA-10B and WW-3. However, the data sets for the oxide wells appear acceptable for analysis.

The selected type curve for the pumping well data (P19.1-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0×10^{8} . This value, in turn, results in a skin coefficient of 5.1 indicating some formation damage or clogging near the well face. As shown in the log-log plot (Figure 25B), the match between the data and the type curve is acceptable. The hydraulic conductivity estimate is 0.3 ft/day and the estimate for the storage coefficient is 6.2×10^{-10}.

The selected type curve for observation well data (P19-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 3.0. As shown in this log-log plot (Figure 23B), the match between the data and the type curve is good. The hydraulic conductivity estimate is 0.2 ft/day and the estimate for the storage coefficient is 7.7×10^{-4}.

The selected type curve for observation well data (P19.2-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0. As shown in this log-log plot (Figure 27B), the match between the data and the type curve is fair. The hydraulic conductivity estimate is 0.2 ft/day and the estimate for the storage coefficient is 1.5×10^{-4}.

The above analyses show that the data deviates strongly from the 2-D flow model. Therefore, these data were reinterpreted using a 3-D model. For this interpretation, the selected type curve for the pumping well data.(P19.1-O) corresponds a C_De^{2s} parameter equal to 10. As shown in the log-log plot (Figure 26B), the match between the data and the type curve is slightly better than that obtained with the 2-D model. The estimated skin coefficient is -3.3 which indicates enhanced hydraulic conductivity near the well as opposed to the formation clogging indicated by the 2-D interpretation. The hydraulic conductivity estimate is 0.01 ft/day and the estimate for the storage coefficient is 5.6 $\times 10^{-3}$.

The selected 3-D type curve for observation well data (P19-O) corresponds a C_De^{2s} parameter equal to 3.0. As shown in this log-log plot (Figure 24B), the match between the data and the type curve is only slightly better than that obtained with the 2-D model. The hydraulic conductivity estimate is 2.4×10^{-4} ft/day and the estimate for the storage coefficient is 1.4×10^{-6}.

The selected 3-D type curve for observation well data (P19.2-O) corresponds a C_De^{2s} parameter equal to 3.0. As shown in this log-log plot (Figure 28B), the match between the data and the type curve is acceptable. The hydraulic conductivity estimate is 2.0 x 10^{-4} ft/day and the estimate for the storage coefficient is 3.4 x 10^{-7}.

Aquifer Test on P28.1-O (Test #1)

This constant rate test involved a single pumping well (P28.1-O) with a discharge of 28 gpm from the oxide zone. Observation wells P28-GL and O28-GL were completed in the Lower Basin Fill Unit (LBFU) and observation wells P28.2-O and O28.1-O were completed in the oxide zone. Irrigation Well England #3 was on during the test but no information is available regarding its pumping rate history. Also, the recovery in the pumping well went beyond static water level. Test interpretation included only the data set from the pumping well.

The selected type curve for the pumping well data (P28.1-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 10. This value, in turn, results in a skin coefficient of -6.7 which indicates enhanced hydraulic conductivity near the well. This enhanced conductivity could be natural, as resulting from nearby fractures, or it could be due to the drilling and well development process. As shown in the log-log plot (Figure 30B), and due to the transient effects produced by nearby pumping, the match between the data and the type curve is only fair. The hydraulic conductivity estimate is 7.7 ft/day. The estimate for the storage coefficient is 5.2 which is clearly unreasonable (S is a dimensionless quantity smaller than one). This impossible storage coefficient estimate results from a data set affected by pumping from irrigation well England #3. This data set is hard to match with a type curve.

Aquifer Test on P28.1-O (Test #2)

This constant rate test involved a single pumping well (P28.1-O) with a discharge of 86 gpm from the oxide zone. Observation wells P28-GL and O28-GL were completed in the Lower Basin Fill Unit (LBFU) and observation wells P28.2-O and O28.1-O were completed in the oxide zone. Irrigation Well BIA-9 was on during testing, as was well P8.1-O. However, the data appear well-behaved and suitable for analysis.

The selected type curve for the pumping well data (P28.1-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 10. This value, in turn, results in a skin coefficient of -4.2 which indicates enhanced hydraulic conductivity near the well. This enhanced conductivity could be natural, as resulting from nearby fractures, or it could be due to the drilling and well development process. As shown in the log-log plot (Figure 31B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is good. The hydraulic conductivity estimate is 3.6 ft/day and the estimate for the storage coefficient is 3.4×10^{-2}.

The selected type curve for the observation well data (P28.2-O) corresponds to a 2-D, homogeneous flow model, with a C_De^{2s} parameter equal to 2.0. As shown in this log-log plot (Figure 32B), and in spite of the transient effects produced by nearby pumping, the match between the data and the type curve is good. The hydraulic conductivity estimate is 2.7 ft/day. The estimate for the storage coefficient is 2.9×10^{-4}.

Aquifer Test on P49-O

The aquifer test conducted on well P49-O consisted of a constant discharge of about 40 gpm. Two observation wells were monitored during this test; well O49-O, completed in the oxide unit, and well O49-GL completed in the Lower Basin Fill Unit. More than 180 ft of drawdown in the pumping well rendered the pressure transducer dry. Pressure response on the observation wells was relatively clean, with well O49-O showing a drawdown of about 95 ft, and a drawdown in the basin fill well of about 0.5 ft. No other wells were reported in operation during this test, so the quality of the data

is good. As mentioned before, only partial data was collected during drawdown in the pumping well, so the hydraulic conductivity for this test was estimated from the shut in data.

The log-log plot (Figure 34B) for this test shows that a 3-D model represents the observed data quite well. A type-curve parameter C_De^{2s} of 0.3 produces and estimated hydraulic conductivity value of 7.8×10^{-3} ft/day and a skin coefficient of -7.7. The estimated storage coefficient is however surprisingly high (0.8). The reason for this extreme value is not apparent at this time.

4.0 DISCUSSION

The hydraulic conductivity estimates from aquifer tests in the basin fill are quite variable, ranging from 0.1 to 61.3 ft/day and, as expected, they are about an order of magnitude larger than the hydraulic conductivity estimates for the oxide zone. The majority of hydraulic conductivity estimates in the Basin Fill and oxide zone are reasonable. A large variation in storativity is observed and some of these estimates are unrealistically small. The smallest values are usually derived from interpretation of pumping well data. As commonly found in most filed tests, and also indicated by the Florence data, test analyses in observation wells tend to give more reasonable storativity estimates than analyses of pumping well data.

Analyses of many of the tests described above show the effects from multiple pumping wells with unknown pumping rate history. It is our opinion that further analyses of these tests would be better accomplished by inverse techniques that use available drawdown data to simultaneously estimate the unknown flow rate history in the agricultural wells and the aquifer parameters. Golder Associates has initiated work to accomplish these analyses. The actual effect of additional pumping from wells in the vicinity of a test on the magnitude of the estimated hydraulic parameters is not well understood. It would depend on whether a particular well is pumping or shut in after some period of pumping. When a nearby well is pumping, the estimates would more likely underestimate the actual aquifer parameters. The true effect needs, however, to be evaluated through analytical studies that simulate typical conditions observed in the field.

Several of the hydraulic responses for the tests analyzed in this report seem to be better interpreted by assuming a 3-D flow geometry. However, the estimated hydraulic conductivity and storativity obtained through the 3-D analysis are two or three orders of magnitude smaller than those obtained from the traditional 2-D radial flow model. The reason for the smaller hydraulic parameters is clear when one considers the area available for flow under each of these models. Under the 2-D radial flow model this area increases as a linear function of the distance from the pumping well, whereas for the 3-D model, it increases with the square of this distance.

In terms of predicting the producing capacity of a well, the distinction between alternative flow geometries is not crucial. However, for evaluation of transport of solutes through the aquifer this distinction becomes extremely relevant. It is important to notice, however, that for the simulation of solute transport in the context of the APP process, use of the 2-D hydraulic parameters results in conservative estimates of solute migration. By using a "reduced" area for solute transport (interaction) one would necessarily overestimate the potential migration of solutes. It is recommended that numerical simulations of flow and transport be carried out with the 2-D hydraulic parameter estimates.

Of paramount importance for the in-situ operation and for environmental protection, is the distinction between porous media flow and that resulting from discrete features. So far, the available field data indicate that flow at the Florence Site can safely be simulated with a porous media approach such as that built within numerical flow models like MODFLOW.

Golder Associates will continue interpreting the available hydraulic test data to support potential needs for the APP process and future mining needs. The next phase of aquifer test interpretation will concentrate on data from observation wells using inverse procedures as briefly described above. The three-dimensional model does not seem to fit the data sets any better than the two-dimensional model. Again, for the sake of conservatism, and due to the large uncertainty in the interpretation of these tests, it is recommended that the values obtained from the 2-D model be used for subsequent numerical simulations.

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6.0 NOMENCLATURE

Symbol		Unit
B	formation volume factors	-
c_r	rock compressibility	Pa^{-1}
c_t	total compressibility	Pa^{-1}
c_w	water compressibility	Pa^{-1}
c_{ww}	water compressibility in wellbore	Pa^{-1}
C	wellbore storage coefficient	m^3/Pa
C_D	dimensionless wellbore storage coefficient	-
d_i	distance to boundary "I"	m
g	acceleration due to gravity	ms^{-2}
h	test section length	m
h_m	thickness of matrix blocks	m
H	head	m
k	intrinsic permeability (1 milli Darcy = 10^{-15} m^2)	m^2
k_f	fracture permeability (in a double porosity system)	m^2
k_{fD}	dimensionless fracture permeability	-
k_{fw}	fracture permeability	m^2
k_m	matrix permeability	m^2
$(kh/\mu)_{1/2}$	mobility ratio	-
K	hydraulic conductivity	ms^{-1}
K_s	hydraulic conductivity of the skin zone	ms^{-1}
l	linear distance	m
m	meters	m
P	pressure	Pa
P_{atm}	atmospheric pressure	Pa
P_D	dimensionless pressure	-
q	flow rate	m^3/day
q_i	the ith constant rate flow period	m^3/s
r	radial distance	m
r_D	dimensionless radius	-
r_e	radius of circular constant pressure boundary	m
r_l	radius of the composite discontinuity	m
r_w	wellbore radius	m
r_{we}	effective well radius	m
s	skin factor of the well	-
s_f	skin factor between the fractures and the matrix	-
S	formation storage (storativity)	-
S_S	specific storage	m^{-1}

NOMENCLATURE - *continued*

Symbol		Unit
t	time	s
t_m	thickness of the matrix blocks	m
t_p	flow period duration	s
t_{pD}	dimensionless flow period duration	-
t_D	dimensionless time	-
V	volume of fluid	m^3
V_w	test section volume	m^3
x_f	fracture half-length	m
Z	elevation	m
α	dual porosity block geometry scale factor	-
ϕ	porosity	fraction
ϕ_f	fracture porosity	fraction
ϕ_m	matrix porosity	fraction
$(\phi c_t h)_{1/2}$	storativity ratio	-
λ	interporosity flow coefficient	-
μ	dynamic viscosity	Pa-s
ω	interporosity storativity ratio	-
ρ	density	Kg m^{-3}
Δt	time change	s
Δt_I	duration of the ith constant rate event	s

Tables

Table 1 Summary of Available Hydraulic Test Data

Active Well	Observation Wells	Start Date	End Date	Well Location	Screen Location	Drawdown Data	Rate Data	Summary Sheet
M1-GL		11-Aug	13-Aug	X	X	X	X	X
	none							
M2-GU		25-Jul	26-Jul	X	X	X	X	X
	M3-GL			X	X	X		X
	M4-O			X	X	X		X
	M5-S			X	?	X		X
M3-GL		26-Jul	27-Jul	X	X	X	X	X
	M2-GU			X	X	X		X
	M4-O			X	X	X		X
	M5-S			X	X	X		X
M4-O		28-Jul	29-Jul	X	X	X	X	X
	M2-GU			X	X	X		X
	M3-GL			X	X	X		X
	M5-S			X	?	X		X
M10-GU		25-Jul	26-Jul	X	X	X	X	X
	M11-GL			X	X	X		X
	M12-O			X	X	X		X
	M13-S			X	X	X		X
M11-GL		29-Jul	30-Jul	X	X	X	X	X
	M10-GU			X	X	X		X
	M12-O			X	X	X		X
	M13-S			X	X	X		X
M12-O		31-Jul	1-Aug	X	X	X	X	X
	M10-GU			X	X	X		X
	M11-GL			X	X	X		X
	M13-S			X	?	X		X
M14-GL		11-Aug	13-Aug	X	X	X	X	X
	M15-GU			X	X	X		X
M15-GU		8-Aug	11-Aug	X	X	X	X	X
	M14-GL			X	X	X		X
M18-GU		8-Aug	11-Aug	X	X	X	X	X
	none							
PW2-1		8-Mar	?	X	X	X	X	N/A
	OB2-1			X	X			
PW3-1		24-Mar	1-Apr	X	X	X	?	N/A
	OB3-1			X	X	X		
PW4-1	(Test 1)	19-May	?	X	X	X	X	N/A
	OB4-1			X	X	X		
PW4-1	(Test 2)	23-May	31-May	X	X	X	X	N/A
	OB4-1			X	X			
P5-O		18-Oct	24 Oct	X	X	X	X	X
	O5.1-O			X	X	X		X
	O5.2-O			X	X	X		X
P5-O-MOD		18-Oct	24 Oct	X	X	X	X	X
	O5.1-O			X	X	X		X
	O5.2-O			X	X	X		X

Table 1 Summary of Available Hydraulic Test Data

Active Well	Observation Wells	Start Date	End Date	Well Location	Screen Location	Drawdown Data	Rate Data	Summary Sheet
PW7-1		16-Jun	21-Jun	X	X	X	X	N/A
	OB7-1			X	X	X		
	O3-GL			X	X	X		
	OB-1			X	X	X		
P8.2-O		?	?	X	X	?	X	?
	P8-GL			X	X	?		
	P8.1-O			X	X	?		
	O8-O			X	X	?		
	O8-GL			X	X	?		
P8.1-O		8-Sep-95	11-Sep	X	X	X	X	X
	P8-GU			X	X	X		X
	P8.2-O			X	X	X		X
	O8-O			X	X	X		X
	O8-GU			X	X	X		X
P8-GU		18-Sep	22-Sep	X	X	X	X	X
	P8.1-O			X	X	X		X
	P8.2-O			X	X	X		X
	O8-O			X	X	X		X
	O8-GU			X	X	X		X
P12-O		1-Jun	7-Jun	X	X	X	X	X
	O12-O			X	X	X		X
	O12-GL			X	X	X		X
P13.1-O		9-Oct	16-Oct	X	X	X	X	X
	P13-GL			X	X	X		X
	P13.2-O			X	X	X		X
	O13-O			X	X	X		X
P15-O		29-Sep	5-Oct	X	X	X	X	X
	P15-GL			X	X	X		X
	O15-O			X	X	X		X
	WW3			?	?	?		X
	BIA-9			?	?	?		X
P19.1-O		3-Jul	6-Jul	X	X	X	X	N/A
	P19-O			X	X	X		
	P19.2-O			X	X	X		
	O19-GL			X	X	X		
	138			X	X	X		
P28-GL		20-Sep	25-Sep	X	X	X	X	X
	P28.1-O			X	X	No Data		
	P28.2-O			X	X	X		X
	O28-GL			X	X	X		X
	O28.1-O			X	X	X		X
	O28.2-S			X	X	X		X
P28.1-O		15-Aug	18-Aug	X	X	X	X	X
(Test 1)	P28.2-O			X	X	X		X
	P28-GL			X	X	X		X
	O28-GL			X	X	X		X
	O28.1-O			X	X	X		X
	O28.2-S			X	X	No Data		

Table 1 Summary of Available Hydraulic Test Data

Active Well	Observation Wells	Start Date	End Date	Well Location	Screen Location	Drawdown Data	Rate Data	Summary Sheet
P28.1-O		8-Sep	11-Sep	X	X	X	X	X
(Test 2)	P28.2-O			X	X	X		X
	P28-GL			X	X	X		X
	O28-GL			X	X	X		X
	O28.1-O			X	X	X		X
	O28.2-S			X	X	No Data		
P28.2-O		2-Oct	5-Oct	X	X	X	X	X
	P28-GL			X	X	X		X
	P28.1-O			X	X	X		X
	O28.1-O			X	X	X		X
	O28-GL			X	X	X		X
	O28.2-O			X	X	X		X
P39-O		19-May	20-May	X	X	X	X	X
	O39-O			X	X	X		X
P49-O		11-Oct	16-Oct	X	X	X	X	X
	O49-O			X	X	X		X
	O49-GL			X	X	X		X

Table 2. Hydraulic Conductivity Estimates

Well	Active/Observation	K (feet/day)	Screened Formation	Comments
M1-GL	Active	17.3	LBFU	(1), (2); Acceptable
M3-GL	Active	15.9	LBFU	(1), (3); Acceptable
M14-GL	Active	1.7	LBFU	(1), (2); Acceptable
M14-GL3d	Active	0.1	LBFU	(1), (2); Acceptable
M15-GU	Active	2.6	LBFU	(1), (2), (3); Acceptable
M18-GL	Active	19.6	LBFU	(1); Fair
P28-GL	Active	8.3	LBFU	(1), (3); Acceptable
O28-GL	Observation (P28-GL)	23.2	LBFU	(1), (3); Acceptable
M3-GL	Observation (M4-O)	14.8	LBFU	(1), (3); Acceptable
P8-GU	Active	61.3	UBFU	(1), (2), (3); Fair
M4-O	Active	0.6	Oxide	(1), (3); Acceptable
PW2-1	Active	1.4	Oxide	Good
PW4-1	Active	3.8	Oxide	Good
PW7-1	Active	0.2	Oxide	(1), (3); Acceptable
OB7-1	Observation (PW7-1)	0.1	Oxide	(1), (3); Acceptable
P12-O	Active	0.4	Oxide	(1), (2), (3); Fair
O12-O	Observation (P12-O)	0.6	Oxide	(1), (2), (3); Fair
P19.1-O	Active	0.3	Oxide	(1), (2), (3); Acceptable
P19-O	Observation (P19.1-O)	0.2	Oxide	(1), (2), (3); Acceptable
P19.2-O	Observation (P19.1-O)	0.2	Oxide	(1), (2), (3); Fair
P19.1-O3d	Active	1.00E-02	Oxide	(1), (2), (3); Acceptable
P19-O3d	Observation (P19.1-O)	2.39E-04	Oxide	(1), (2), (3); Acceptable
P19.2-O3d	Observation (P19.1-O)	1.99E-04	Oxide	(1), (2), (3); Acceptable
P39-O	Active	0.3	Oxide	Good
O39-O	Observation (P39-O)	0.3	Oxide	Good
P28.1-O	Active	7.7	Oxide	(1), (3); Fair
P28.1-O (2)	Active	3.6	Oxide	(1); Good
P28.2 -O	Observation (P28.1-O)	2.7	Oxide	(1); Good
P28.2-O	Active	3.1	Oxide	(1), (3); Fair
O28.1-O	Observation (P28.2-O)	3.0	Oxide	(1), (3); Acceptable
P13.1-O	Active	0.3	Oxide	Good
				Obs. Well shows 3-D behavior
P49-O3d	Active/Recovery Data	7.75E-03	Oxide	Good, Clear 3-D behavior
P15-O	Active	0.5	Oxide	(1),(3); Acceptable

(1) Other wells were pumping during this test at an unknown rate
(2) Data indicates recovery over the initial "static" water table
(3) Observation wells show effects of recovery or drawdown produced by other wells

Qualifiers	Description
Good	The reported K value is a good indication of the formation hydraulic conductivity
Acceptable	The reported K value is most likely an under-estimation of the formation conductivity
Fair	The reported K value has a large uncertainty due to conditions during test

Figures

APPENDIX A

FlowDim Analysis File : **m1-gld.dat**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**4.35E-06**	m^3/Pa
h	Length of aquifer tested	**12.19**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+08
P (kPa)	7.5335E-01
T (hr)	3.9350E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
7.43E-04	**1.20E-02**	**17.29**	**6.10E-05**	**6.10E-03**	**3.32**

FlowDim Analysis File : **m3gloddb.fd1**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.000E-03**	Pa s
ρ	Groundwater density	**1.000E+03**	kg/m^3
c_t	Total compressibility	**5.400E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**N/A**	m^3/Pa
h	Length of aquifer tested	**18.29**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	N/A
P (kPa)	6.4470E-01
T (hr)	4.1462E-01

Results

$T(m^2/sec)$	K (feet/min)	K(feet/dat)	K (m/s)	K (cm/s)	Skin
9.53E-04	**1.03E-02**	**14.77**	**5.21E-05**	**5.21E-03**	#########

FlowDim Analysis File : **m14-gld.dat**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**2.35E-06**	m^3/Pa
h	Length of aquifer tested	**18.29**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi \, c_t \, h \, r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+06
P (kPa)	1.1410E-01
T (hr)	1.1015E+02

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.12E-04	**1.21E-03**	**1.74**	**6.15E-06**	**6.15E-04**	**1.18**

FlowDim Analysis File : **m14gld3d.dat**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**2.22E-06**	m^3/Pa
h	Length of aquifer tested	**18.29**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+01
P (kPa)	1.0766E-02
T (hr)	1.1022E+01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
5.31E-06	**5.71E-05**	**0.08**	**2.90E-07**	**2.90E-05**	**-4.54**

FlowDim Analysis File : **m15-gud.dat**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**2.78E-07**	m^3/Pa
h	Length of aquifer tested	**12.19**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+10
P (kPa)	1.1287E-01
T (hr)	9.2222E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.11E-04	**1.80E-03**	**2.59**	**9.14E-06**	**9.14E-04**	**6.65**

FlowDim Analysis File : **m18-gud.dat**

	Parameter		Units
r_w	Well radius	0.064	m
μ	Groundwater viscosity	1.00E-03	Pa s
ρ	Groundwater density	1.00E+03	kg/m^3
c_t	Total compressibility	5.40E-10	1/Pa
ϕ	Porosity of formation	10.00	%
C	Wellbore storage	2.25E-06	m^3/Pa
h	Length of aquifer tested	12.19	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+15
P (kPa)	8.5570E-01
T (hr)	8.6654E+02

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
8.44E-04	1.36E-02	19.64	6.93E-05	6.93E-03	11.36

FlowDim Analysis File : **mf39pwpd.dat**

	Parameter		Units
r_w	Well radius	**0.130**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**1.04E-06**	m^3/Pa
h	Length of aquifer tested	**108.20**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+02
P (kPa)	2.0728E-02
T (hr)	2.4897E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.12E-04	**2.04E-04**	**0.29**	**1.04E-06**	**1.04E-04**	**-1.76**

FlowDim Analysis File : **mf39owpd.dat**

	Parameter		Units
r_w	Well radius	**0.127**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**50.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**126.80**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+00
P (kPa)	2.6738E-02
T (hr)	9.3173E-01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.44E-04	**2.24E-04**	**0.32**	**1.14E-06**	**1.14E-04**	#########

FlowDim Analysis File : **ob7-1dda.fd1**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.000E-03**	Pa s
ρ	Groundwater density	**1.000E+03**	kg/m^3
c_t	Total compressibility	**5.400E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**N/A**	m^3/Pa
h	Length of aquifer tested	**103.63**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	N/A
P (kPa)	1.2560E-02
T (hr)	5.7458E+00

Results

$T(m^2/sec)$	K (feet/min)	K(feet/dat)	K (m/s)	K (cm/s)	Skin
4.95E-05	**9.40E-05**	**0.14**	**4.78E-07**	**4.78E-05**	#########

FlowDim Analysis File : **012-oddc.fd1**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.000E-03**	Pa s
ρ	Groundwater density	**1.000E+03**	kg/m^3
c_t	Total compressibility	**5.400E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**N/A**	m^3/Pa
h	Length of aquifer tested	**152.40**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	N/A
P (kPa)	5.0164E-02
T (hr)	1.0792E+00

Results

$T(m^2/sec)$	K (feet/min)	K(feet/dat)	K (m/s)	K (cm/s)	Skin
3.21E-04	**4.15E-04**	**0.60**	**2.11E-06**	**2.11E-04**	#########

FlowDim Analysis File : **o28-gld.dat**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**9.14**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+00
P (kPa)	1.0130E-01
T (hr)	6.1809E+01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
7.49E-04	**1.61E-02**	**23.22**	**8.19E-05**	**8.19E-03**	#########

FlowDim Analysis File : **o281-od.dat**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**30.48**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+00
P_{DM}	4.2352E-02
T_{DM}	4.3542E-01

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.17E-04	**2.05E-03**	**2.95**	**1.04E-05**	**1.04E-03**	#########

FlowDim Analysis File : **pw2-1d.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**2.36E-06**	m^3/Pa
h	Length of aquifer tested	**67.06**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+08
P (kPa)	6.5031E-02
T (hr)	3.1235E+02

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.20E-04	**9.41E-04**	**1.35**	**4.78E-06**	**4.78E-04**	**4.31**

FlowDim Analysis File : **pm3-glda.fd1**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**8.16E-07**	m^3/Pa
h	Length of aquifer tested	**12.19**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+06
P (kPa)	6.9300E-01
T (hr)	1.9300E+03

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
6.83E-04	**1.10E-02**	**15.88**	**5.60E-05**	**5.60E-03**	**1.51**

FlowDim Analysis File : **pw4-1.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**1.87E-06**	m^3/Pa
h	Length of aquifer tested	**103.63**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+08
P (kPa)	1.9640E-01
T (hr)	1.6933E+03

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.37E-03	**2.61E-03**	**3.76**	**1.33E-05**	**1.33E-03**	**4.65**

FlowDim Analysis File : **pm4-od.fd1**

	Parameter		Units
r_w	Well radius	**0.06**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**1.38E-06**	m^3/Pa
h	Length of aquifer tested	**18.29**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+08
P (kPa)	2.4300E-02
T (hr)	6.0000E+01

Results

$T(m^2/sec)$	K (feet/min)	K (feet/day)	K (m/s)	K (cm/s)	Skin
3.59E-05	**3.86E-04**	**0.56**	**1.96E-06**	**1.96E-04**	**3.75**

FlowDim Analysis File : **PW7-1dda.fd1**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.000E-03**	Pa s
ρ	Groundwater density	**1.000E+03**	kg/m^3
c_t	Total compressibility	**5.400E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**6.871E-07**	m^3/Pa
h	Length of aquifer tested	**103.63**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+02
P (kPa)	2.1298E-02
T (hr)	2.8162E+02

Results

$T(m^2/sec)$	K (feet/min)	K (feet/day)	K (m/s)	K (cm/s)	Skin
8.40E-05	**1.59E-04**	**0.23**	**8.10E-07**	**8.10E-05**	**-2.10**

FlowDim Analysis File : **p8-gud.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**1.19E-05**	m^3/Pa
h	Length of aquifer tested	**36.58**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+06
P (kPa)	9.0703E-01
T (hr)	1.5374E+03

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
7.91E-03	**4.26E-02**	**61.31**	**2.16E-04**	**2.16E-02**	**0.90**

FlowDim Analysis File : **P12-oddc.fd1**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.000E-03**	Pa s
ρ	Groundwater density	**1.000E+03**	kg/m^3
c_t	Total compressibility	**5.400E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**4.640E-06**	m^3/Pa
h	Length of aquifer tested	**152.40**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	3.0000E+00
P (kPa)	3.1823E-02
T (hr)	1.0126E+02

Results

$T(m^2/sec)$	K (feet/min)	K (feet/day)	K (m/s)	K (cm/s)	Skin
2.04E-04	**2.63E-04**	**0.38**	**1.34E-06**	**1.34E-04**	**-4.27**

FlowDim Analysis File : **P131od.dat**

	Parameter		Units
r_w	Well radius	0.076	m
μ	Groundwater viscosity	1.00E-03	Pa s
ρ	Groundwater density	1.00E+03	kg/m^3
c_t	Total compressibility	5.40E-10	1/Pa
ϕ	Porosity of formation	0.05	%
C	Wellbore storage	1.75E-03	m^3/Pa
h	Length of aquifer tested	206.35	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+06
P (kPa)	4.2200E-02
T (hr)	2.5150E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
1.91E-04	1.82E-04	0.26	9.26E-07	9.26E-05	-3.38

FlowDim Analysis File : **P132od3d.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**0.05**	%
C	Wellbore storage	**N/A**	m^3/Pa
h	Length of aquifer tested	**182.27**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	N/A
P (kPa)	3.6000E-05
T (hr)	4.2500E-01

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
8.18E-08	**8.84E-08**	**1.27E-04**	**4.49E-10**	**4.49E-08**	########

FlowDim Analysis File : **P150d.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**0.05**	%
C	Wellbore storage	**4.94E-06**	m^3/Pa
h	Length of aquifer tested	**219.46**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+02
P (kPa)	6.6100E-02
T (hr)	1.7940E+02

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.84E-04	**3.44E-04**	**0.50**	**1.75E-06**	**1.75E-04**	**-5.02**

FlowDim Analysis File : **p19-od.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**60.35**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2\, \pi\, \phi\, c_t\, h\, r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	3.0000E+00
P (kPa)	1.8917E-02
T (hr)	3.7000E-01

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
4.10E-05	**1.34E-04**	**0.19**	**6.80E-07**	**6.80E-05**	#########

FlowDim Analysis File : **p19-od3d.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**60.35**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	3.0000E+00
P (kPa)	4.6825E-05
T (hr)	2.4582E-01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
5.08E-08	**1.66E-07**	**0.00**	**8.41E-10**	**8.41E-08**	#########

FlowDim Analysis File : **p191-od.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**4.58E-07**	m^3/Pa
h	Length of aquifer tested	**60.35**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+08
P (kPa)	2.9442E-02
T (hr)	3.2135E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
6.39E-05	**2.08E-04**	**0.30**	**1.06E-06**	**1.06E-04**	**5.08**

FlowDim Analysis File : **p191od3d.dat**

	Parameter		Units
r_w	Well radius	0.076	m
μ	Groundwater viscosity	1.00E-03	Pa s
ρ	Groundwater density	1.00E+03	kg/m^3
c_t	Total compressibility	5.40E-10	1/Pa
ϕ	Porosity of formation	5.00	%
C	Wellbore storage	4.19E-07	m^3/Pa
h	Length of aquifer tested	60.35	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+01
P (kPa)	2.1754E-03
T (hr)	2.5952E+01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
2.36E-06	7.70E-06	0.01	3.91E-08	3.91E-06	-3.28

FlowDim Analysis File : **p192-od.dat**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**60.35**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+00
P (kPa)	1.4484E-02
T (hr)	1.7103E+00

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.14E-05	**1.02E-04**	**0.15**	**5.20E-07**	**5.20E-05**	#########

FlowDim Analysis File : **p192od3d.dat**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**60.35**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	3.0000E+00
P (kPa)	3.8942E-05
T (hr)	1.0011E+00

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
4.22E-08	**1.38E-07**	**0.00**	**7.00E-10**	**7.00E-08**	#########

FlowDim Analysis File : **p28-gld.dat**

	Parameter		Units
r_w	Well radius	**0.064**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**10.00**	%
C	Wellbore storage	**8.71E-07**	m^3/Pa
h	Length of aquifer tested	**9.14**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi \, c_t \, h \, r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+06
P (kPa)	3.6017E-02
T (hr)	7.0454E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
2.66E-04	**5.73E-03**	**8.26**	**2.91E-05**	**2.91E-03**	**1.33**

FlowDim Analysis File : **p281-oad.dat**

	Parameter		Units
r_w	Well radius	0.067	m
μ	Groundwater viscosity	1.00E-03	Pa s
ρ	Groundwater density	1.00E+03	kg/m^3
c_t	Total compressibility	5.40E-10	1/Pa
ϕ	Porosity of formation	5.00	%
C	Wellbore storage	1.50E-04	m^3/Pa
h	Length of aquifer tested	30.48	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+01
P (kPa)	2.8879E-01
T (hr)	1.2647E+01

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
8.25E-04	5.33E-03	7.68	2.71E-05	2.71E-03	-6.69

FlowDim Analysis File : **p281-obd.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**1.28E-06**	m^3/Pa
h	Length of aquifer tested	**30.48**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+01
P (kPa)	4.6017E-02
T (hr)	6.9315E+02

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.86E-04	**2.49E-03**	**3.59**	**1.26E-05**	**1.26E-03**	**-4.18**

FlowDim Analysis File : **p282-obd.dat**

	Parameter		Units
r_w	Well radius	**0.051**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**NA**	m^3/Pa
h	Length of aquifer tested	**30.18**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	2.0000E+00
P (kPa)	3.3963E-02
T (hr)	3.9303E+00

Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
2.84E-04	**1.86E-03**	**2.67**	**9.43E-06**	**9.43E-04**	#########

FlowDim Analysis File : **p282-od.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**5.00**	%
C	Wellbore storage	**1.41E-04**	m^3/Pa
h	Length of aquifer tested	**30.18**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s} \, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	1.0000E+01
P (kPa)	4.4105E-02
T (hr)	5.4115E+00

Results

T(m^2/sec)	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.30E-04	**2.15E-03**	**3.10**	**1.09E-05**	**1.09E-03**	**-6.53**

FlowDim Analysis File : **P49Od.dat**

	Parameter		Units
r_w	Well radius	**0.076**	m
μ	Groundwater viscosity	**1.00E-03**	Pa s
ρ	Groundwater density	**1.00E+03**	kg/m^3
c_t	Total compressibility	**5.40E-10**	1/Pa
ϕ	Porosity of formation	**0.05**	%
C	Wellbore storage	**1.78E-06**	m^3/Pa
h	Length of aquifer tested	**126.19**	m

Skin Factor Calculation

Assuming formation storativity, the skin factor (s) can be calculated from the following equation.

$$s = \frac{\ln (C_D e^{2s}\, 2 \pi \phi c_t h r_w^2 / C)}{2}$$

Match Point Parameters From Analysis

$C_D e^{2s}$	3.0000E-01
P (kPa)	1.7500E-03
T (hr)	8.9400E+00

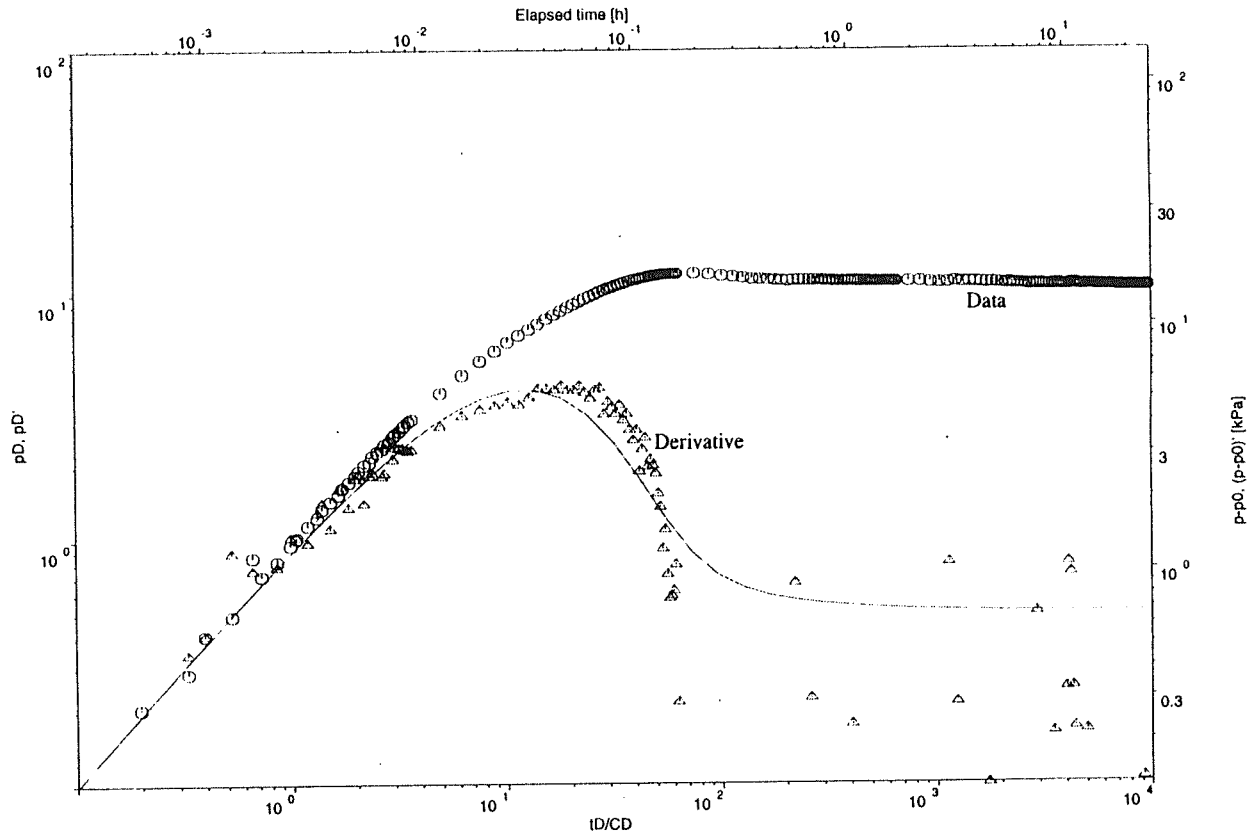
Results

$T(m^2/sec)$	K (feet/min)	K (ft/day)	K (m/s)	K (cm/s)	Skin
3.45E-06	**5.38E-06**	**7.75E-03**	**2.73E-08**	**2.73E-06**	**-7.69**

APPENDIX B

Florence, Arizona / M1-GL
Lower Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

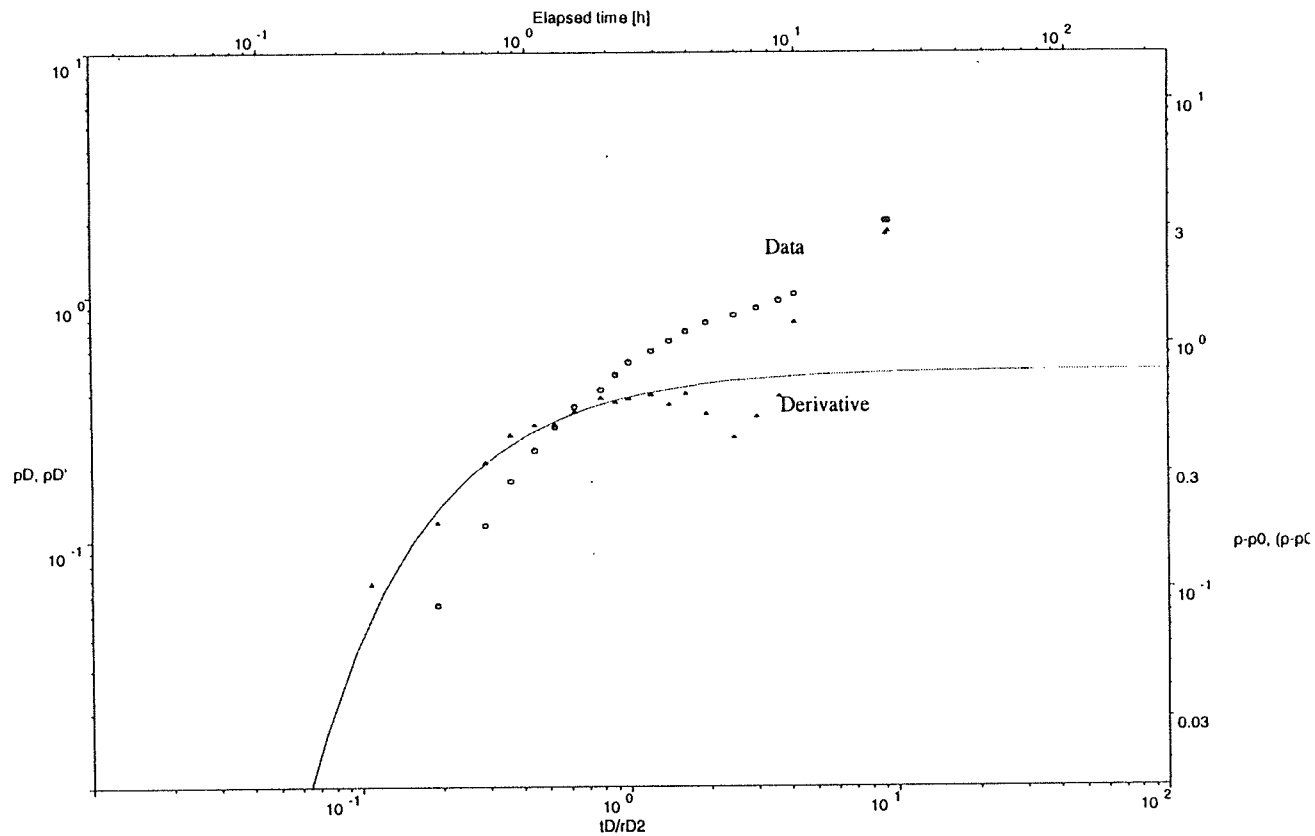
C=	4.35E-06	m3/Pa
T=	7.43E-04	m2/s
S=	8.43E-09	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 1B

Golder Associates

Florence, Arizona / M3-GL
Lower Gila / Obs Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

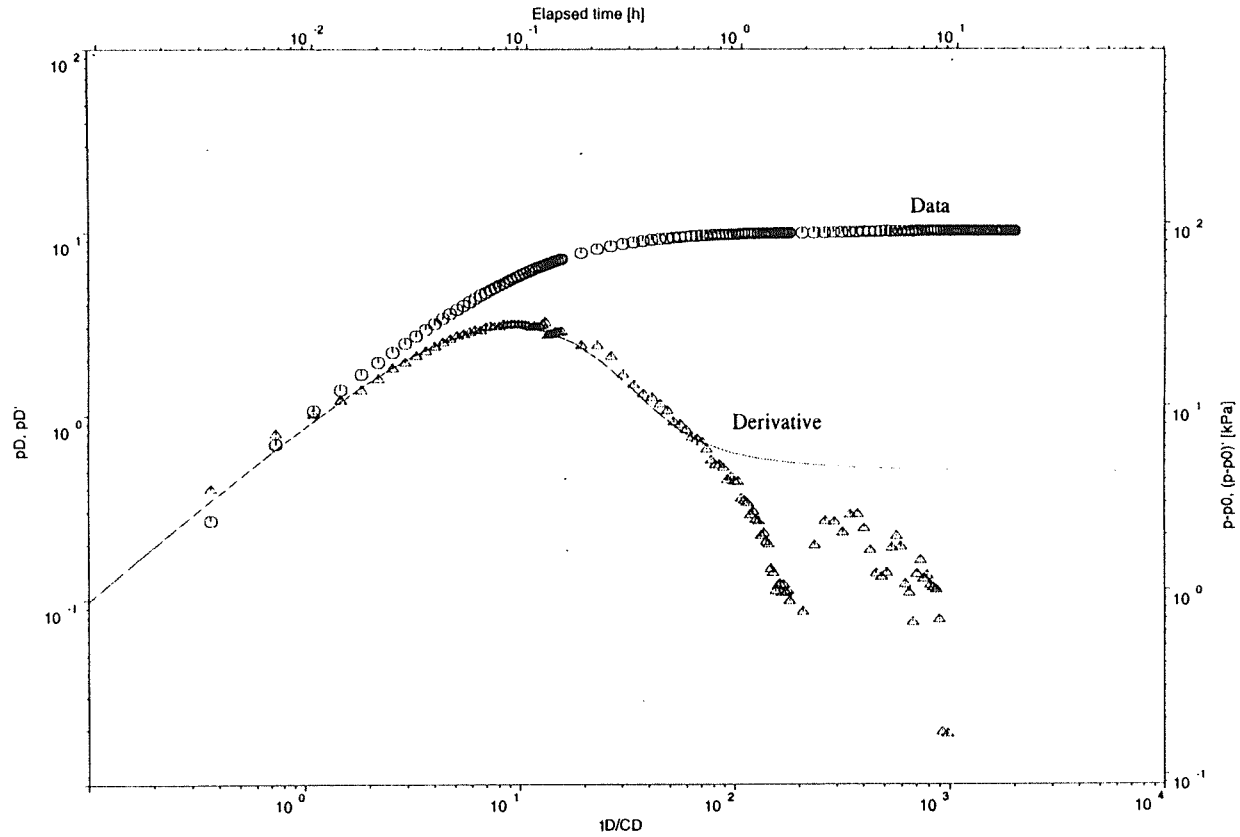
T=	9.53E-04	m2/s
S=	8.78E-02	-
rD=	1.53E+02	-
n=	2.00E+00	-

Figure 2B

Golder Associates

Florence Site / M14-GL
Lower Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



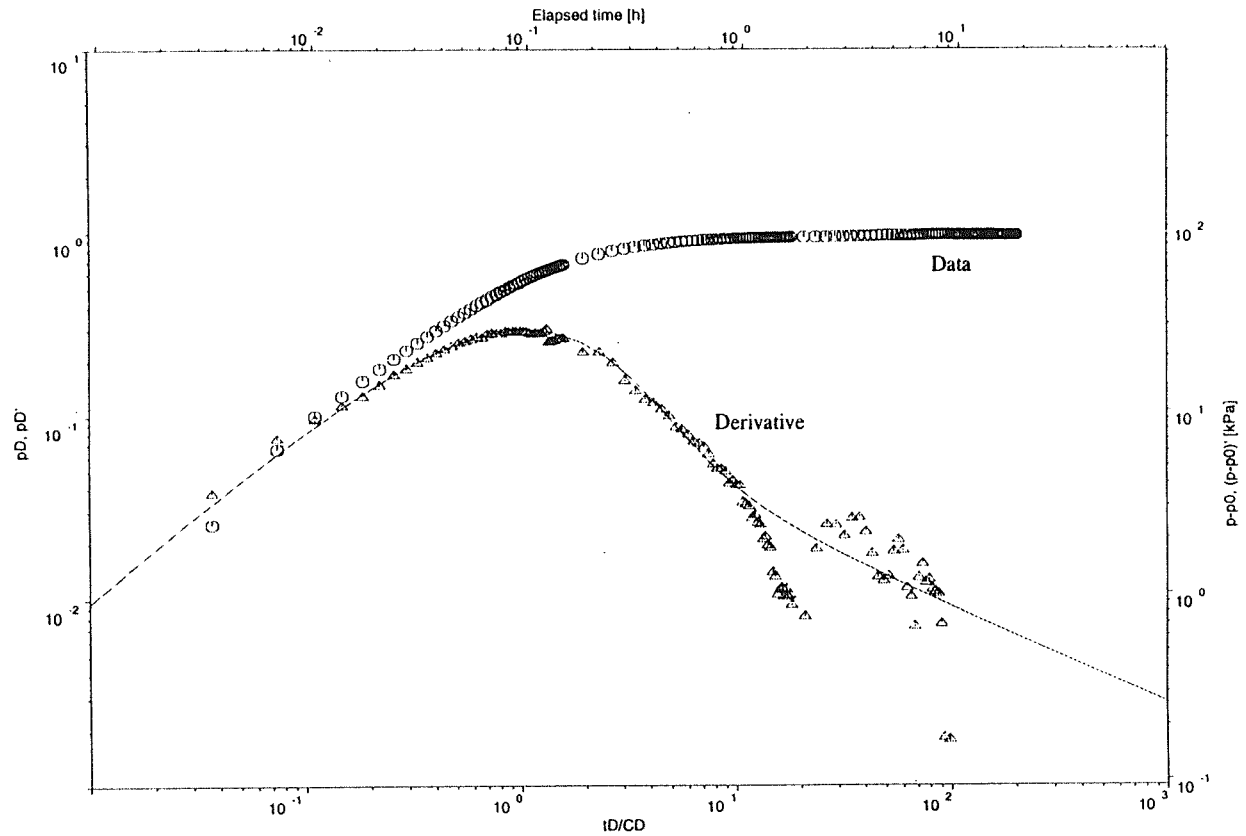
FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

C=	2.35E-06	m3/Pa
T=	1.12E-04	m2/s
S=	9.11E-07	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 3B

Florence Site / M14-GL
Lower Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

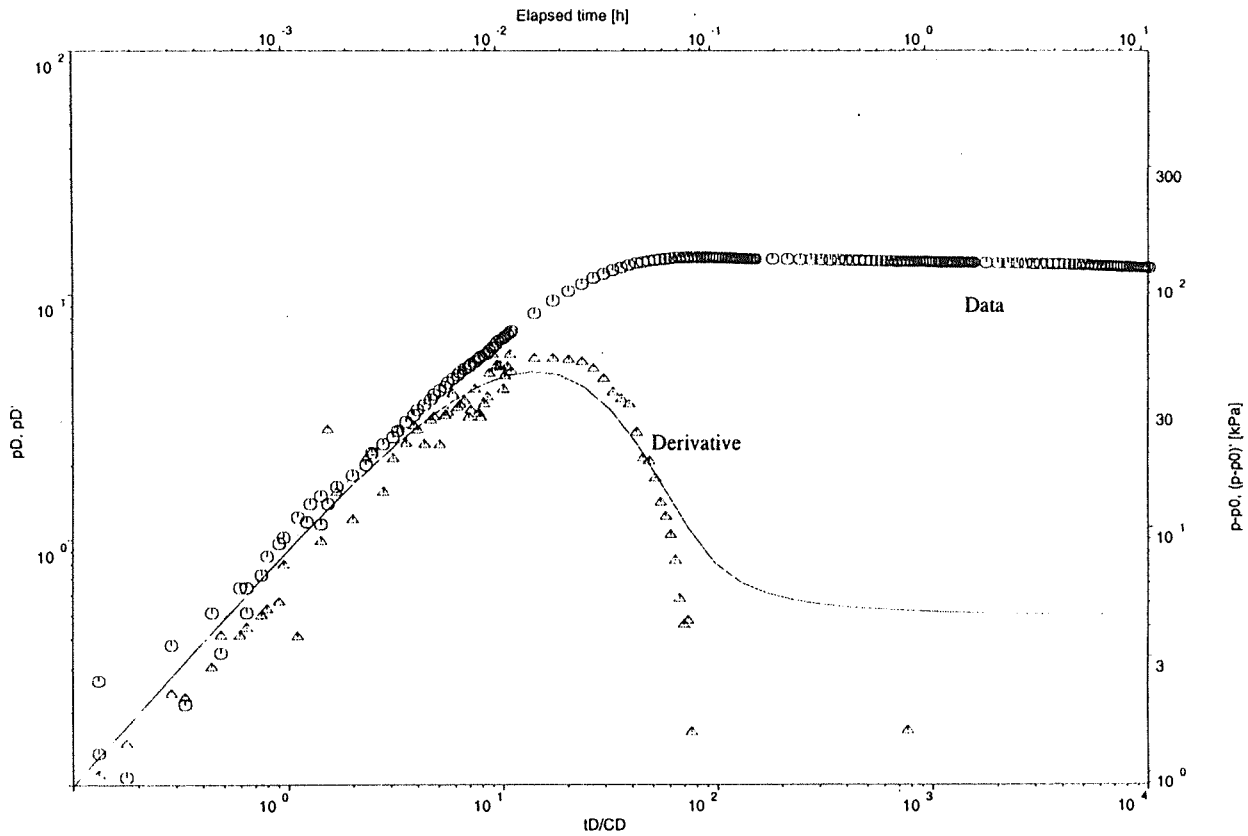
C=	2.22E-06	m3/Pa
T=	5.31E-06	m2/s
S=	4.30E-02	-
s=	0.00E+00	-
n=	3.00E+00	-

Figure 4B

Golder Associates

Florence, Arizona / M15-G
Upper Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

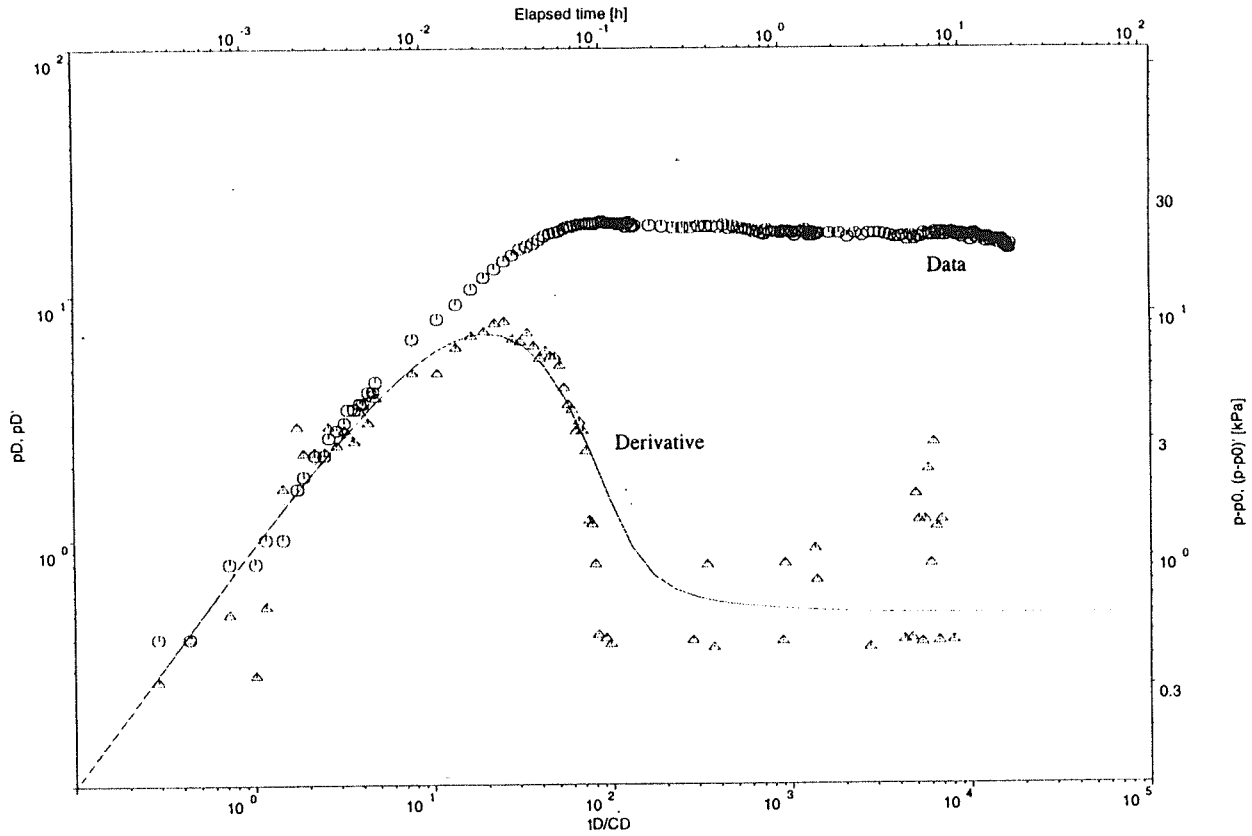
C=	2.78E-07	m3/Pa
T=	1.11E-04	m2/s
S=	1.08E-11	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 5B

Golder Associates

Florence, Arizona / M18-G
Upper Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

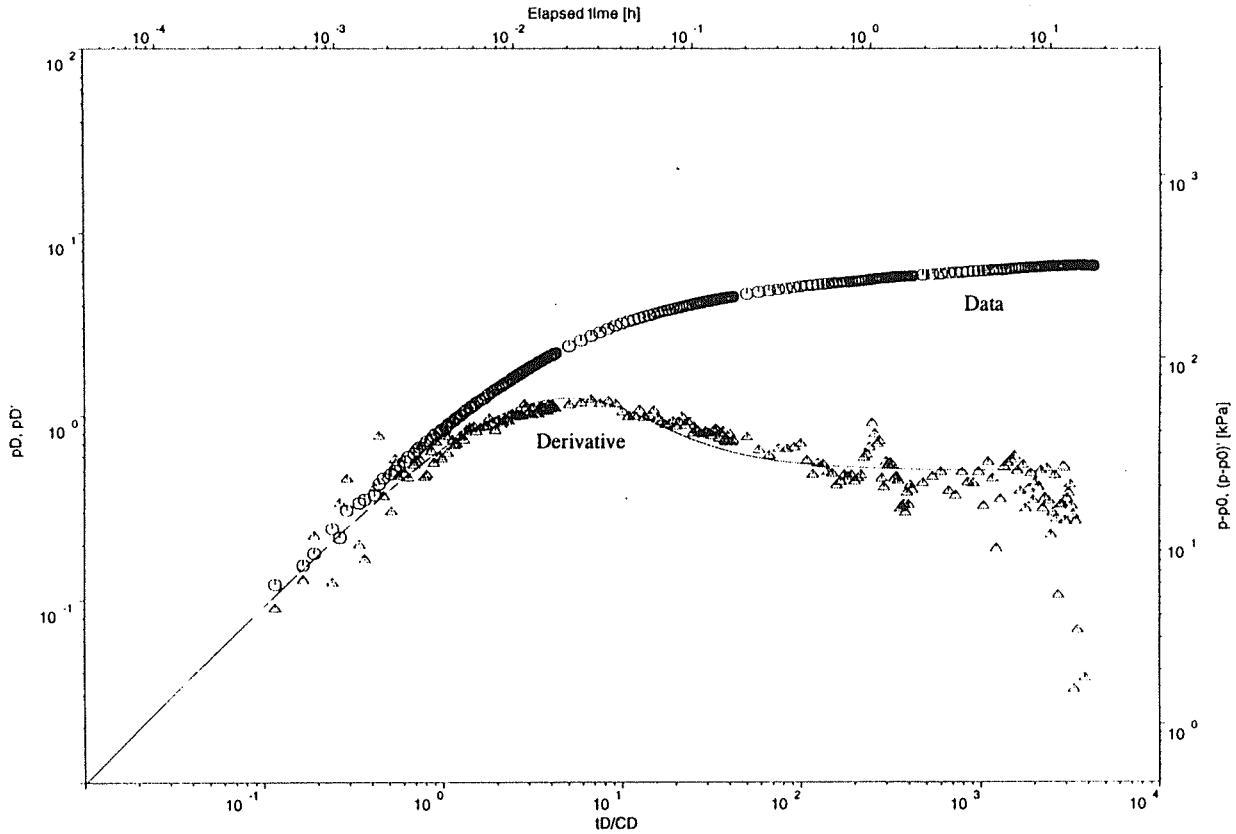
C=	2.25E-06	m3/Pa
T=	8.44E-04	m2/s
S=	8.70E-16	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 6B

Golder Associates

Florence, Arizona / P30-O
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

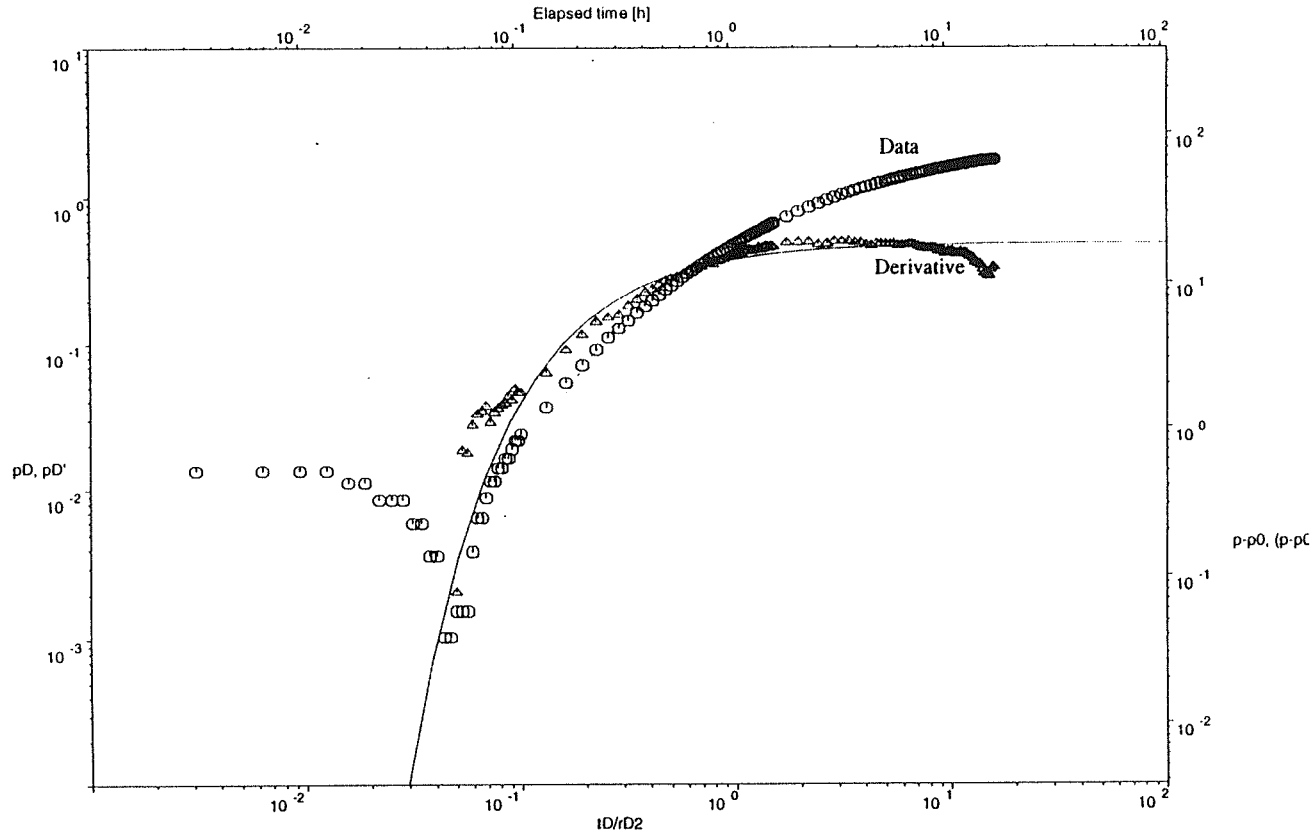
C=	1.04E-06	m3/Pa
T=	1.12E-04	m2/s
S=	9.60E-04	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 7B

Golder Associates

Florence, Arizona / O39-O
Oxide / Observation Well

FlowDim Version
(c) Golder Associates



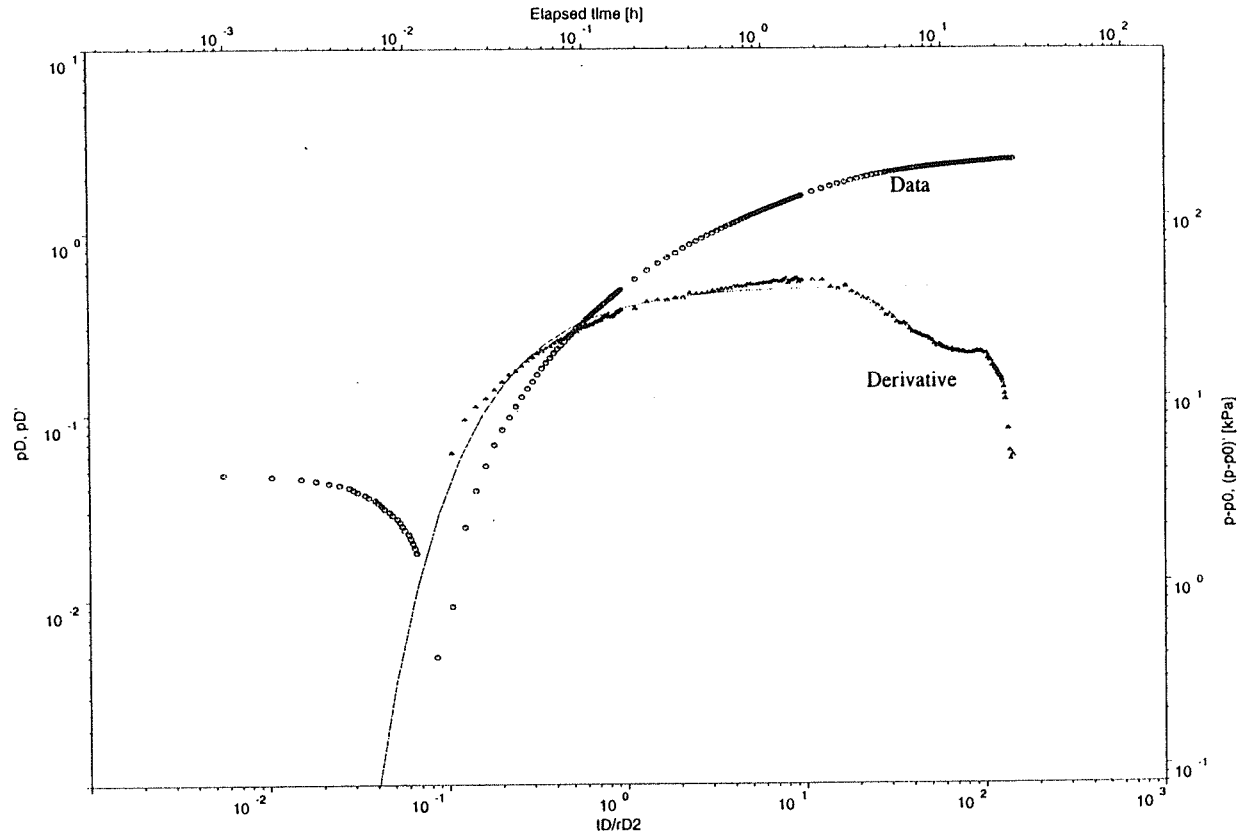
FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

T=	1.45E-04	m2/s
S=	4.32E-04	-
rD=	2.83E+02	-
n=	2.00E+00	-

Figure 8B **Golder Associates**

Florence, Arizona / OB7-1
Oxide / Observation Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

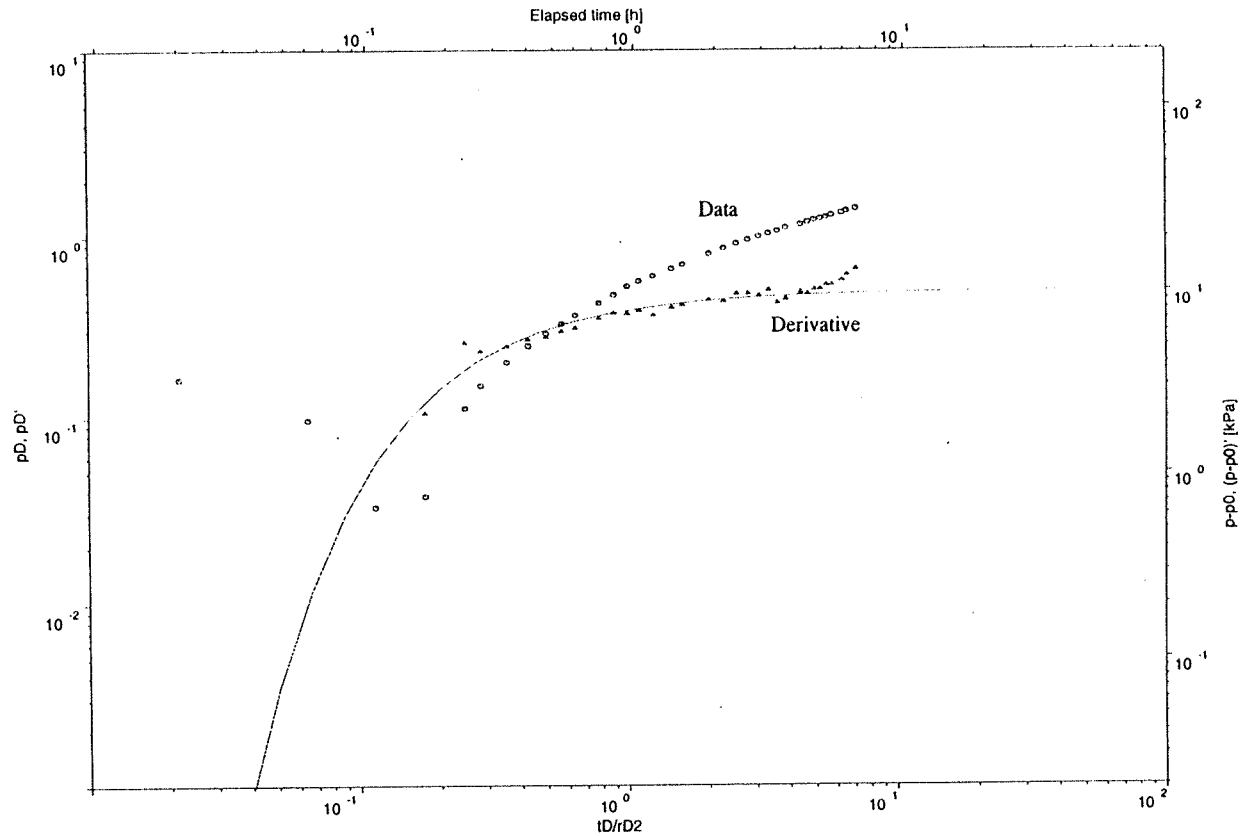
T=	4.95E-05	m2/s
S=	1.33E-04	-
rD=	2.01E+02	-
n=	2.00E+00	-

Figure 9B

Golder Associates

Florence, Arizona / O12-O
Oxide / Observation Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

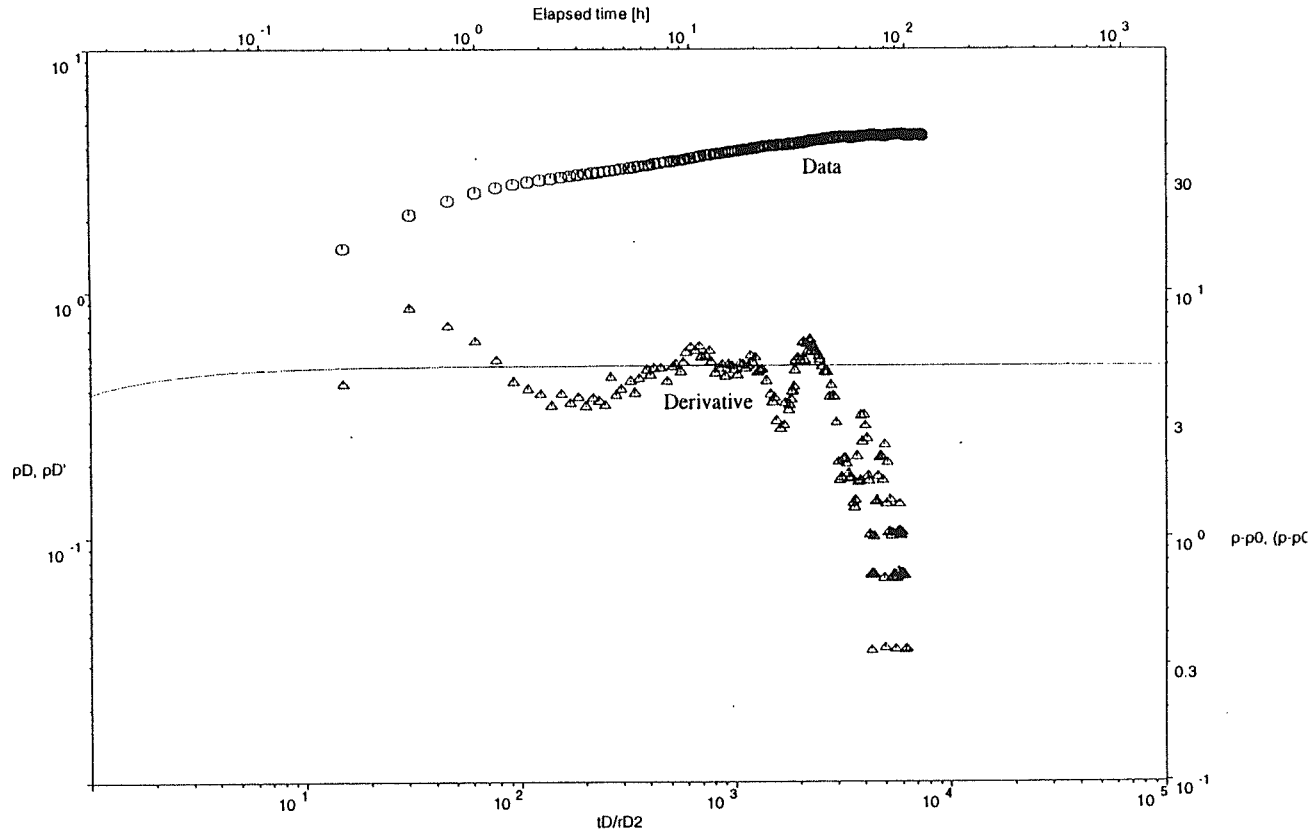
T=	3.21E-04	m2/s
S=	2.24E-03	-
rD=	2.87E+02	-
n=	2.00E+00	-

Figure 10B

Golder Associates

Florence, Arizona / O28-G
Lower Gila / Obs. Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

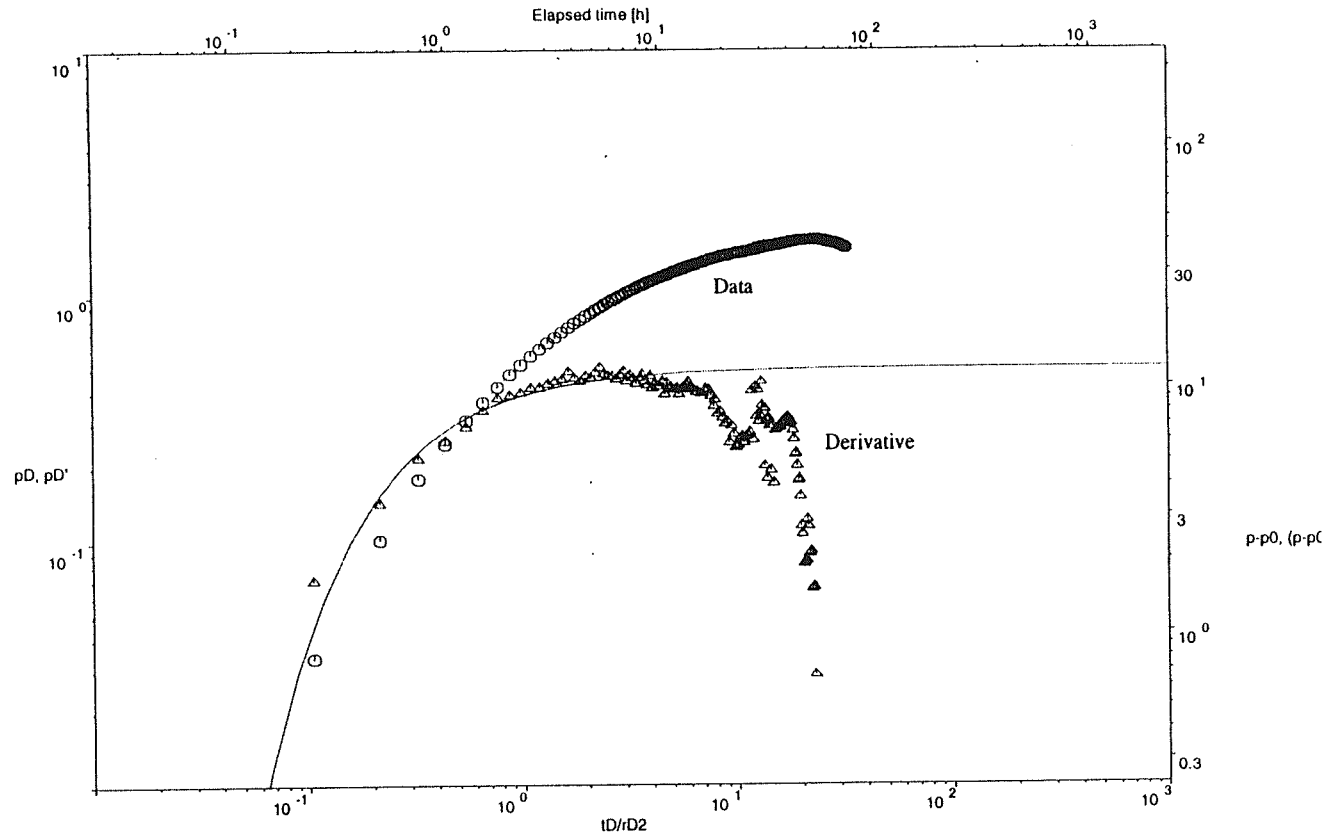
T=	7.49E-04	m2/s
S=	2.70E-05	-
rD=	7.92E+02	-
n=	2.00E+00	-

Figure 11B

Golder Associates

Florence, Arizona / O28.1
Oxide / Obs. Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

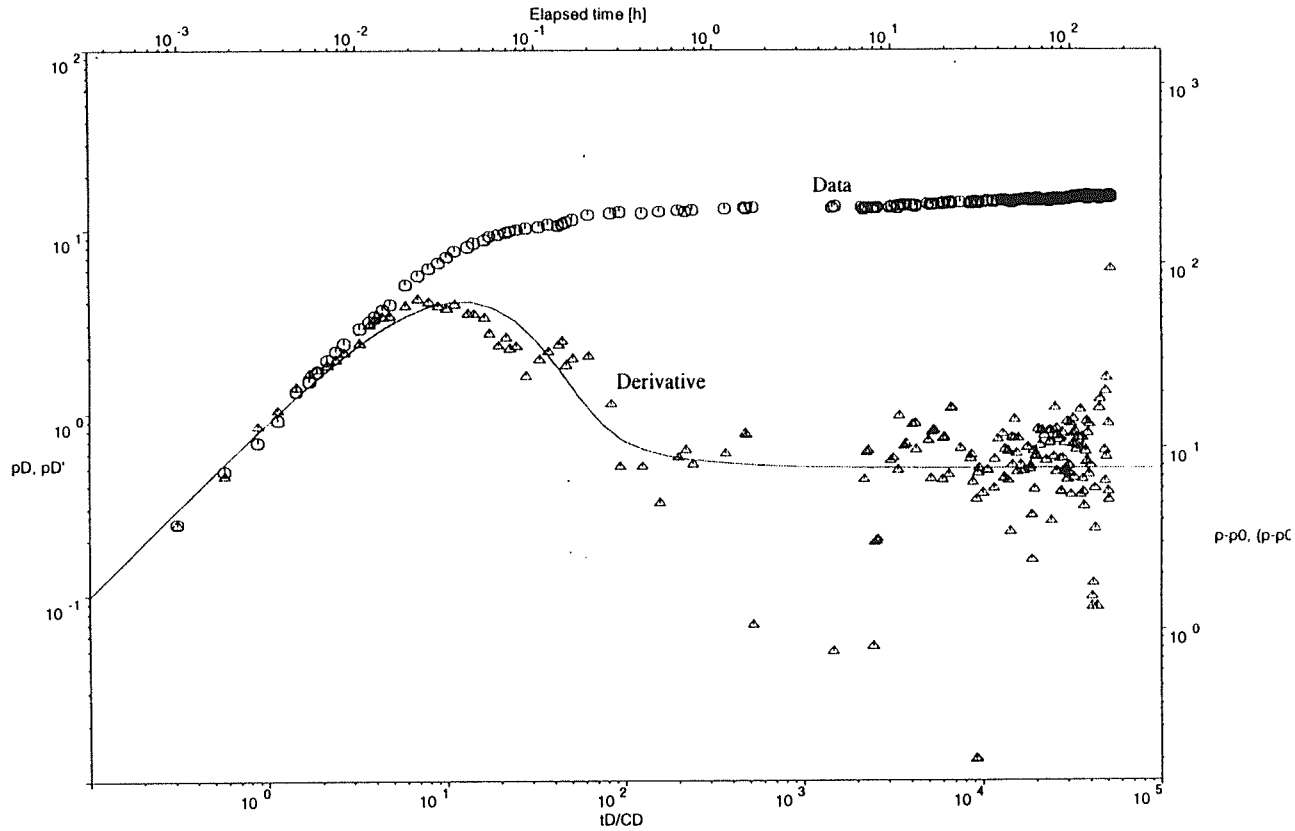
T=	3.17E-04	m2/s
S=	1.06E-03	-
rD=	9.79E+02	-
n=	2.00E+00	-

Figure 12B

Golder Associates

Florence, Arizona / PW2-1
Oxide / Pumping Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

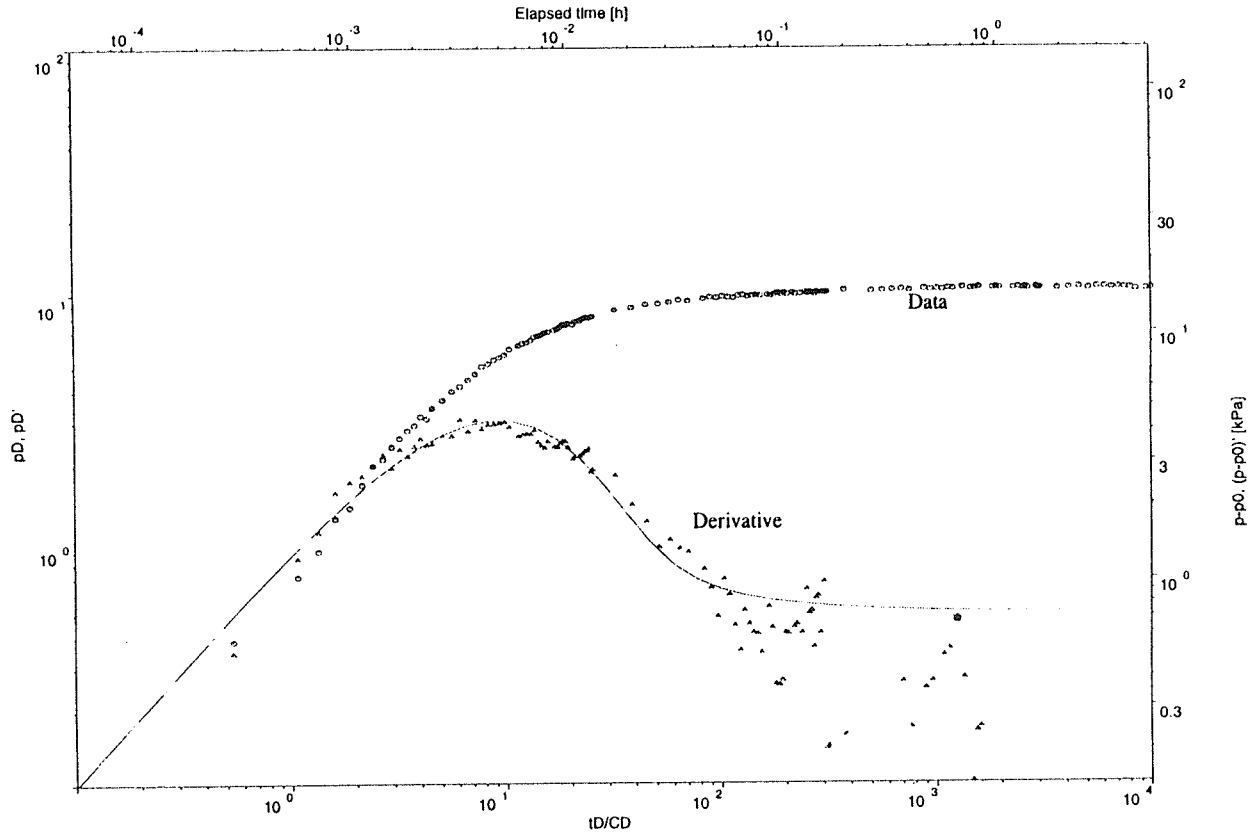
C=	2.36E-06	m3/Pa
T=	3.20E-04	m2/s
S=	3.18E-09	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 13B

Golder Associates

Florence, Arizona / M3-GL
Lower Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

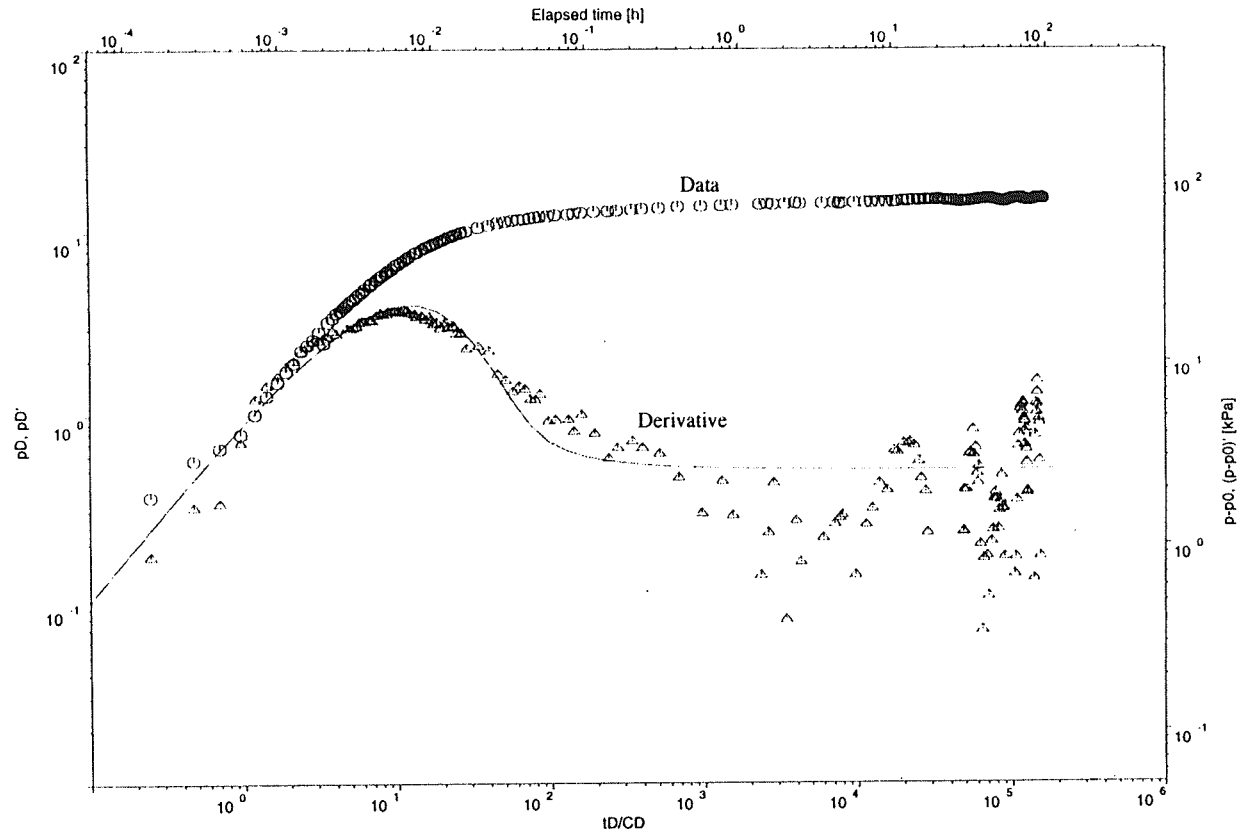
C=	8.16E-07	m3/Pa
T=	6.83E-04	m2/s
S=	3.16E-07	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 14B

Golder Associates

Florence, Arizona / PW4-1
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

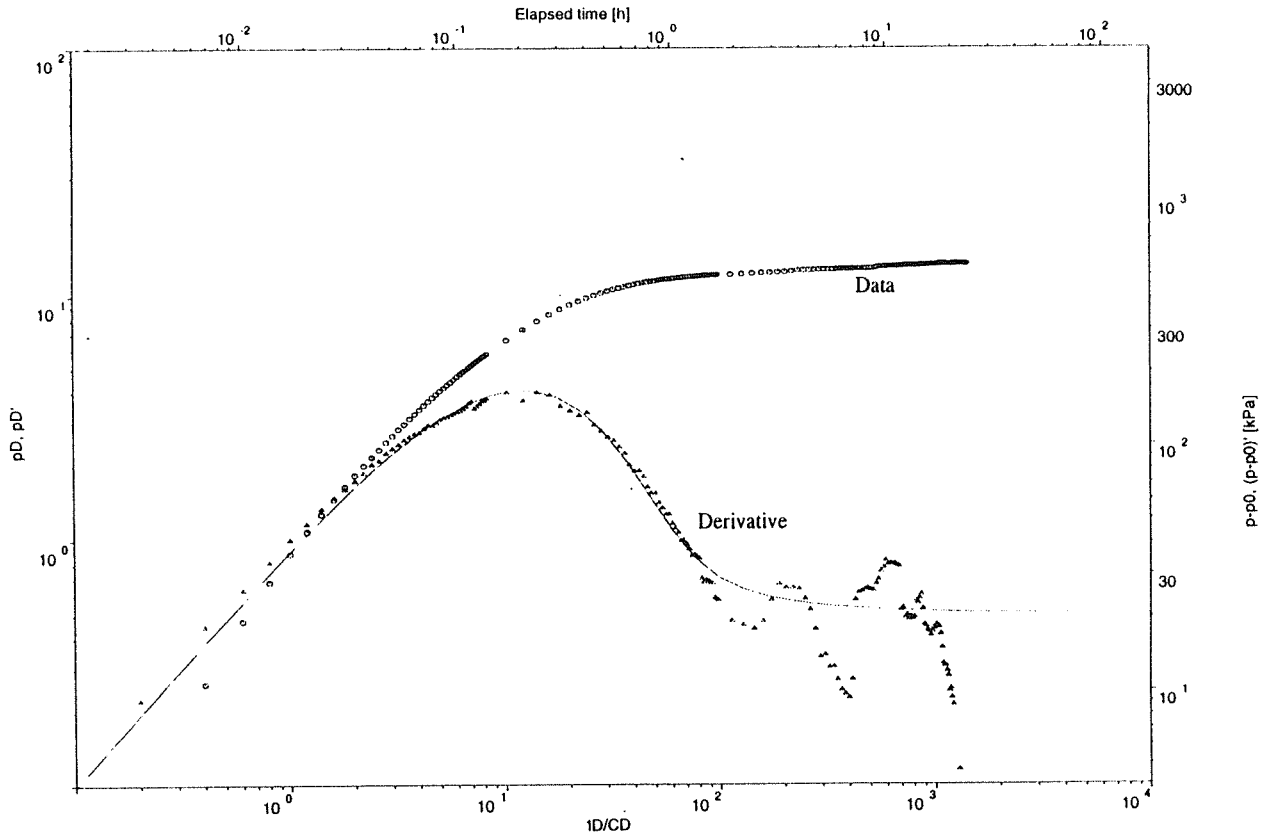
C=	1.87E-06	m3/Pa
T=	1.37E-03	m2/s
S=	2.52E-09	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 15B

Golder Associates

Florence, Arizona / M4-O
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



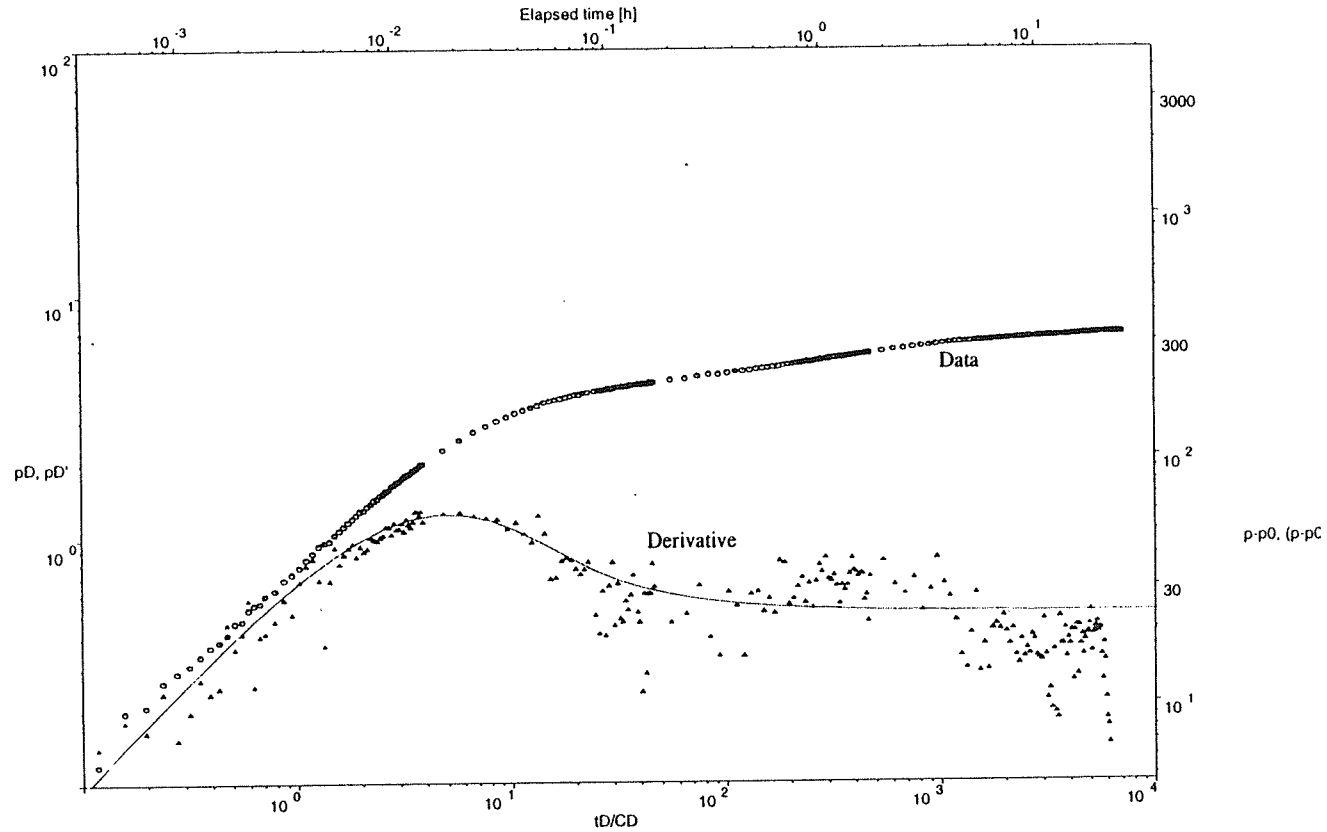
FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

C=	1.38E-06	m3/Pa
T=	3.59E-05	m2/s
S=	2.68E-09	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 16B

Florence Arizona / PW7-1
Oxide / Pumping Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

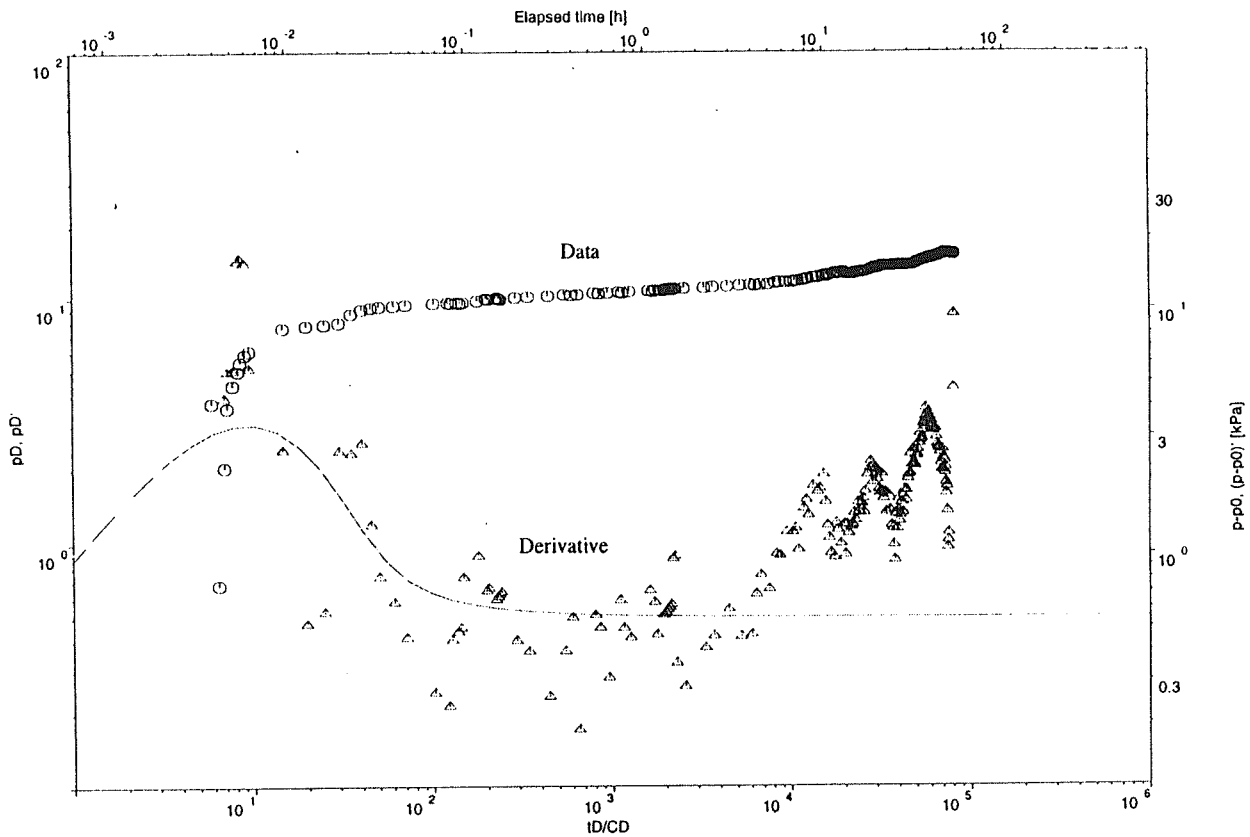
C=	6.87E-07	m3/Pa
T=	8.40E-05	m2/s
S=	1.85E-03	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 17B

Golder Associates

Florence, Arizona / P8-GU
Upper Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

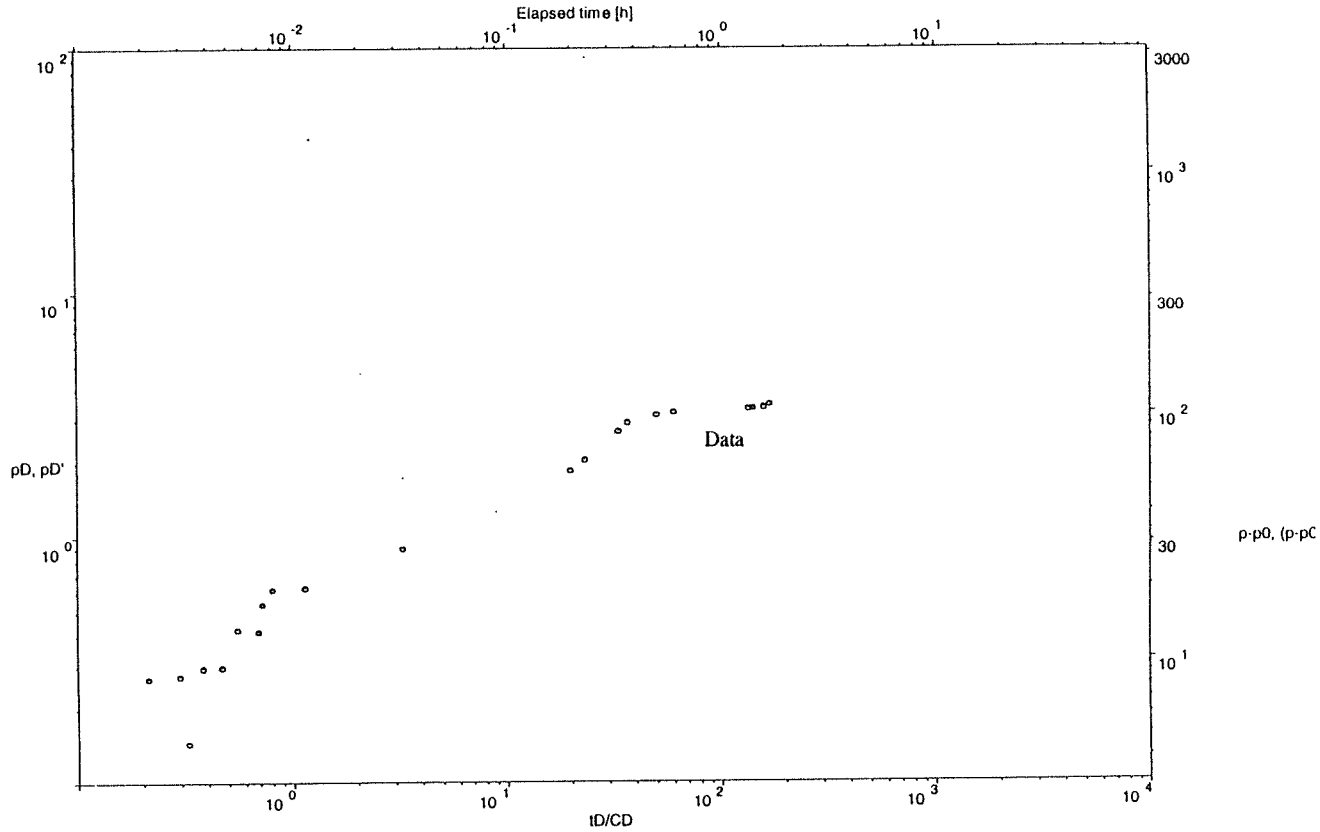
C=	1.19E-05	m3/Pa
T=	7.91E-03	m2/s
S=	3.19E-06	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 18B

Golder Associates

Florence Arizona / P12-O
Oxide / Pumping Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

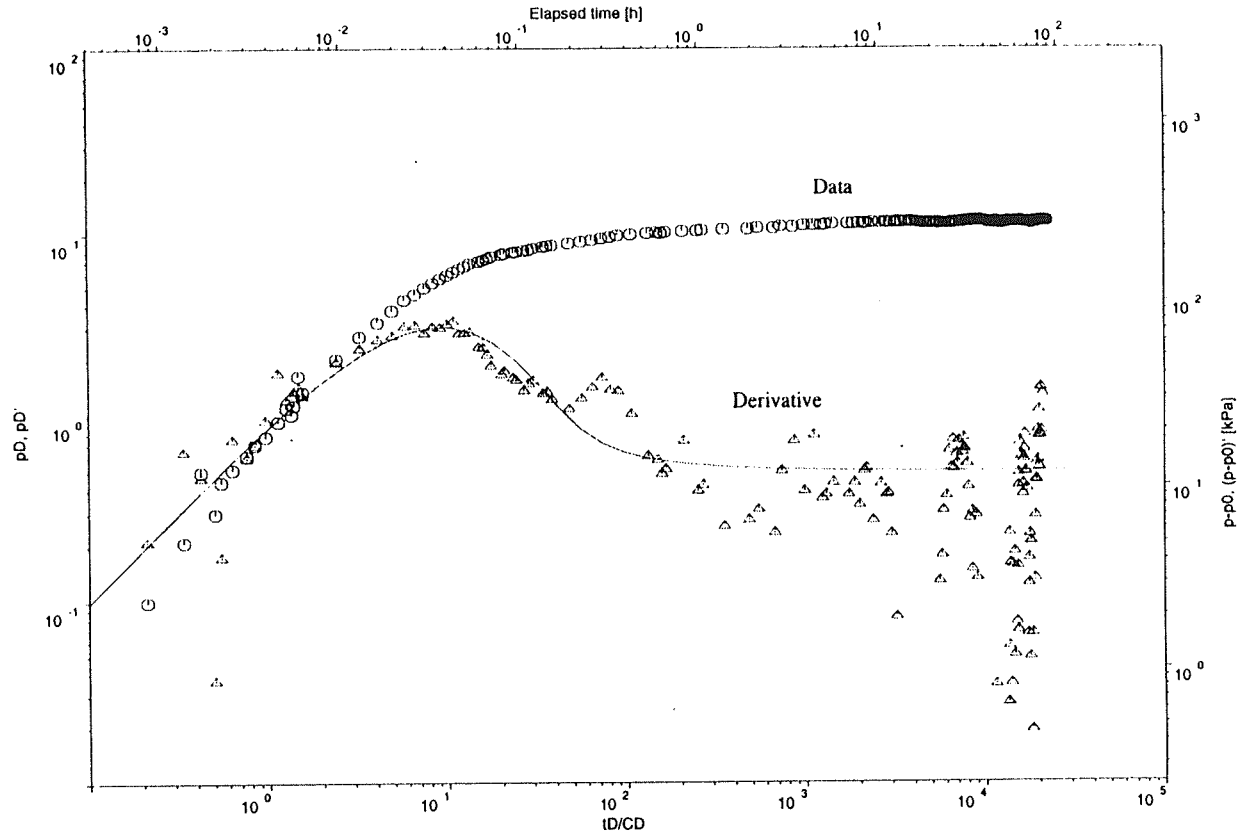
C=	4.64E-06	m3/Pa
T=	2.04E-04	m2/s
S=	4.16E-01	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 19B

Golder Associates

Florence, Arizona / P13.1
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



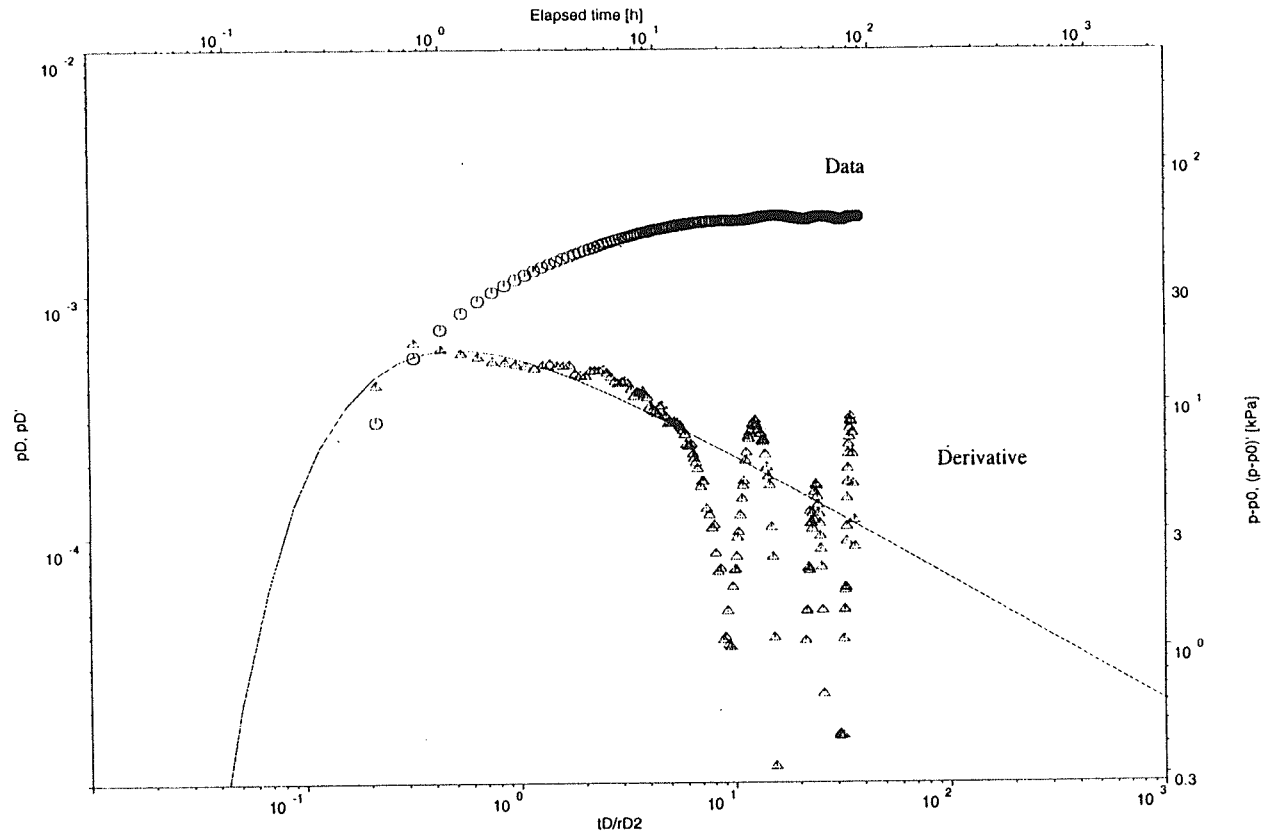
FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

C=	1.75E-06	m3/Pa
T=	1.91E-04	m2/s
S=	4.72E-07	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 20B

Florence, Arizona / P13.2
Oxide / Obs. Well (P13.1-

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

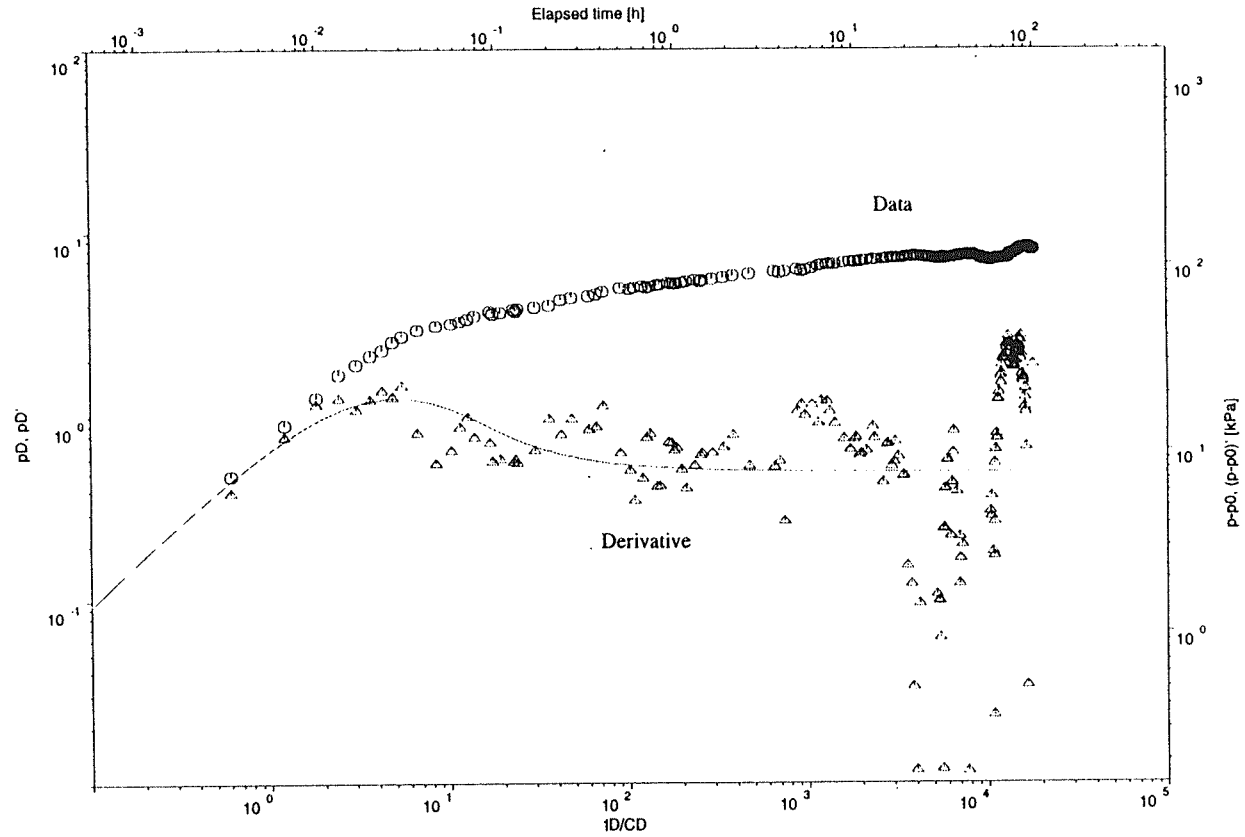
T=	8.18E-08	m2/s
S=	7.04E-07	-
rD=	4.12E+02	-
n=	3.00E+00	-

Figure 21B

Golder Associates

Florence, Arizona / P15-O
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

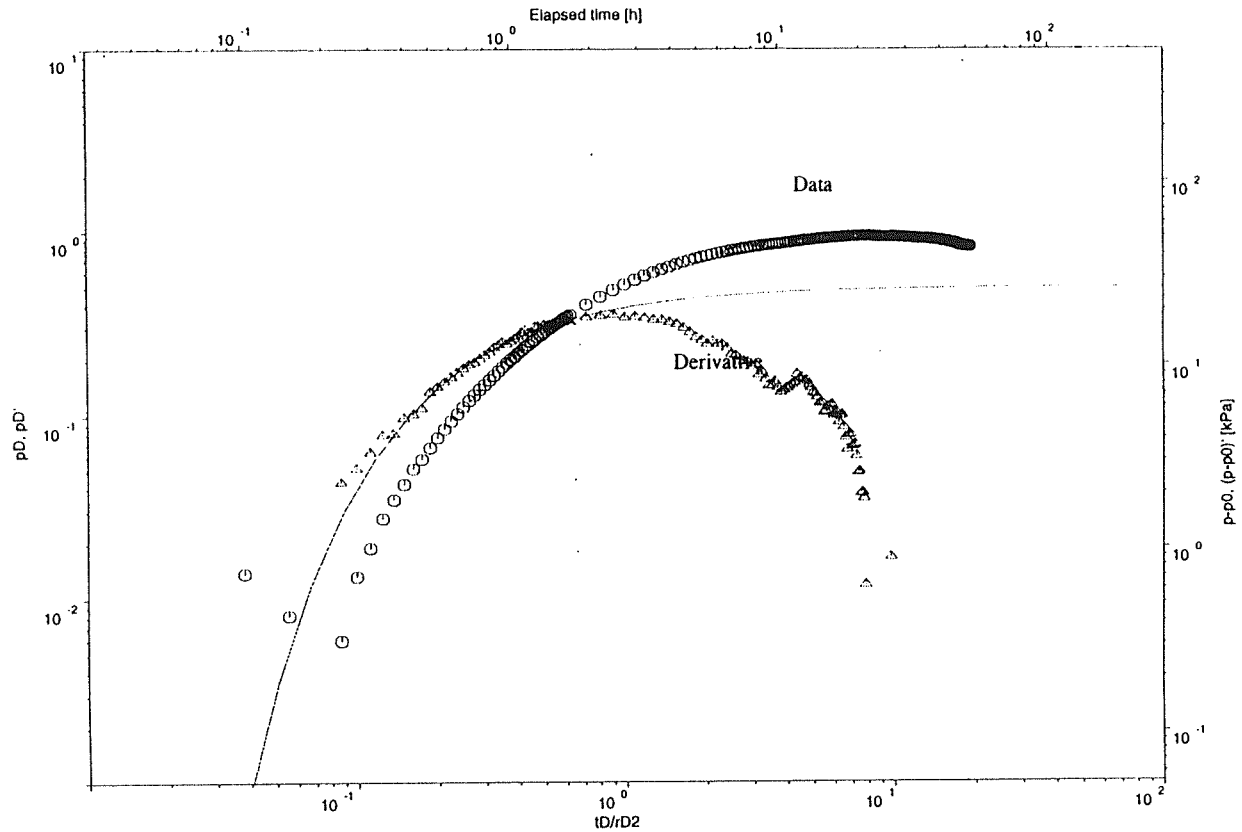
C=	4.94E-06	m3/Pa
T=	3.84E-04	m2/s
S=	1.33E-02	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 22B

Golder Associates

Florence, Arizona / P19-O
Oxide / Observ. Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

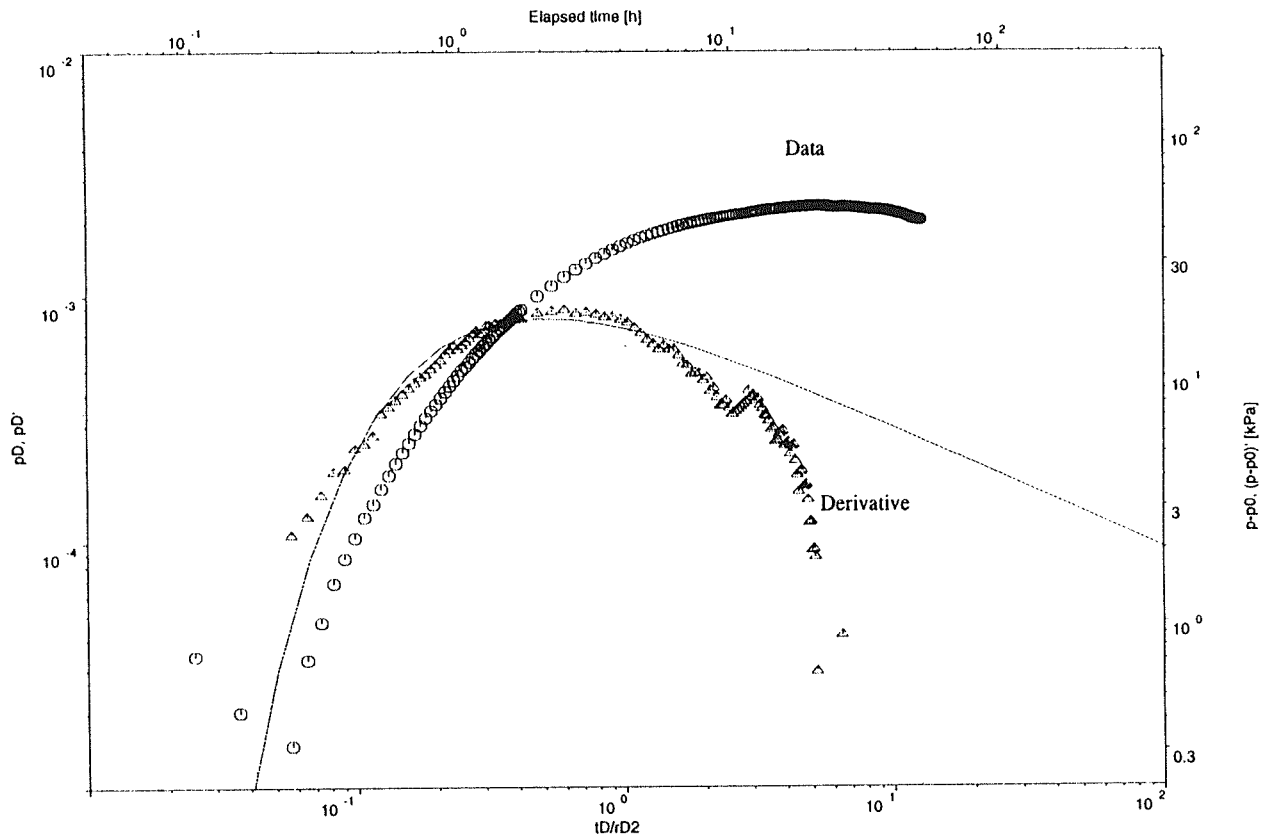
T=	4.10E-05	m2/s
S=	7.66E-04	-
rD=	2.98E+02	-
n=	2.00E+00	-

Figure 23B

Golder Associates

Florence, Arizona / P19-O
Oxide / Observ. Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

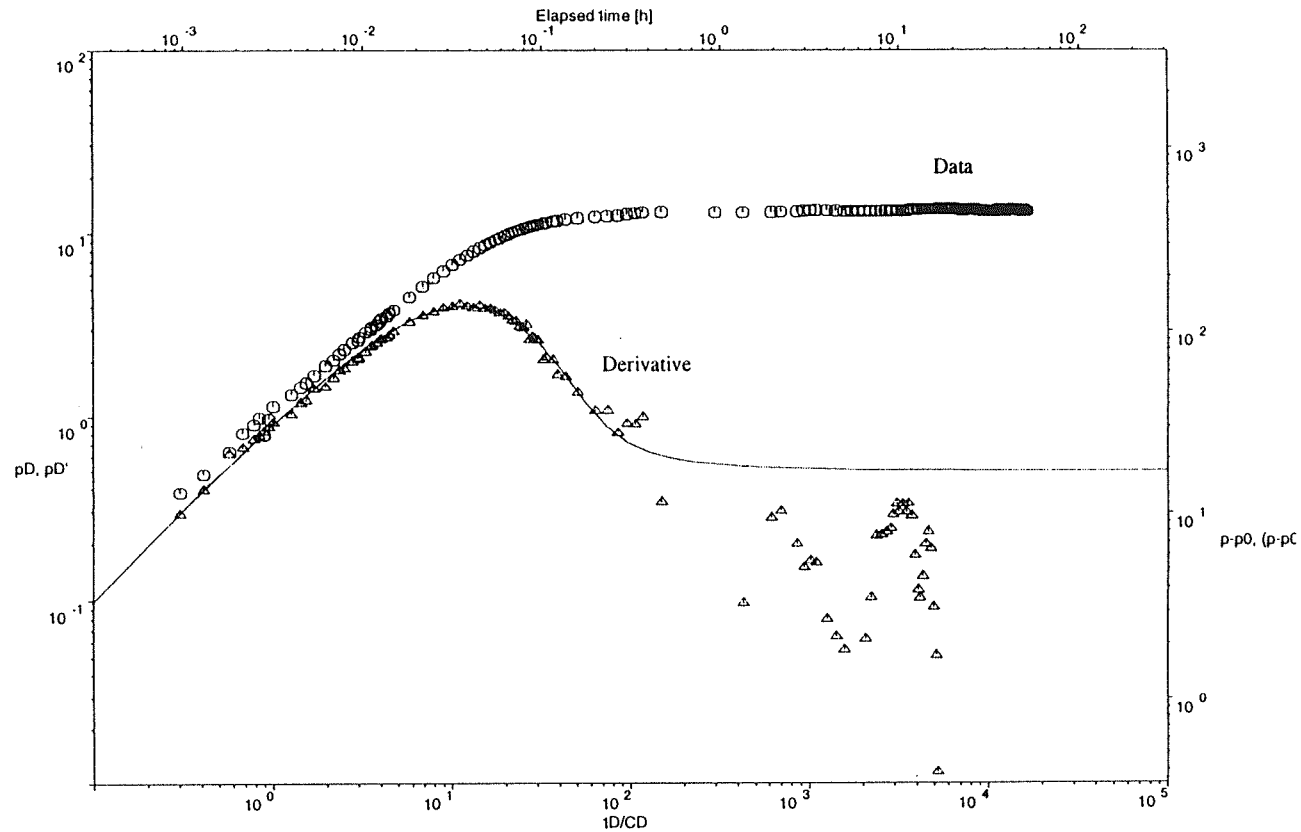
T=	5.08E-08	m2/s
S=	1.44E-06	-
rD=	2.98E+02	-
n=	3.00E+00	-

Figure 24B

Golder Associates

Florence, Arizona / P19.1
Oxide / Withdrawal

FlowDim Version
(c) Golder Associates



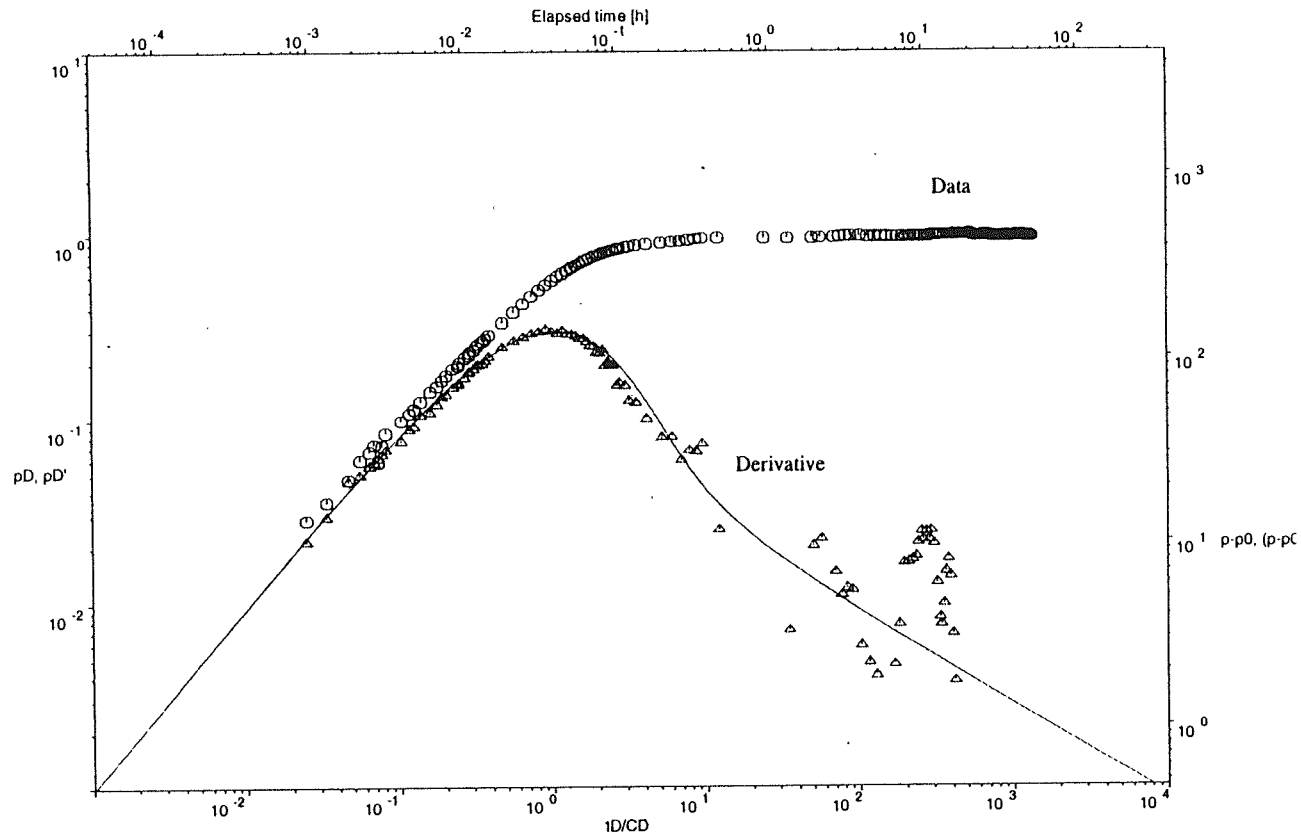
FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

C=	4.58E-07	m3/Pa
T=	6.39E-05	m2/s
S=	6.16E-10	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 25B

Florence, Arizona / P19.1
Oxide / Withdrawal

FlowDim Version
(c) Golder Associates



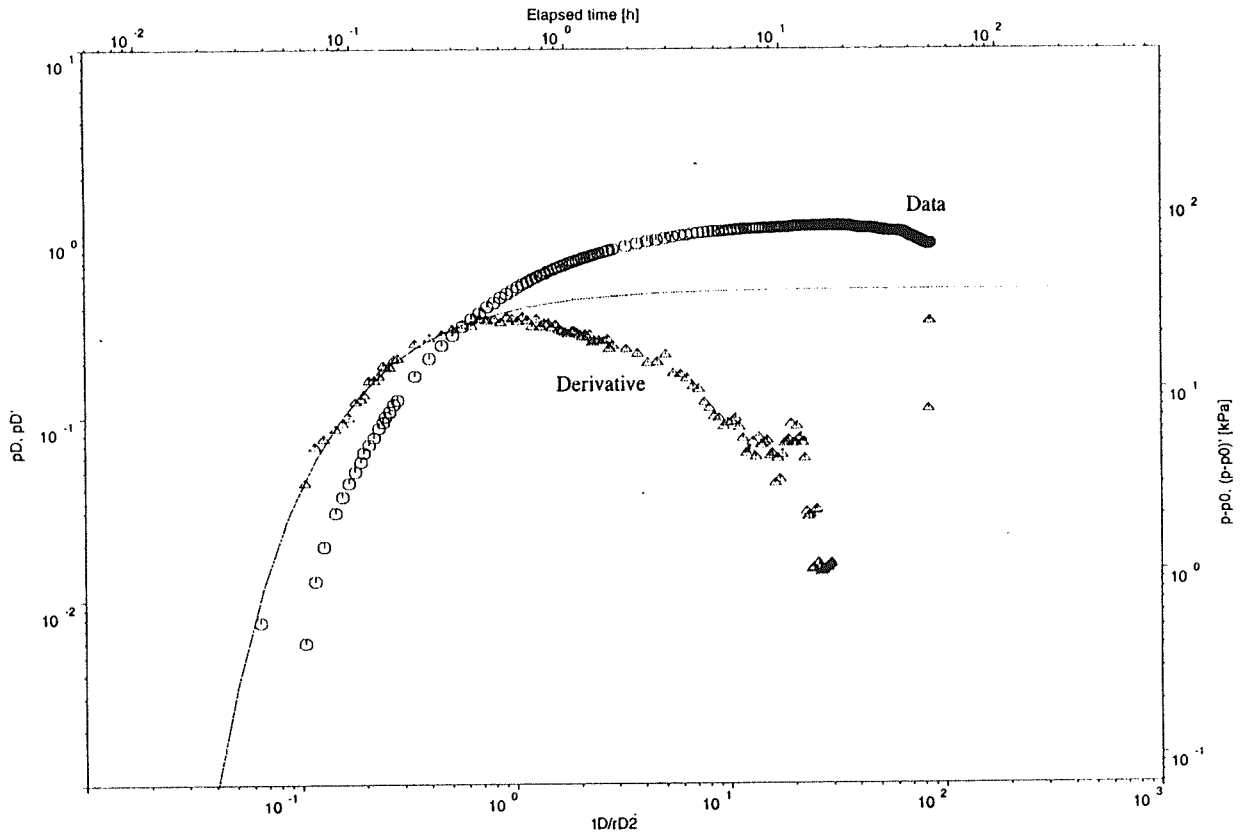
FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

C=	4.19E-07	m3/Pa
T=	2.36E-06	m2/s
S=	5.64E-03	-
s=	0.00E+00	-
n=	3.00E+00	-

Figure 26B

Florence, Arizona / P19.2
Oxide / Observ. Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

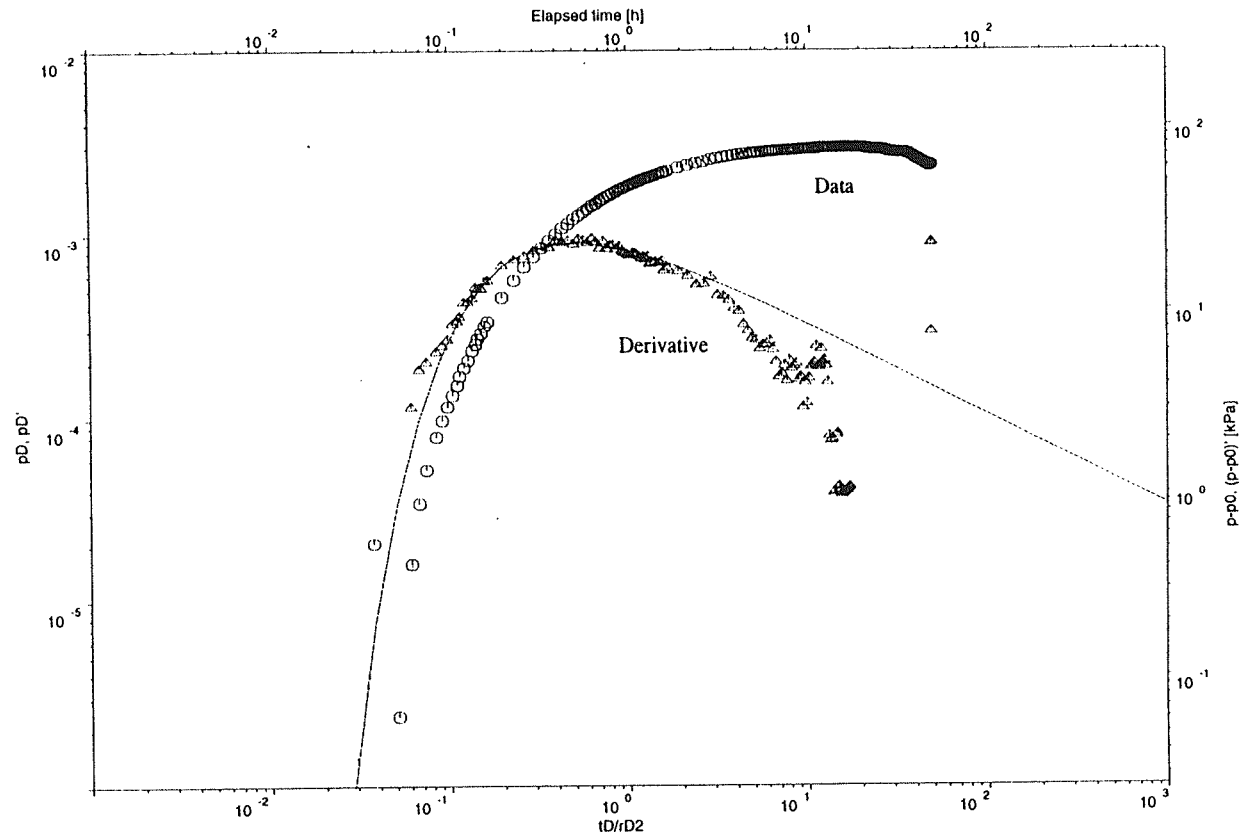
T=	3.14E-05	m2/s
S=	1.47E-04	-
rD=	2.68E+02	-
n=	2.00E+00	-

Figure 27B

Golder Associates

Florence, Arizona / P19.2
Oxide / Observ. Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Observation
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

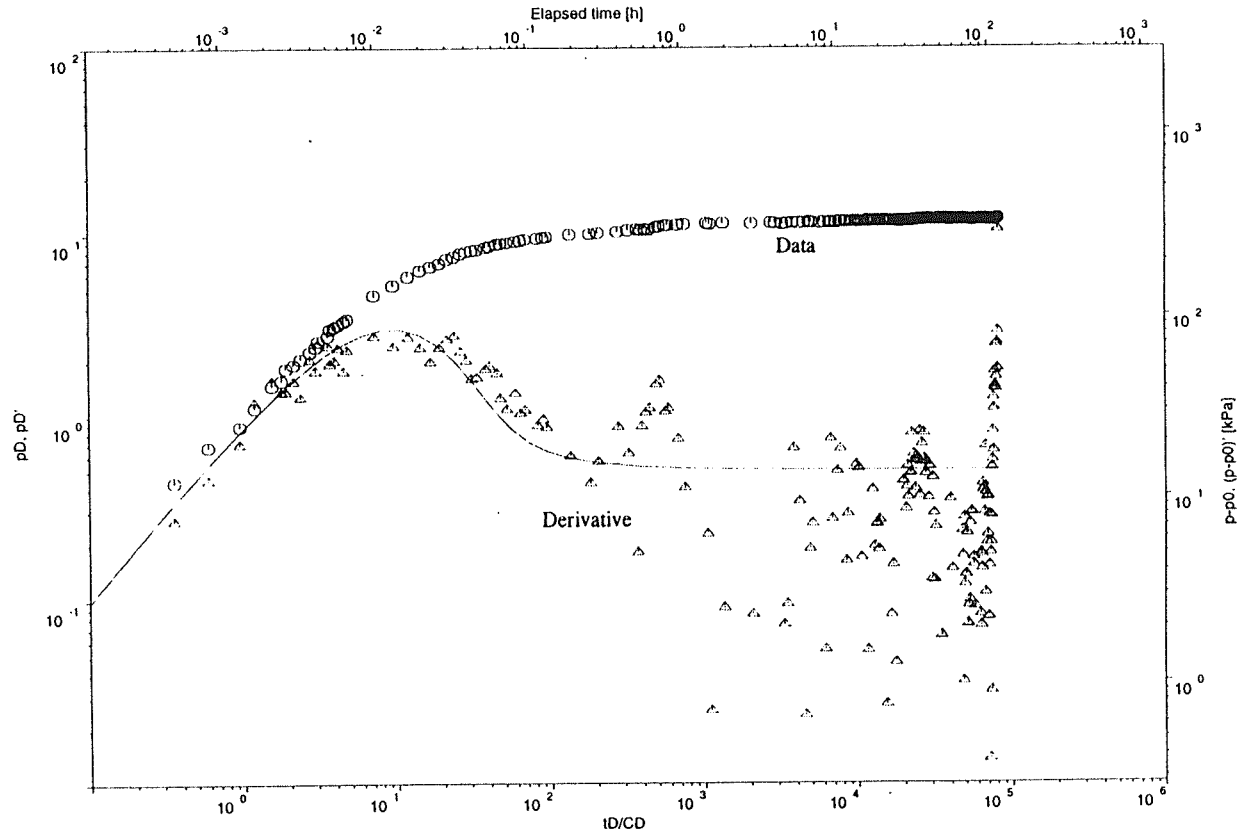
T=	4.22E-08	m2/s
S=	3.38E-07	-
rD=	2.68E+02	-
n=	3.00E+00	-

Figure 28B

Golder Associates

Florence, Arizona / P28-G
Lower Gila / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



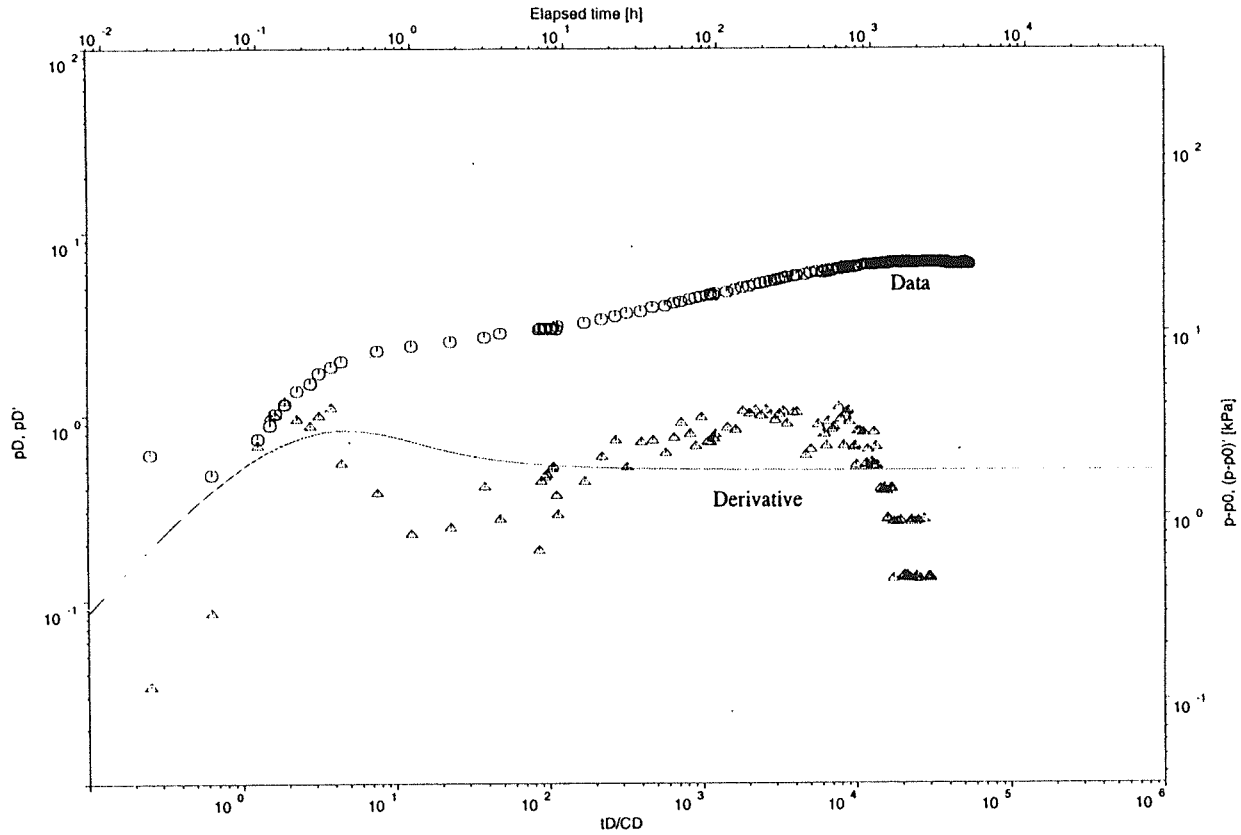
FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

C=	8.71E-07	m3/Pa
T=	2.66E-04	m2/s
S=	3.37E-07	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 29B

Florence, Arizona / P28.1
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



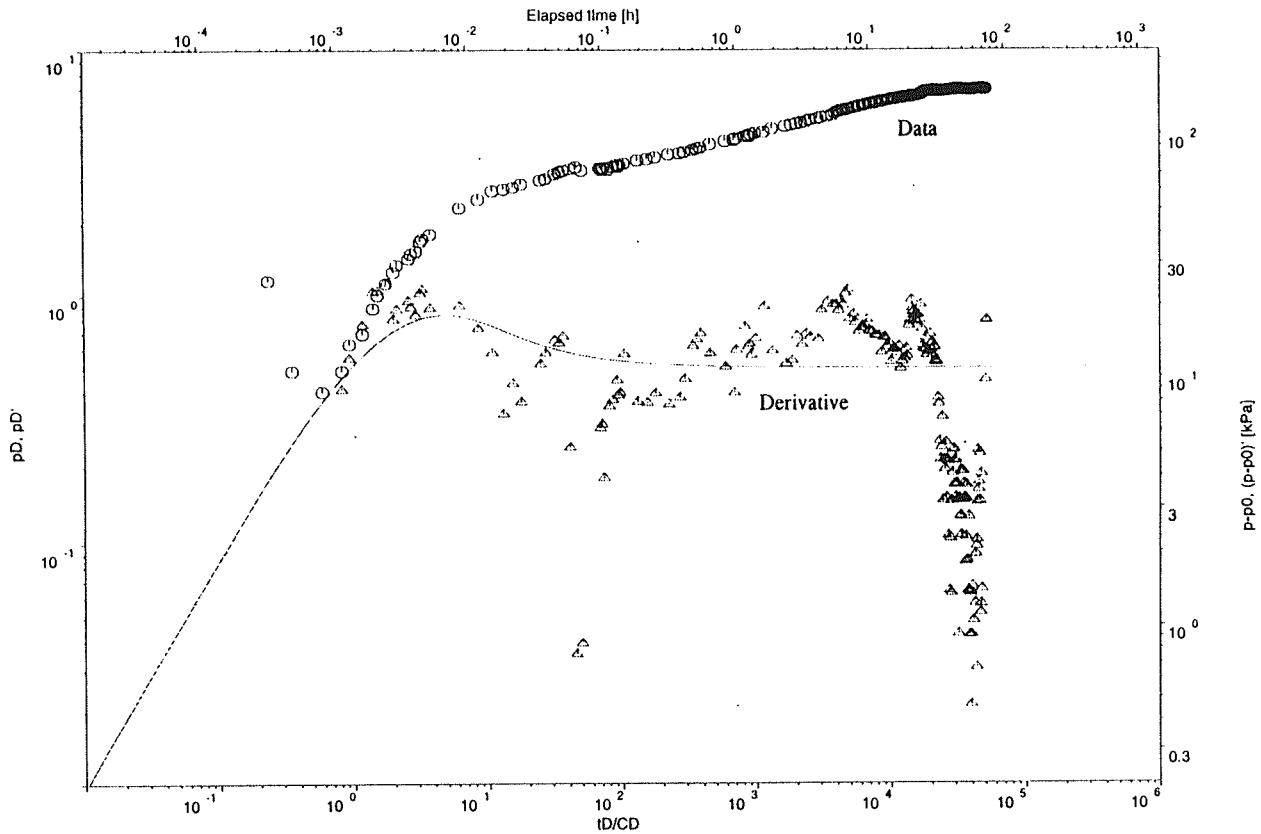
FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

C=	1.50E-04	m3/Pa
T=	8.25E-04	m2/s
S=	5.20E+00	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 30B

Forence, Anzona / P28.1-
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

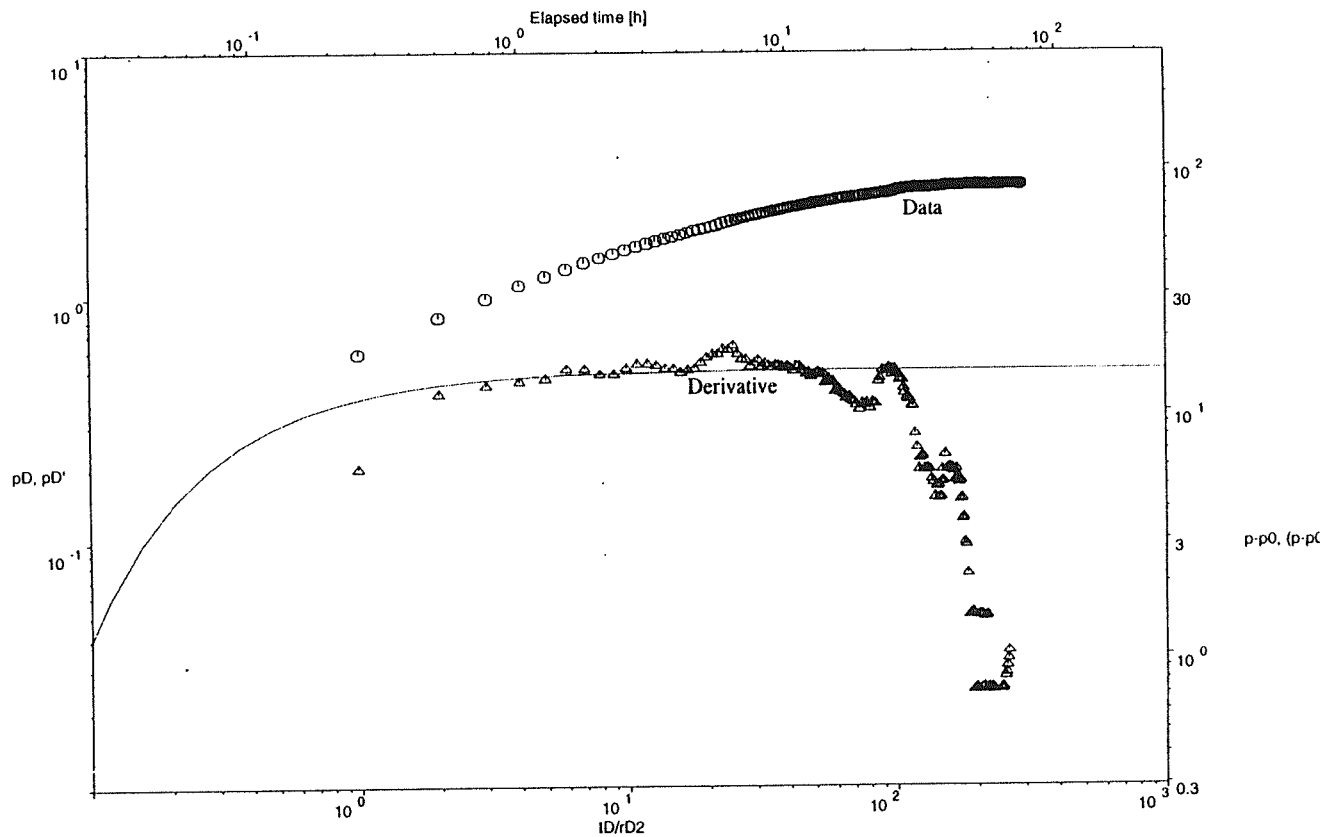
C=	1.28E-06	m3/Pa
T=	3.86E-04	m2/s
S=	3.45E-02	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 31B

Golder Associates

Florence, Arizona / P28.2
Oxide / Pumping Well

FlowDim Version
(c) Golder Associates



FLOW MODEL :
BOUNDARY CONDITIONS: Constant rate
WELL TYPE :
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-

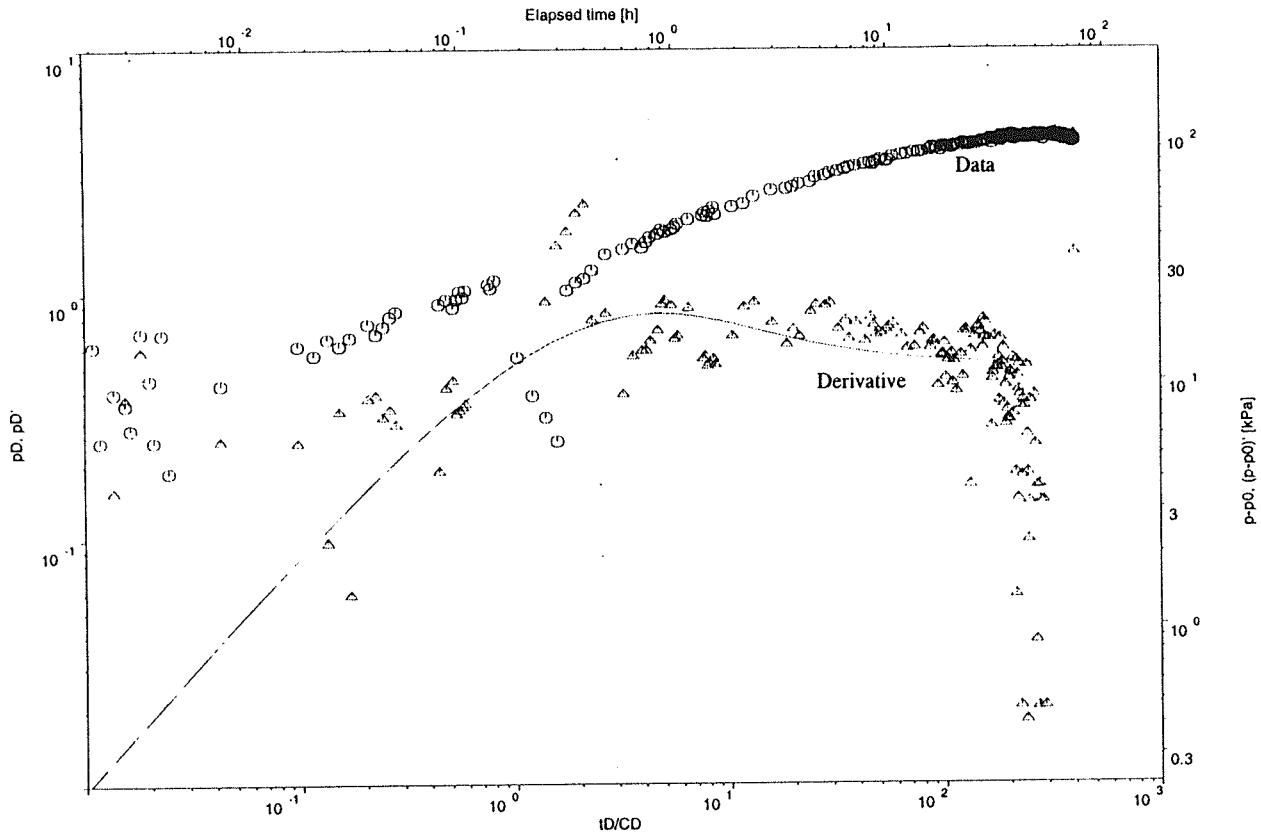
T=	2.84E-04	m2/s
S=	2.91E-04	-
rD=	5.89E+02	-
n=	2.00E+00	-

Figure 32B

Golder Associates

Florence, Arizona / P28.2
Oxide / Pumping Well

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : No superposition
PLOT TYPE : Log-log

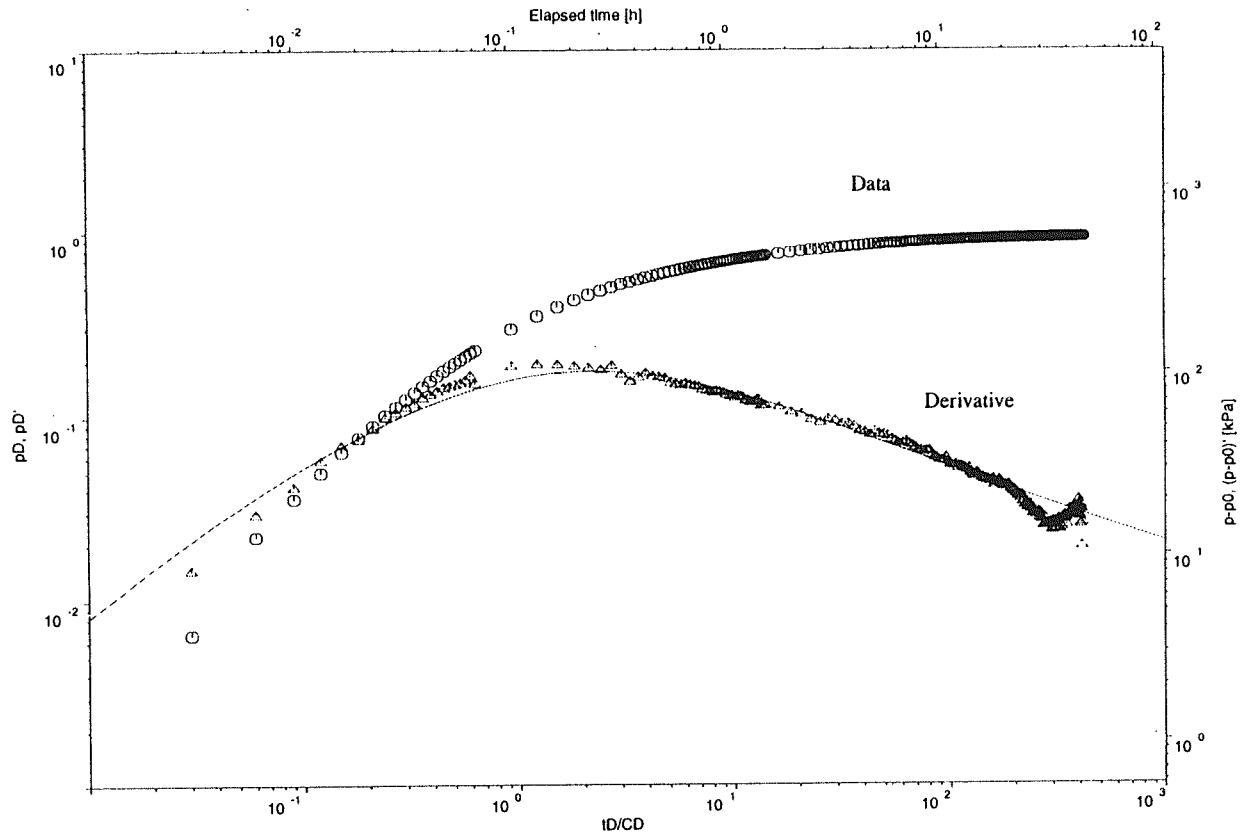
C=	1.41E-04	m3/Pa
T=	3.30E-04	m2/s
S=	3.78E+00	-
s=	0.00E+00	-
n=	2.00E+00	-

Figure 33B

Golder Associates

Florence, Anzona / P49-O
Oxide / Recovery

FlowDim Version 2.14b
(c) Golder Associates



FLOW MODEL : Homogeneous
BOUNDARY CONDITIONS: Constant rate
WELL TYPE : Source
SUPERPOSITION TYPE : Build-up TC
PLOT TYPE : Log-log

C=	1.78E-06	m3/Pa
T=	3.45E-06	m2/s
S=	7.99E-01	-
s=	0.00E+00	-
n=	3.00E+00	-

Figure 34B

APPENDIX C

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	M1-GL
Interval name	Lower Gila
Event name	Pumping Well
Test date	11 - 13 Aug. 1995
Input file name	m1-gld.rec

Well parameters

Well depth	[m brp]	1.2802E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.2190E+01

Testparameter

Flow rate	[l/min]	3.7900E+01
Test duration	[h]	2.4458E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	7.5775E-11
Transmissivity	[m2/s]	7.4335E-04
Storage	[m/Pa]	8.5961E-13
Storativity	[-]	8.4327E-09
Wellbore storage	[m3/Pa]	4.3535E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	3.9350E+02
Pressure match	[1/kPa]	7.5335E-01

Comments

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TEST ANALYSIS REPORT 29.10.1995

Identification

Site name	Florence, Arizona
Well name	M3-GL
Interval name	Lower Gila
Event name	Observation Well (M4-O)
Test date	28 - 29 July, 1995
Input file name	m3gloddb.fd1

Well parameters

Well depth	[m bgl]	1.5545E+02
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.8290E+01
Distance to active well	[m]	9.7100E+00
Active wellbore radius	[m]	6.3500E+02

Testparameter

Flow rate	[l/min]	5.6780E+01
Test duration	[h]	2.2171E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	9.7150E-11
Transmissivity	[m2/s]	9.5304E-04
Storage	[m/Pa]	8.9465E-06
Storativity	[-]	8.7765E-02
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	1.5291E+02
Time match	[1/h]	4.1462E-01
Pressure match	[1/kPa]	6.4470E-01

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence Site
Well name	M14-GL
Interval name	Lower Gila
Event name	Pumping Well
Test date	11 - 12 Aug. 1995
Input file name	m14-gld.rec

Well parameters

Well depth	[m brp]	2.8956E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.8290E+01

Testparameter

Flow rate	[l/min]	3.7850E+01
Test duration	[h]	1.8180E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.1462E-11
Transmissivity	[m2/s]	1.1244E-04
Storage	[m/Pa]	9.2897E-11
Storativity	[-]	9.1132E-07
Wellbore storage	[m3/Pa]	2.3524E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.1015E+02
Pressure match	[1/kPa]	1.1410E-01

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence Site
Well name	M14-GL
Interval name	Lower Gila
Event name	Pumping Well
Test date	11 - 12 Aug. 1995
Input file name	m14gld3d.rec

Well parameters

Well depth	[m brp]	2.8956E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.8290E+01

Testparameter

Flow rate	[l/min]	3.7850E+01
Test duration	[h]	1.8180E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	5.4085E-13
Transmissivity	[m2/s]	5.3057E-06
Storage	[m/Pa]	4.3810E-06
Storativity	[-]	4.2977E-02
Wellbore storage	[m3/Pa]	2.2182E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	3.0000E+00
Time match	[1/h]	1.1022E+01
Pressure match	[1/kPa]	1.0766E-02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	M15-GU
Interval name	Upper Gila
Event name	Pumping Well
Test date	8 - 9 Aug. 1995
Input file name	m15-gud.rec

Well parameters

Well depth	[m brp]	1.9202E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.2190E+01

Testparameter

Flow rate	[l/min]	3.7900E+01
Test duration	[h]	1.6695E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.1353E-11
Transmissivity	[m2/s]	1.1137E-04
Storage	[m/Pa]	1.0991E-15
Storativity	[-]	1.0782E-11
Wellbore storage	[m3/Pa]	2.7832E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	9.2222E+02
Pressure match	[1/kPa]	1.1287E-01

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	M18-GU
Interval name	Upper Gila
Event name	Pumping Well
Test date	8 - 11 Aug. 1995
Input file name	m18-gud.rec

Well parameters

Well depth	[m brp]	7.3150E+01
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.2190E+01

Testparameter

Flow rate	[l/min]	3.7900E+01
Test duration	[h]	1.9194E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	8.6070E-11
Transmissivity	[m2/s]	8.4434E-04
Storage	[m/Pa]	8.8678E-20
Storativity	[-]	8.6993E-16
Wellbore storage	[m3/Pa]	2.2455E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	8.6654E+02
Pressure match	[1/kPa]	8.5570E-01

Comments

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TEST ANALYSIS REPORT 15.11.1995

Identification

Site name	Florence, Arizona
Well name	P39-O
Interval name	Oxide
Event name	Pumping Well
Test date	19 - 20 May, 1995
Input file name	mf39pwpd.rec

Well parameters

Well depth	[m brp]	2.7890E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	1.3000E-01
Interval length	[m]	1.0820E+02

Testparameter

Flow rate	[l/min]	2.0800E+02
Test duration	[h]	1.6917E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.1442E-11
Transmissivity	[m2/s]	1.1225E-04
Storage	[m/Pa]	9.7900E-08
Storativity	[-]	9.6040E-04
Wellbore storage	[m3/Pa]	1.0390E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	2.4897E+02
Pressure match	[1/kPa]	2.0728E-02

Comments

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TEST ANALYSIS REPORT 15.11.1995

Identification

Site name	Florence, Arizona
Well name	O39-O
Interval name	Oxide
Event name	Observ. Well (P39-O)
Test date	19 - 20 May, 1995
Input file name	mf39owpd.rec

Well parameters

Well depth	[m brp]	2.7920E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	1.2700E-01
Interval length	[m]	1.2680E+02
Distance to active well	[m]	3.6000E+01

Testparameter

Flow rate	[l/min]	2.0800E+02
Test duration	[h]	1.6857E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.4760E-11
Transmissivity	[m2/s]	1.4479E-04
Storage	[m/Pa]	4.4004E-08
Storativity	[-]	4.3168E-04
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	2.8346E+02
Time match	[1/h]	9.3173E-01
Pressure match	[1/kPa]	2.6738E-02

Comments

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TEST ANALYSIS REPORT 27.10.1995

Identification

Site name	Florence, Arizona
Well name	OB7-1
Interval name	Oxide
Event name	Observation Well
Test date	16 - 21 June, 1995
Input file name	ob7-1dda.fd1

Well Parameters

Well depth	[m bgl]	2.7432E+02
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.0363E+02
Distance to active well	[m]	1.5300E+01

Test Parameters

Flow rate	[l/min]	1.5142E+02
Test duration	[h]	2.4666E+01

Fluid and Formation Parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	5.0475E-12
Transmissivity	[m2/s]	4.9516E-05
Storage	[m/Pa]	1.3510E-08
Storativity	[-]	1.3253E-04
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	2.0079E+02
Time match	[1/h]	5.7458E+00
Pressure match	[1/kPa]	1.2560E-02
Type Curve Match	[-]	

Comments

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TEST ANALYSIS REPORT 27.10.1995

Identification

Site name	Florence, Arizona
Well name	O12-O
Interval name	Oxide
Event name	Observation Well
Test date	1 - 7 June, 1995
Input file name	o12-oddc.fd1

Well Parameters

Well depth	[m bgl]	2.9570E+02
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	1.5240E+02
Distance to active well	[m]	2.1900E+01
Radius of active well	[m]	7.6200E-02

Test Parameters

Flow rate	[l/min]	2.4610E+02
Test duration	[h]	6.6313E+00

Fluid and Formation Parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.2764E-11
Transmissivity	[m2/s]	3.2141E-04
Storage	[m/Pa]	2.2788E-07
Storativity	[-]	2.2355E-03
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	2.8740E+02
Time match	[1/h]	1.0792E+00
Pressure match	[1/kPa]	5.0164E-02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification	
Site name	Florence, Arizona
Well name	O28-GL
Interval name	Lower Gila
Event name	Obs. Well (P28-GL)
Test date	20 - 25 Sep. 1995
Input file name	o28-gld.rec

Well parameters		
Well depth	[m brp]	9.7540E+01
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	9.1400E+00
Distance to active well	[m]	4.0220E+01

Testparameter		
Flow rate	[l/min]	2.8391E+02
Test duration	[h]	1.1873E+02

Fluid and formation parameters		
Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions	
Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis		
Transmissibility	[m3]	7.6324E-11
Transmissivity	[m2/s]	7.4874E-04
Storage	[m/Pa]	2.7481E-09
Storativity	[-]	2.6959E-05
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	7.9173E+02
Time match	[1/h]	6.1809E+01
Pressure match	[1/kPa]	1.0130E-01

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	O28.1-O
Interval name	Oxide
Event name	Obs. Well (P28.2-O)
Test date	2 - 5 Oct. 1995
Input file name	o281-od.rec

Well parameters

Well depth	[m brp]	1.6154E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	3.0480E+01
Distance to active well	[m]	4.9730E+01

Testparameter

Flow rate	[l/min]	2.8770E+02
Test duration	[h]	7.3888E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.2337E-11
Transmissivity	[m2/s]	3.1723E-04
Storage	[m/Pa]	1.0811E-07
Storativity	[-]	1.0605E-03
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	9.7894E+02
Time match	[1/h]	4.3542E-01
Pressure match	[1/kPa]	4.2352E-02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	PW2-1
Interval name	Oxide
Event name	Pumping Well
Test date	8 Mar. 1995
Input file name	pw2-1d.rec

Well parameters

Well depth	[m brp]	1.9507E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	6.7060E+01

Testparameter

Flow rate	[l/min]	1.8927E+02
Test duration	[h]	1.6767E+02

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.2665E-11
Transmissivity	[m2/s]	3.2045E-04
Storage	[m/Pa]	3.2419E-13
Storativity	[-]	3.1803E-09
Wellbore storage	[m3/Pa]	2.3643E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	3.1235E+02
Pressure match	[1/kPa]	6.5031E-02

Comments

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TEST ANALYSIS REPORT 27.10.1995

Identification	
Site name	Florence, Arizona
Well name	M3-GL
Interval name	Lower Gila
Event name	Pumping Well
Test date	26 - 27 July, 1995
Input file name	pm3-glda.fd1

Well parameters		
Well depth	[m bgl]	1.1278E+02
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.2190E+01

Test parameters		
Flow rate	[l/min]	3.7850E+01
Test duration	[h]	2.6919E+01

Fluid and formation parameters		
Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions	
Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis		
Transmissibility	[m3]	6.9585E-11
Transmissivity	[m2/s]	6.8263E-04
Storage	[m/Pa]	3.2211E-11
Storativity	[-]	3.1599E-07
Wellbore storage	[m3/Pa]	8.1567E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.9287E+03
Pressure match	[1/kPa]	6.9273E-01
Type Curve Match	[-]	1.0000E+06

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	PW4-1
Interval name	Oxide
Event name	Pumping Well
Test date	19 May, 1995
Input file name	pw4-1.rec

Well parameters

Well depth	[m brp]	2.4384E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.0363E+02

Testparameter

Flow rate	[l/min]	2.6876E+02
Test duration	[h]	9.5190E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.4008E-10
Transmissivity	[m2/s]	1.3742E-03
Storage	[m/Pa]	2.5645E-13
Storativity	[-]	2.5158E-09
Wellbore storage	[m3/Pa]	1.8703E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.6933E+03
Pressure match	[1/kPa]	1.9640E-01

Comments

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TEST ANALYSIS REPORT 27.10.1995

Identification

Site name	Florence, Arizona
Well name	M4-O
Interval name	Oxide
Event name	Pumping Well
Test date	28 - 29 July, 1995
Input file name	pm4-od.fd1

Well parameters

Well depth	[m bgl]	1.5240E+02
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	1.8290E+01

Test parameters

Flow rate	[l/min]	5.6780E+01
Test duration	[h]	2.3641E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.6643E-12
Transmissivity	[m2/s]	3.5947E-05
Storage	[m/Pa]	2.7270E-13
Storativity	[-]	2.6752E-09
Wellbore storage	[m3/Pa]	1.3811E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	5.9983E+01
Pressure match	[1/kPa]	2.4317E-02
Type Curve Match	[-]	2.0000E+08

Comments

FlowDim V2.14b

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TEST ANALYSIS REPORT 26.10.1995

Identification	
Site name	Florence, Arizona
Well name	PW7-1
Interval name	Oxide
Event name	Pumping Test
Test date	16 - 21 June 1995
Input file name	pw7-1dda.fd1

Well parameters		
Well depth	[m bgl]	2.7432E+02
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.0363E+02

Test parameter		
Flow rate	[l/min]	1.5142E+02
Test duration	[h]	2.4919E+01

Fluid and formation parameters		
Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions	
Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis		
Transmissibility	[m3]	8.5587E-12
Transmissivity	[m2/s]	8.3960E-05
Storage	[m/Pa]	1.8842E-07
Storativity	[-]	1.8484E-03
Wellbore storage	[m3/Pa]	6.8707E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	2.8162E+02
Pressure match	[1/kPa]	2.1298E-02
Type Curve Match	[-]	1.0000E+02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P8-GU
Interval name	Upper Gila
Event name	Pumping Well
Test date	18 - 22 Sep. 1995
Input file name	p8-gud.rec

Well parameters

Well depth	[m brp]	8.2300E+01
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	3.6580E+01

Testparameter

Flow rate	[l/min]	3.3501E+02
Test duration	[h]	5.3012E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	8.0643E-10
Transmissivity	[m2/s]	7.9111E-03
Storage	[m/Pa]	3.2522E-10
Storativity	[-]	3.1904E-06
Wellbore storage	[m3/Pa]	1.1859E-05
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.5374E+03
Pressure match	[1/kPa]	9.0703E-01

Comments

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TEST ANALYSIS REPORT 26.10.1995

Identification

Site name	Florence Arizona
Well name	P12-O
Interval name	Oxide
Event name	Pumping Test
Test date	1 - 7 June, 1995
Input file name	p12-oddc.fdt

Well parameters

Well depth	[m bgl]	1.0000E+02
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.5240E+02

Test parameters

Flow rate	[l/min]	2.4610E+02
Test duration	[h]	1.6624E+00

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	2.0785E-11
Transmissivity	[m2/s]	2.0390E-04
Storage	[m/Pa]	4.2419E-05
Storativity	[-]	4.1613E-01
Wellbore storage	[m3/Pa]	4.6404E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.0126E+02
Pressure match	[1/kPa]	3.1823E-02
Type Curve parameter	[-]	3.0000E+00

Comments

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TEST ANALYSIS REPORT 23.11.1995

Identification

Site name	Florence, Arizona
Well name	P13.1-O
Interval name	Oxide
Event name	Pumping Well
Test date	9 - 16 Oct. 1995
Input file name	p131od.rec

Well parameters

Well depth	[m brp]	4.4958E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	2.0635E+02

Testparameter

Flow rate	[l/min]	1.7413E+02
Test duration	[h]	8.8082E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	1.9503E-11
Transmissivity	[m2/s]	1.9133E-04
Storage	[m/Pa]	4.8082E-11
Storativity	[-]	4.7168E-07
Wellbore storage	[m3/Pa]	1.7533E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	2.5149E+02
Pressure match	[1/kPa]	4.2203E-02

Comments

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TEST ANALYSIS REPORT 24.11.1995

Identification

Site name	Florence, Arizona
Well name	P13.2-O
Interval name	Oxide
Event name	Obs, Well (P13.1-O)
Test date	9 - 16 Oct. 1995
Input file name	p132od3d.rec

Well parameters

Well depth	[m brp]	4.2672E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.8227E+02
Distance to active well	[m]	3.1370E+01

Testparameter

Flow rate	[l/min]	1.7413E+02
Test duration	[h]	8.8176E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	8.3410E-15
Transmissivity	[m2/s]	8.1825E-08
Storage	[m/Pa]	7.1721E-11
Storativity	[-]	7.0358E-07
Inner shell flow dimension	[-]	3.0000E+00
Dimensionles obs. point distance	[-]	4.1168E+02
Time match	[1/h]	4.2545E-01
Pressure match	[1/kPa]	3.6089E-05

Comments

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TEST ANALYSIS REPORT 25.11.1995

Identification

Site name	Florence, Arizona
Well name	P15-O
Interval name	Oxide
Event name	Pumping Well
Test date	29 Sep-5 Oct. 1995
Input file name	p15od.rec

Well parameters

Well depth	[m brp]	4.2062E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	2.1946E+02

Testparameter

Flow rate	[l/min]	2.2330E+02
Test duration	[h]	1.0083E+02

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.9175E-11
Transmissivity	[m2/s]	3.8431E-04
Storage	[m/Pa]	1.3542E-06
Storativity	[-]	1.3285E-02
Wellbore storage	[m3/Pa]	4.9380E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.7936E+02
Pressure match	[1/kPa]	6.6105E-02

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19-O
Interval name	Oxide
Event name	Observ. Well
Test date	3 - 6 Jul. 1995
Input file name	p19-0d.rec

Well parameters

Well depth	[m brp]	2.0726E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	6.0350E+01
Distance to active well	[m]	2.2720E+01

Testparameter

Flow rate	[l/min]	8.3280E+01
Test duration	[h]	5.1266E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	4.1810E-12
Transmissivity	[m2/s]	4.1016E-05
Storage	[m/Pa]	7.8809E-08
Storativity	[-]	7.7311E-04
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	2.9816E+02
Time match	[1/h]	3.7000E-01
Pressure match	[1/kPa]	1.8917E-02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19-O
Interval name	Oxide
Event name	Observ. Well
Test date	3 - 6 Jul. 1995
Input file name	p19-od3d.rec

Well parameters

Well depth	[m brp]	2.0726E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	6.0350E+01
Distance to active well	[m]	2.2720E+01

Testparameter

Flow rate	[l/min]	8.3280E+01
Test duration	[h]	5.1266E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	5.1759E-15
Transmissivity	[m2/s]	5.0775E-08
Storage	[m/Pa]	1.4684E-10
Storativity	[-]	1.4405E-06
Inner shell flow dimension	[-]	3.0000E+00
Dimensionles obs. point distance	[-]	2.9816E+02
Time match	[1/h]	2.4582E-01
Pressure match	[1/kPa]	4.6825E-05

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19.1-O
Interval name	Oxide
Event name	Withdrawal
Test date	3 - 6 Jul. 1995
Input file name	p191-od.rec

Well parameters

Well depth	[m brp]	2.0726E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	6.0350E+01

Testparameter

Flow rate	[l/min]	8.3300E+01
Test duration	[h]	5.1267E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	6.5087E-12
Transmissivity	[m2/s]	6.3851E-05
Storage	[m/Pa]	6.2788E-14
Storativity	[-]	6.1595E-10
Wellbore storage	[m3/Pa]	4.5791E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	3.2135E+02
Pressure match	[1/kPa]	2.9442E-02

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19.1-O
Interval name	Oxide
Event name	Withdrawal
Test date	3 - 6 Jul. 1995
Input file name	p191od3d.rec

Well parameters

Well depth	[m brp]	2.0726E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	6.0350E+01

Testparameter

Flow rate	[l/min]	8.3300E+01
Test duration	[h]	5.1267E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	2.4052E-13
Transmissivity	[m2/s]	2.3595E-06
Storage	[m/Pa]	5.7460E-07
Storativity	[-]	5.6368E-03
Wellbore storage	[m3/Pa]	4.1894E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	3.0000E+00
Time match	[1/h]	2.5952E+01
Pressure match	[1/kPa]	2.1754E-03

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19.2-O
Interval name	Oxide
Event name	Observ. Well
Test date	3 - 6 Jul. 1995
Input file name	p192-od.rec

Well parameters

Well depth	[m brp]	1.9111E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	6.0350E+01
Distance to active well	[m]	2.1200E+01

Testparameter

Flow rate	[l/min]	8.3280E+01
Test duration	[h]	4.9513E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.2012E-12
Transmissivity	[m2/s]	3.1404E-05
Storage	[m/Pa]	1.4992E-08
Storativity	[-]	1.4707E-04
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	2.6835E+02
Time match	[1/h]	1.7103E+00
Pressure match	[1/kPa]	1.4484E-02

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P19.2-O
Interval name	Oxide
Event name	Observ. Well
Test date	3 - 6 Jul. 1995
Input file name	p192od3d.rec

Well parameters

Well depth	[m brp]	1.9111E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	6.0350E+01
Distance to active well	[m]	2.1200E+01

Testparameter

Flow rate	[l/min]	8.3280E+01
Test duration	[h]	4.9513E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	4.3045E-15
Transmissivity	[m2/s]	4.2228E-08
Storage	[m/Pa]	3.4441E-11
Storativity	[-]	3.3786E-07
Inner shell flow dimension	[-]	3.0000E+00
Dimensionles obs. point distance	[-]	2.6835E+02
Time match	[1/h]	1.0011E+00
Pressure match	[1/kPa]	3.8942E-05

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P28-GL
Interval name	Lower Gila
Event name	Pumping Well
Test date	20 - 25, Sep. 1995
Input file name	p28-gld.rec

Well parameters

Well depth	[m brp]	9.7540E+01
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.3500E-02
Interval length	[m]	9.1400E+00

Testparameter

Flow rate	[l/min]	2.8390E+02
Test duration	[h]	1.1539E+02

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	1.0000E-01

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	2.7137E-11
Transmissivity	[m2/s]	2.6622E-04
Storage	[m/Pa]	3.4388E-11
Storativity	[-]	3.3735E-07
Wellbore storage	[m3/Pa]	8.7080E-07
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	7.0454E+02
Pressure match	[1/kPa]	3.6017E-02

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P28.1-O
Interval name	Oxide
Event name	Pumping Well
Test date	15 - 18 Aug, 1995
Input file name	p281-oad.rec

Well parameters

Well depth	[m brp]	1.5850E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	6.7200E-02
Interval length	[m]	3.0480E+01

Testparameter

Flow rate	[l/min]	1.0978E+02
Test duration	[h]	4.2844E+03

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	8.4137E-11
Transmissivity	[m2/s]	8.2539E-04
Storage	[m/Pa]	5.3035E-04
Storativity	[-]	5.2027E+00
Wellbore storage	[m3/Pa]	1.5040E-04
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	1.2647E+01
Pressure match	[1/kPa]	2.8879E-01

Comments

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TEST ANALYSIS REPORT 15.11.1995

Identification

Site name	Forence, Arizona
Well name	P28.1-O
Interval name	Oxide
Event name	Pumping Well
Test date	8 - 11 Sep, 1995
Input file name	p281-obd.rec

Well parameters

Well depth	[m brp]	1.5850E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	3.0480E+01

Testparameter

Flow rate	[l/min]	3.2180E+02
Test duration	[h]	7.4053E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.9300E-11
Transmissivity	[m2/s]	3.8554E-04
Storage	[m/Pa]	3.5153E-06
Storativity	[-]	3.4485E-02
Wellbore storage	[m3/Pa]	1.2818E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	6.9315E+02
Pressure match	[1/kPa]	4.6017E-02

Comments

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TEST ANALYSIS REPORT 15.11.1995

Identification

Site name	Florence, Arizona
Well name	P28.2-O
Interval name	Oxide
Event name	Obs. Well (P28.1-O)
Test date	8 - 11 Sep, 1995
Input file name	p282-obd.rec

Well parameters

Well depth	[m brp]	1.6150E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	5.0800E-02
Interval length	[m]	3.0180E+01
Distance to active well	[m]	2.9910E+01

Testparameter

Flow rate	[l/min]	3.2170E+02
Test duration	[h]	7.3898E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Observation
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	2.8996E-11
Transmissivity	[m2/s]	2.8446E-04
Storage	[m/Pa]	2.9688E-08
Storativity	[-]	2.9124E-04
Inner shell flow dimension	[-]	2.0000E+00
Dimensionles obs. point distance	[-]	5.8878E+02
Time match	[1/h]	3.9303E+00
Pressure match	[1/kPa]	3.3963E-02

Comments

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TEST ANALYSIS REPORT 16.11.1995

Identification

Site name	Florence, Arizona
Well name	P28.2-O
Interval name	Oxide
Event name	Pumping Well
Test date	2 - 5 Oct. 1995
Input file name	p282-od.rec

Well parameters

Well depth	[m brp]	1.5820E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	3.0180E+01

Testparameter

Flow rate	[l/min]	2.8769E+02
Test duration	[h]	7.4052E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-02

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Drawdown

Results of analysis

Transmissibility	[m3]	3.3674E-11
Transmissivity	[m2/s]	3.3035E-04
Storage	[m/Pa]	3.8581E-04
Storativity	[-]	3.7848E+00
Wellbore storage	[m3/Pa]	1.4068E-04
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	2.0000E+00
Time match	[1/h]	5.4115E+00
Pressure match	[1/kPa]	4.4105E-02

Comments

FlowDim V2.14b Copyright (c) Golder Associates 1994

TEST ANALYSIS REPORT 25.11.1995

Identification

Site name	Florence, Arizona
Well name	P49-O
Interval name	Oxide
Event name	Recovery
Test date	11 - 16 Oct. 1995
Input file name	p490r.rec

Well parameters

Well depth	[m brp]	3.9258E+02
Reference point elevation	[m asl]	0.0000E+00
Wellbore radius	[m]	7.6200E-02
Interval length	[m]	1.2619E+02

Testparameter

Production/Injection time	[h]	4.5700E+01
Flow rate	[1/min]	1.5142E+02
Test duration	[h]	4.7164E+01

Fluid and formation parameters

Viscosity	[Pa s]	1.0000E-03
Total compressibility	[1/Pa]	5.4000E-10
Porosity	[-]	5.0000E-03

Model assumptions

Flow model	Homogeneous
Boundary conditions	Constant rate
Well type	Source
Superposition type	Buildup

Results of analysis

Transmissibility	[m3]	3.5205E-13
Transmissivity	[m2/s]	3.4536E-06
Storage	[m/Pa]	8.1397E-05
Storativity	[-]	7.9851E-01
Wellbore storage	[m3/Pa]	1.7804E-06
Skin (assumed)	[-]	0.0000E+00
Inner shell flow dimension	[-]	3.0000E+00
Time match	[1/h]	8.9386E+00
Pressure match	[1/kPa]	1.7517E-03

Comments

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MEMORANDUM

TO: Mr. Steven A. Mellon
Brown and Caldwell
3636 N. Central Ave., Suite 300
Phoenix, Arizona 85012

FROM: Amado Guzman
Tucson Office

Our Reference: 953-2908

DATE: December 1, 1995

RE: Florence Electronic Data

Dear Steve:

Please find enclosed the reduced data files for the hydraulic tests included in our interpretation report. I have prepared a list of these files and their relationship to the figures presented in Appendix B. Please let me know if you need any additional information.

Cheers!

Enc. (12) Diskettes

cc. Mr. John Kline
Magma Copper Co.
Resource Development Technology Group
7400 N. Oracle Rd. Suite 162
Tucson, Arizona 85704
WITH ENCLOSURES (1) Diskette

Reduced data files and corresponding figures within Appendix B. Files contain two columns; time (hours) versus head (KPa).

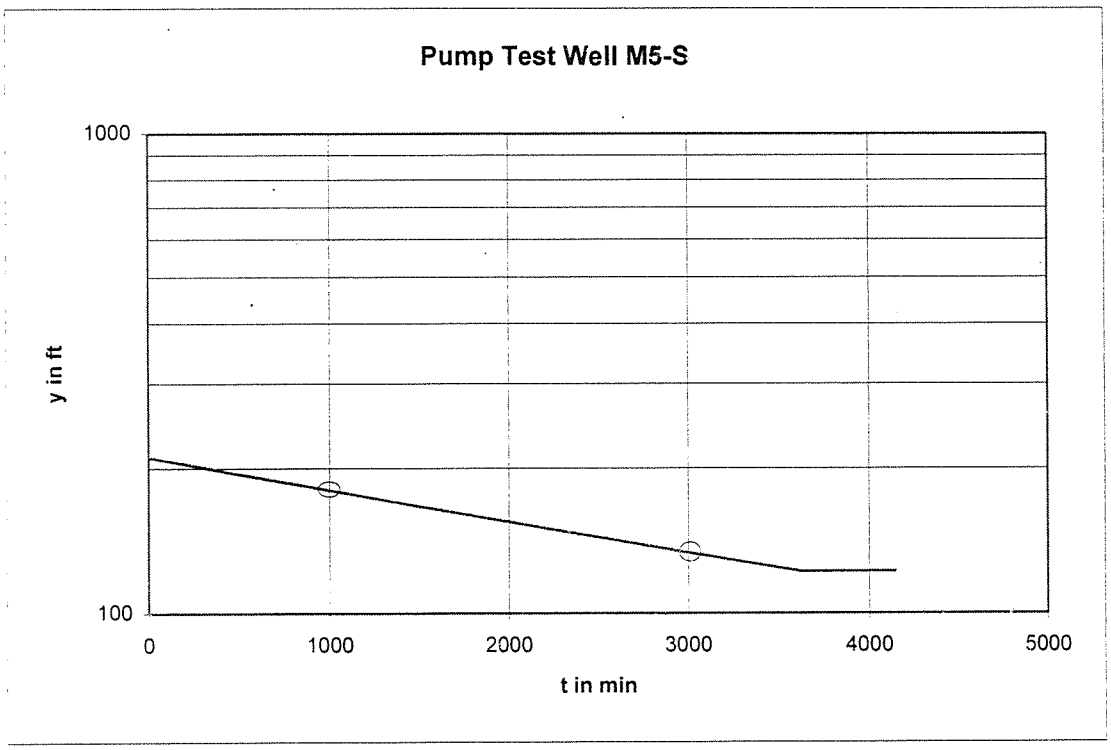
Figure	Well ID	Name of Data File			
1B,	M1-GL	M1-GLD DAT	7,342	11-16-95	3:41a
2B,	M3-GL	M3GLPD DAT	6,354	08-29-95	9:31p
3B,	M14-GL	M14-GLD DAT	5,302	11-16-95	3:43a
4B,	M14-GL (3-D)	Same as previous			
5B,	M15-GU	M15-GUD DAT	7,138	11-16-95	3:42a
6B,	M18-GL	M18-GUD DAT	6,186	11-16-95	3:40a
7B,	P39-O	MF39PWPD DAT	7,920	11-15-95	12:01p
8B,	O39-O	MF39OWPD DAT	4,758	11-15-95	12:02p
9B,	OB7-1	OB7-1OD DAT	8,328	12-01-95	2:25p
10B,	O12-O	O12-ODDC FD1	22,449	10-27-95	11:44a
11B,	O28-GL	O28-GLD DAT	6,458	11-16-95	2:29a
12B,	O28.1-O	O281-OD DAT	6,220	11-16-95	1:24a
13B,	PW2-1	PW2-1D DAT	8,498	11-16-95	4:54p
14B,	M3-GL	M3GLODDB FDT	746	10-29-95	3:18p
15B,	PW4-1	PW4-1 DAT	7,478	11-16-95	4:29p
16B,	M4-O	M4OPD DAT	5,469	08-29-95	9:57p
17B,	PW7-1	PW7-1OD DAT	8,158	12-01-95	2:27p
18B,	P8-GU	P8-GUD DAT	6,696	11-16-95	2:26a
19B,	P12-O	P12-ODDB FDT	2,684	10-22-95	7:22p
20B,	P13.1-O	P131OD DAT	7,988	11-23-95	12:41p
21B,	P13.2-O (3-D)	P132OD DAT	8,294	11-23-95	12:44p
22B,	P15-O	P15OD DAT	8,260	11-25-95	12:06p
23B,	P19-O	P19-OD DAT	8,396	11-16-95	11:30a
24B,	P19-O (3-D)	Same as previous			
25B,	P19.1-O	P191-OD DAT	6,390	11-16-95	11:29a
26B,	P19.1-O (3-D)	Same as Previous			
27B,	P19.2-O	P192-OD DAT	8,838	11-16-95	11:32a
28B,	P19.2-O (3-D)	Same as Previous			
29B,	P28-GL	P28-GLD DAT	8,770	11-16-95	2:27a
30B,	P28.1-O	P281-OAD DAT	7,444	11-15-95	1:33p
31B,	P28.1-O (Test #2)	P281-OBD DAT	7,852	11-15-95	2:06p
32B,	P28.2-O (Test #2)	P282-OBD DAT	6,662	11-15-95	2:06p
33B,	P28.2-O	P282-OD DAT	8,090	11-16-95	1:22a
34B,	P49-O (3-D)	P49OR DAT	8,498	11-24-95	7:21p

M5-S Pump Out Slug Test
Brown and Caldwell

Project: 1899 for Magma Copper Company, Florence, AZ
Test Date: July 25-28, 1995

Depth of well, Dw=	380	ft
Depth to water Dd=	122.13	ft
D=Dw-Dd	257.87	ft
b=D	257.87	ft
d=	60	ft
y=	211	ft
rc=	0.2	ft
rw=	0.35	ft
d/rw=	171.4286	
b/rw=	736.7714	
from Fig 16.6		
C=	11.6	
ln(Re/rw)	4.268473	
K=	3.1E-04	ft/day

t=tx-to=	2005
ln(ho/ht)=	0.300301
slope=	0.00015

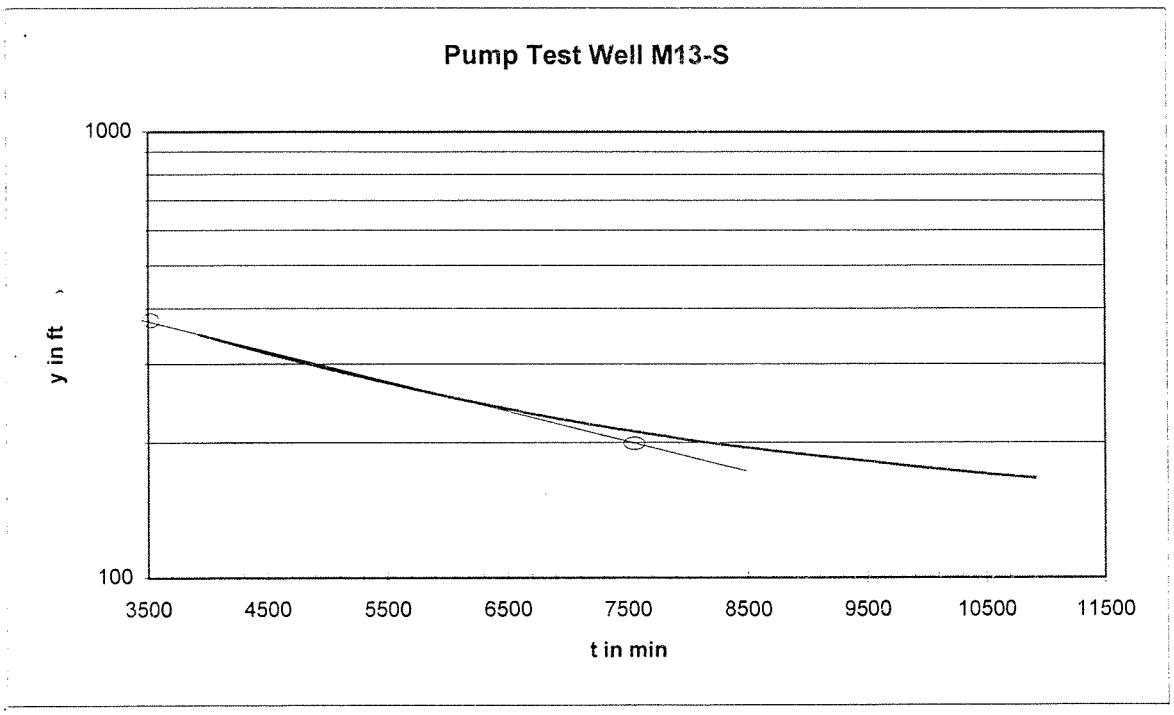


Reference: Bouwer, H., The Bouwer and Rice Slug Test - An Update. Ground Water Vol. 27, No. 3, 1989

M13-S Pump Out Slug Test
Brown and Caldwell

Project: 1899 for Magma Copper Company, Florence, AZ
Test Date: July 28 - Aug 1, 1995

Depth of well, Dw=	345	ft	t=tx-to=	4050
Depth to water Dd=	150.79	ft	ln(ho/ht)=	0.641854
D=Dw-Dd	194.21	ft	slope=	0.000158
b=D	194.21	ft		
d=	60	ft		
y=	349	ft		
rc=	0.2	ft		
rw=	0.35	ft		
d/rw=	171.4286			
b/rw=	554.8857			
from Fig 16.6				
C=	11.6			
ln(Re/rw)	4.136481			
K=	3.1E-04	ft/day		



Reference: Bouwer, H., The Bouwer and Rice Slug Test - An Update. Ground Water Vol. 27, No. 3, 1989

EXHIBIT B-3

Documentation of Successful Hydraulic Control and USEPA Approval of Cessation of Hydraulic Control

BHP

WATER PERMITS

JUN 17 1998

RECEIVED

BHP Copper

6 April 1998

Ms. Julie Collins
ADEQ Compliance Officer
Arizona Department of Environmental Quality
3033 N. Central Ave.
Phoenix, AZ 85012

Dear Ms. Collins,

In order to satisfy Part II.E.1.a of Aquifer Protection Permit #101704 (permit page 7), BHP Copper is submitting data demonstrating that hydraulic control was maintained during a 90-day pre-operational period. The pre-operational compliance test was conducted from November 8, 1997 until February 10, 1998. The attached information and graphs are based on two data sets. The first set is the electrical conductivity readings measured by field technicians on daily composite samples. The second set of data includes the elevation of the water table for four pairs of pumping and observation wells. These pairs are located in the four quadrants of the compliance test area and are representative of conditions in the field area. Each pair consists of a pumping well and an observation well located 50 feet to the east or west of the pumping well. The pairs are:

Quadrant	Pumping Well	Observation Well
Northwest	BHP4	OWB3
Northeast	BHP3	OWB1
Southwest	BHP5	OWB4
Southeast	BHP2	OWB5

The data for electrical conductivity was measured by hand. The samples were taken by two methods. The wells labeled as BHP2, BHP3, BHP4, and BHP5 were continuously running pumping wells. The samples on these wells were made from a 24-hour composite, with each individual sample being a 0.25 gallon sample taken every six hours. These samples were blended and a portion taken for analysis. Observation wells OWB1, OWB3, OWB4, and OWB5 did not have pumps in them during the test. These wells were sampled using a sample baler with a small pump attached to guarantee a good sample. The procedure for this sampling was to turn the pump

on for five minutes and then let the sample collect for another two minutes before retrieving the baler. This sample was then analyzed. The conductivity readings were conducted on site with a YSI meter by the person doing the sampling.

The data for the water elevation levels was gathered electronically using the controllers in the well field on each individual well. The controllers upload this information continuously to the well field computer at the operator control room. The water levels of the individual wells were taken from 12 hour (12 o'clock to 12 o'clock) electronic shift files. Each well has an electronic file for each shift; these files contain readings taken every five minutes. The readings were averaged over the shift, and entered into a spread sheet.

Aberrations in the conductivity data are a result of operator error and instrument error including interference of hand-held radios used in the same room as the conductivity probe. Aberrations in the water level data are primarily a result of instrument error including maintenance problems with pressure transducers and temporary adjustments to the pumps. On OWB5, there is a period of missing or unreliable data between December 21 to December 29, 1997 caused by the malfunction of the pressure transducer in the well head. Replacements also malfunctioned, but a properly performing unit was eventually in place. If you have any questions about the data or graphs, please call me at (520) 868-5092. Thank you.

Yours sincerely,

Corolla Hoag

Ms. Corolla (Cori) Hoag

Attached: graphs showing electrical conductivity and water levels, and field measurements.

BHP

This sheet only
For our files.
C.H.

To: Corolla Hoag Sr. Geologist

CC: File

From: Michael Kline

Date: April 3, 1998

Compliance Test Report Information

Data for Compliance test and explanation

The data consists of two sets of readings. The first is the electrical conductivity. The second is elevation of water table for observation pairs in the well field. This is grouped into pairs corresponding to the four sides of the well field. These pairs are: North West (BHP4,OWB3), North East (BHP3,OWB1), South West (BHP5,OWB4), South East (BHP2,OWB5).

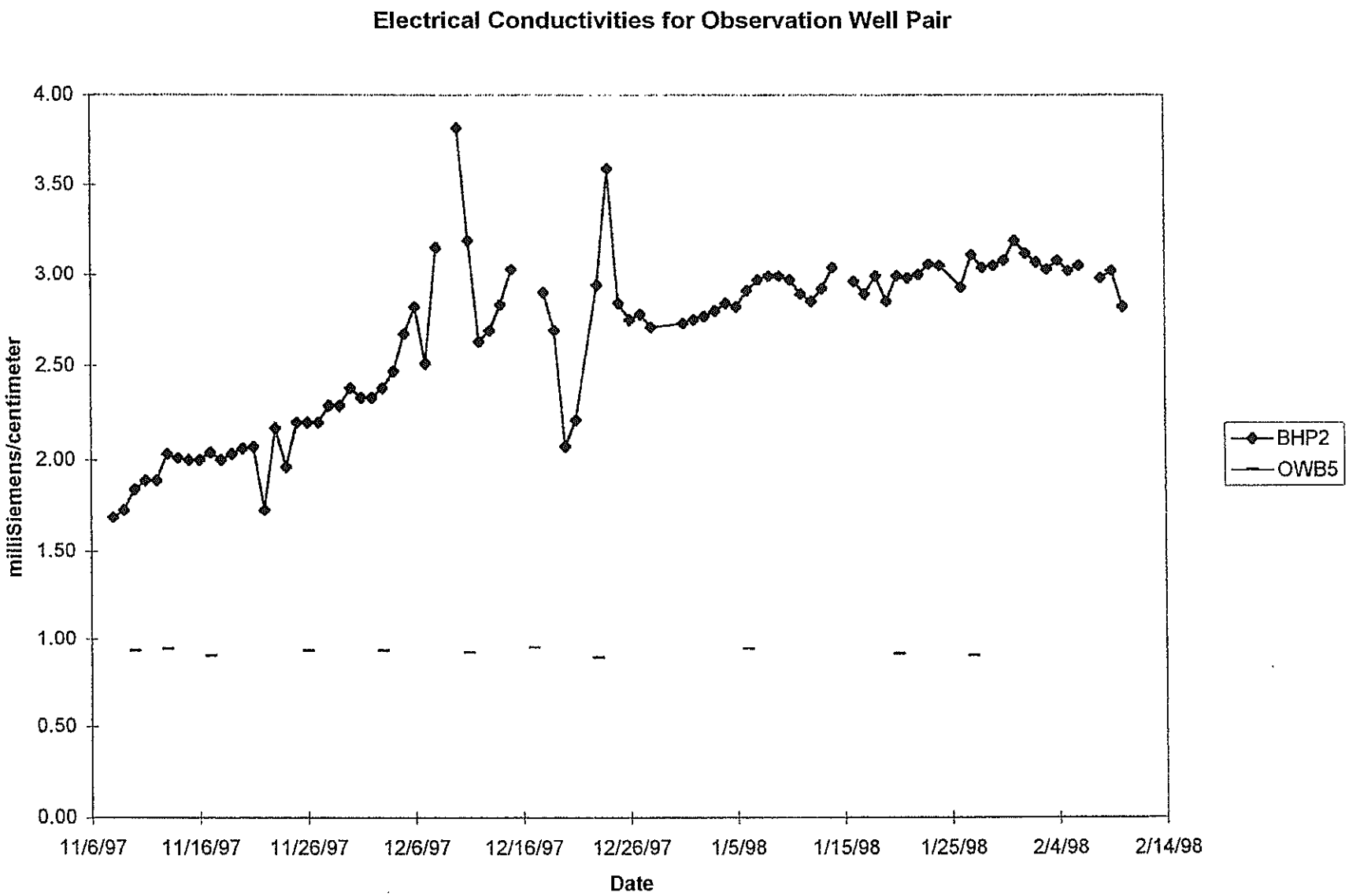
The Data for electrical conductivity was taken by hand. These samples were taken two ways. The wells labeled as BHP2, BHP3, BHP4, and BHP5 were used as continuously running pumping wells. The samples on these wells are made from a twenty four hour composite, with each individual sample being a ¼ gallon sample taken every 6 hours. These samples were blended, and a portion cut for analysis. The wells labeled as OWB1, OWB3, OWB4, and OWB5 did not have pumps in them during the test. These wells were sampled using a sample baler with a small pump attached to guarantee a good sample. The procedure for this sampling was to turn the pump on for five minutes and then let the sample set for another two before retrieving the baler. This sample was then analyzed. The analysis used for electrical conductivity was performed by the person doing the sampling. This was done on sight using the YSI meter located in the control room.

The data for the Water levels was gathered electronically using the controllers in the well field on each individual well. The controllers download this information continuously to the well field computer at the operator trailer. The water levels of the individual wells were taken from 12 hour (12 o'clock to 12 o'clock) shift files. Each well has its own individual file for each shift. These files contain readings taken every five minutes. These readings where averaged over the shift, and entered onto a spread sheet (d:\data\daily average.xls). This data was translated from depth of water table from surface to Elevation of water table using Excel.

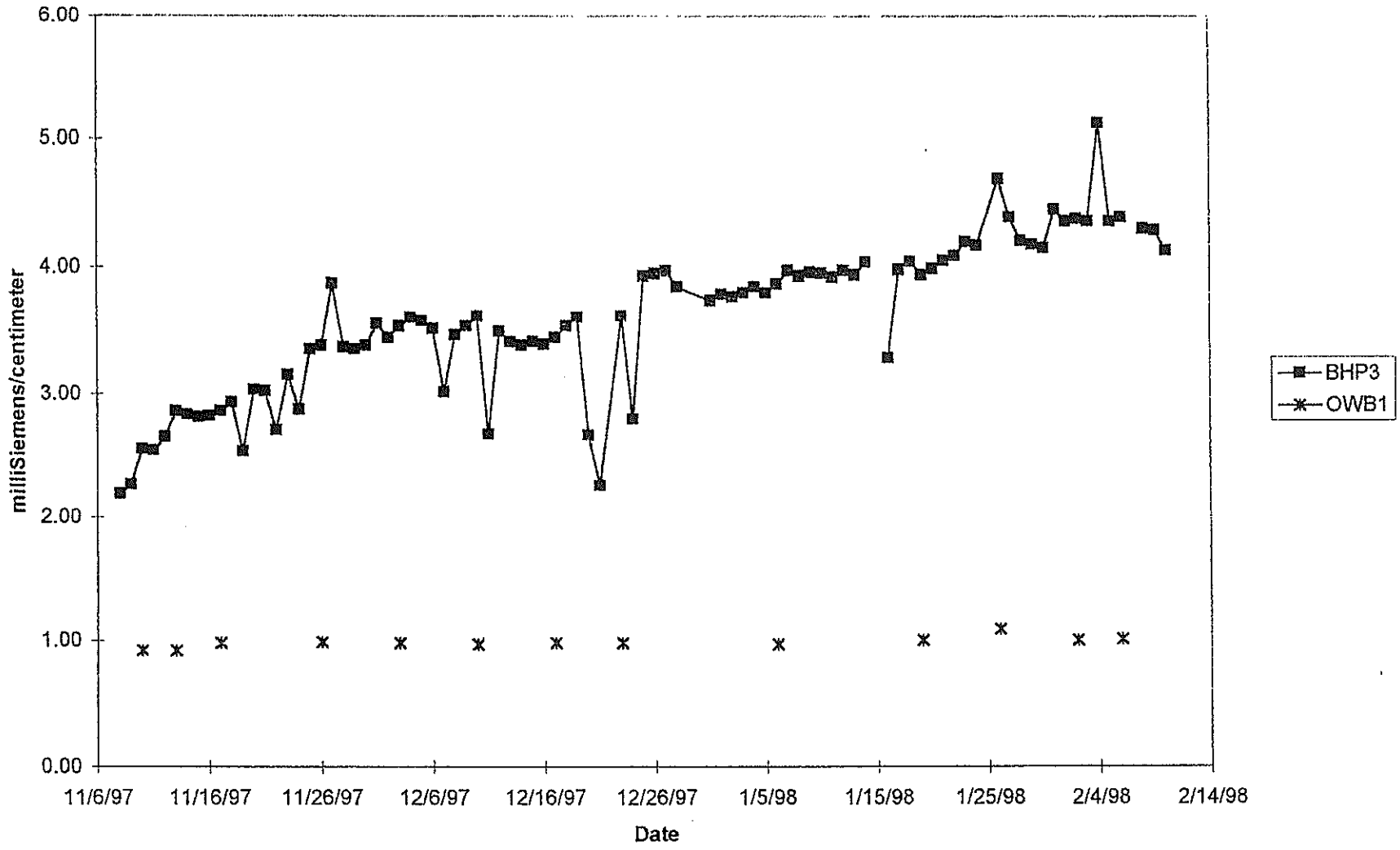
On OWB5 there is a period of missing and corrupted data (12/21/97 to 12/29/970) this was caused by malfunction of pressure transducer in well head. A replacement was placed in within a day but this was also malfunctioning.

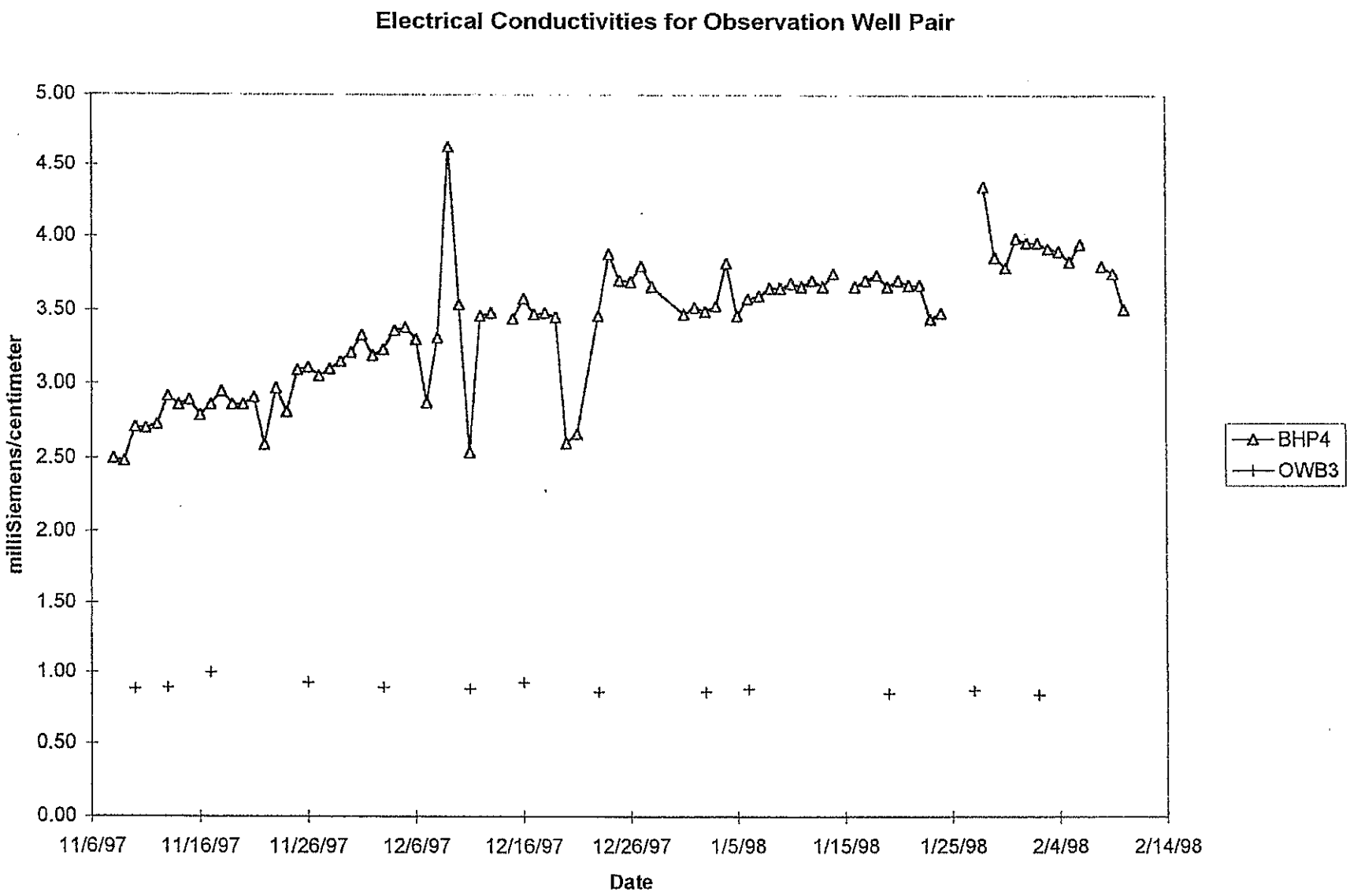
The following pages contain graphs of the electrical conductivity and the water table elevation versus time. Also included is a copy of the data for these graphs.

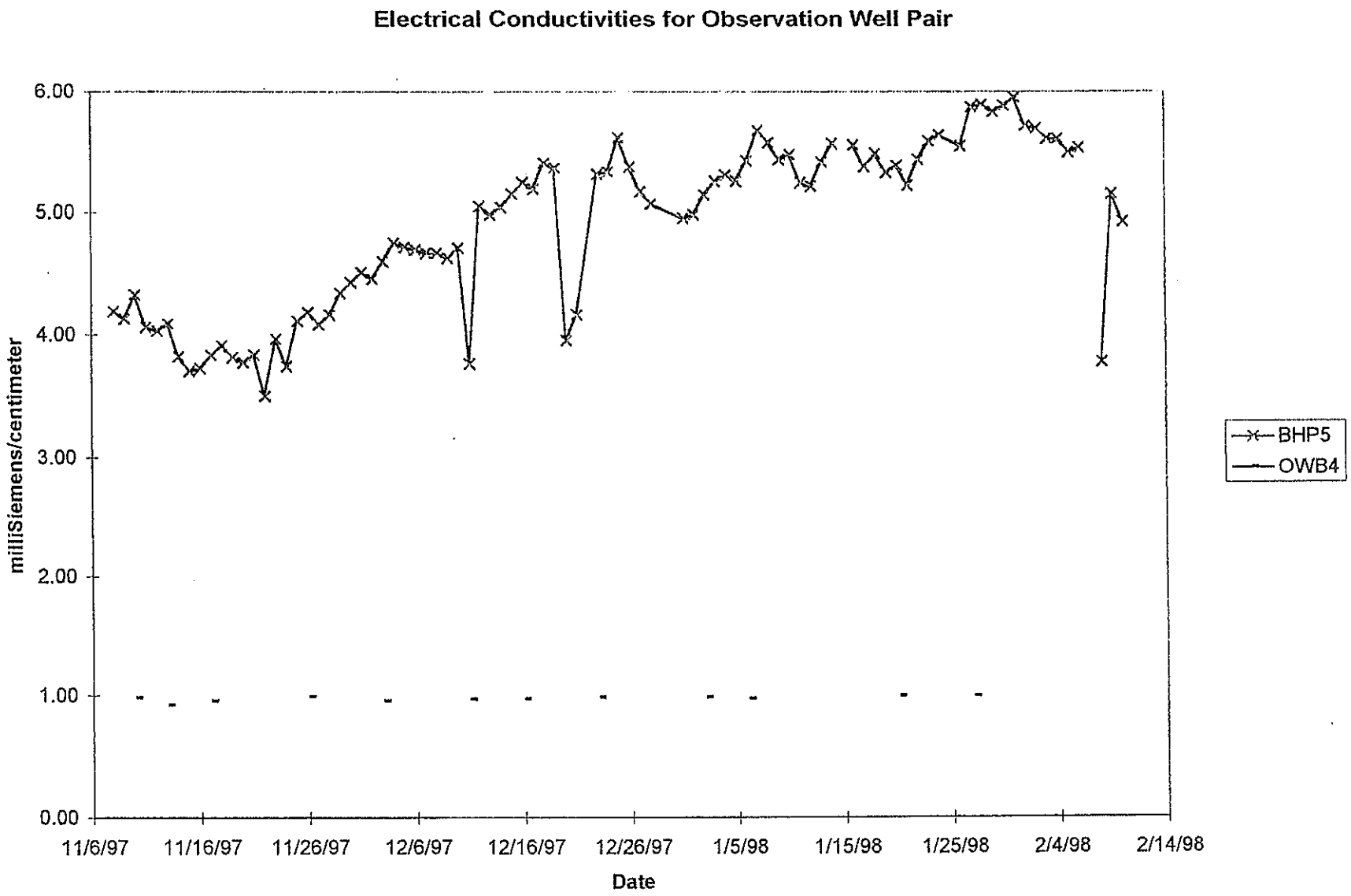
Michael Kline


Electrical Conductivities for Observation Well Pair
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
milliSiemens/centimeter
11/6/97
11/16/97
11/26/97
12/6/97
12/16/97
12/26/97
1/5/98
1/15/98
1/25/98
2/4/98
2/14/98
Date
BHP2
OWB5

Electrical Conductivities for Observation Well Pair




Electrical Conductivities for Observation Well Pair
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
milliSiemens/centimeter
11/6/97
11/16/97
11/26/97
12/6/97
12/16/97
12/26/97
1/5/98
1/15/98
1/25/98
2/4/98
2/14/98
Date
BHP4
OWB3

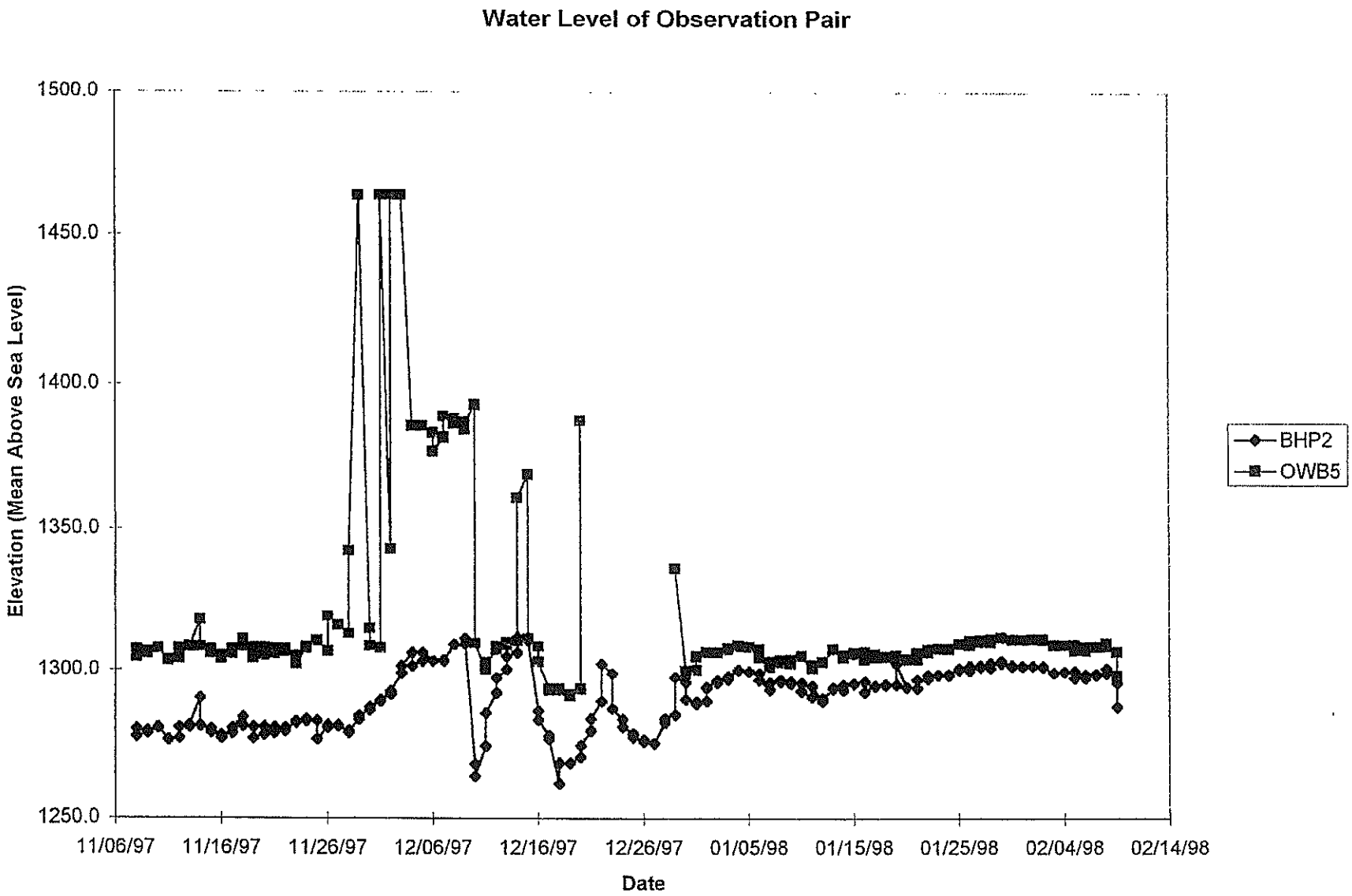

Electrical Conductivities for Observation Well Pair
6.00
5.00
4.00
3.00
2.00
1.00
0.00
milliSiemens/centimeter
11/6/97
11/16/97
11/26/97
12/6/97
12/16/97
12/26/97
1/5/98
1/15/98
1/25/98
2/4/98
2/14/98
Date
BHP5
OWB4

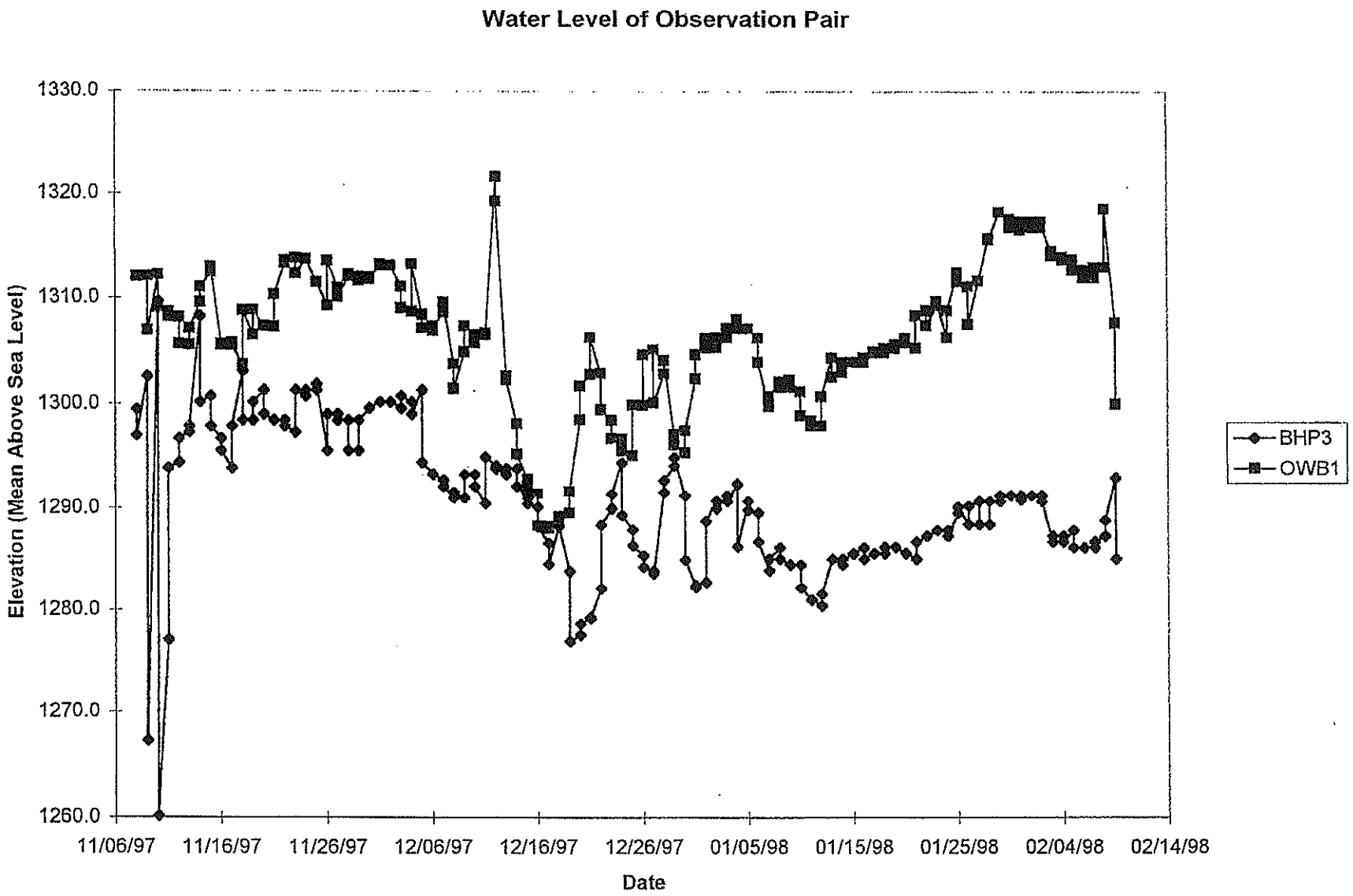
Electrical Conductivity Readings in milliSiemens/centimeter

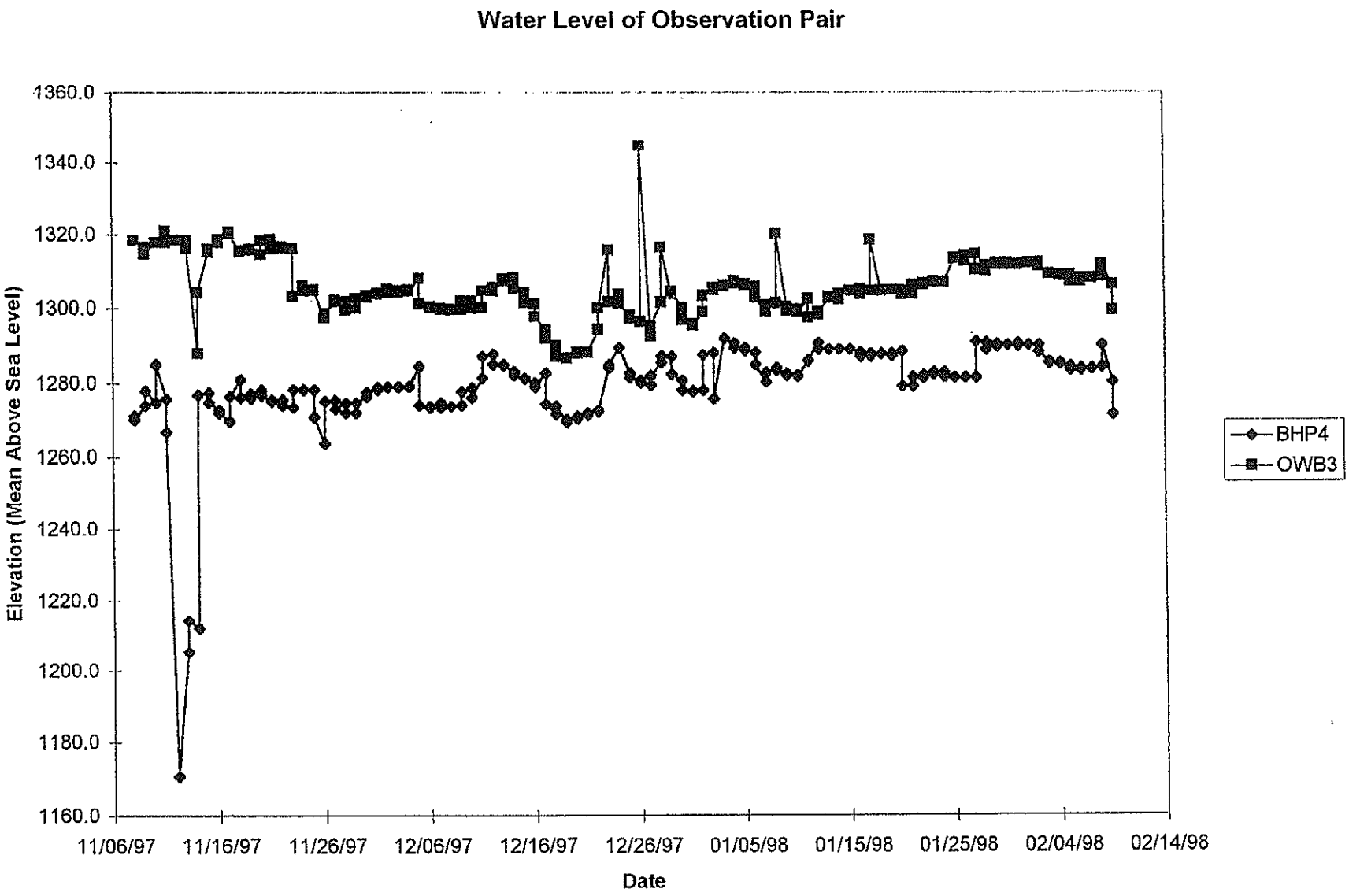
Date	BHP5	OWB1	OWB2	OWB3	OWB4	OWB5	OWB6
11/8/97	4.19		1.89				
11/9/97	4.13		1.96				
11/10/97	4.33	0.92	1.87	0.88	0.98	0.93	0.91
11/11/97	4.06		1.94				
11/12/97	4.03		1.86				
11/13/97	4.09	0.92	1.95	0.89	0.92	0.94	0.87
11/14/97	3.82		1.91				
11/15/97	3.70		2.13				
11/16/97	3.72		1.86				
11/17/97	3.83	0.98	1.88	1.00	0.95	0.90	0.92
11/18/97	3.91		1.88				
11/19/97	3.81						
11/20/97	3.77		1.93				
11/21/97	3.83		1.92				
11/22/97	3.50						
11/23/97	3.96		1.91				
11/24/97	3.74						
11/25/97	4.11						
11/26/97	4.18	0.99	1.91	0.93	0.99	0.93	0.92
11/27/97	4.08						
11/28/97	4.16						
11/29/97	4.34						
11/30/97	4.43						
12/1/97	4.51						
12/2/97	4.46						
12/3/97	4.60	0.98	1.89	0.89	0.95	0.93	0.85
12/4/97	4.75						
12/5/97	4.72		1.91				
12/6/97	4.70						
12/7/97	4.67						
12/8/97	4.67		1.98				
12/9/97	4.63						
12/10/97	4.71	0.97	1.88				
12/11/97	3.76			0.88	0.97	0.92	0.93
12/12/97	5.05		1.93				
12/13/97	4.98						
12/14/97	5.04						
12/15/97	5.15						
12/16/97	5.24			0.93	0.97		
12/17/97	5.19	0.98	1.92			0.95	0.89
12/18/97	5.40						
12/19/97	5.36		2.15				
12/20/97	3.95						
12/21/97	4.16						
12/23/97	5.31	0.98		0.86	0.98	0.89	0.89
12/24/97	5.33						
12/25/97	5.61						
12/26/97	5.37		1.87				
12/27/97	5.17						
12/28/97	5.07						

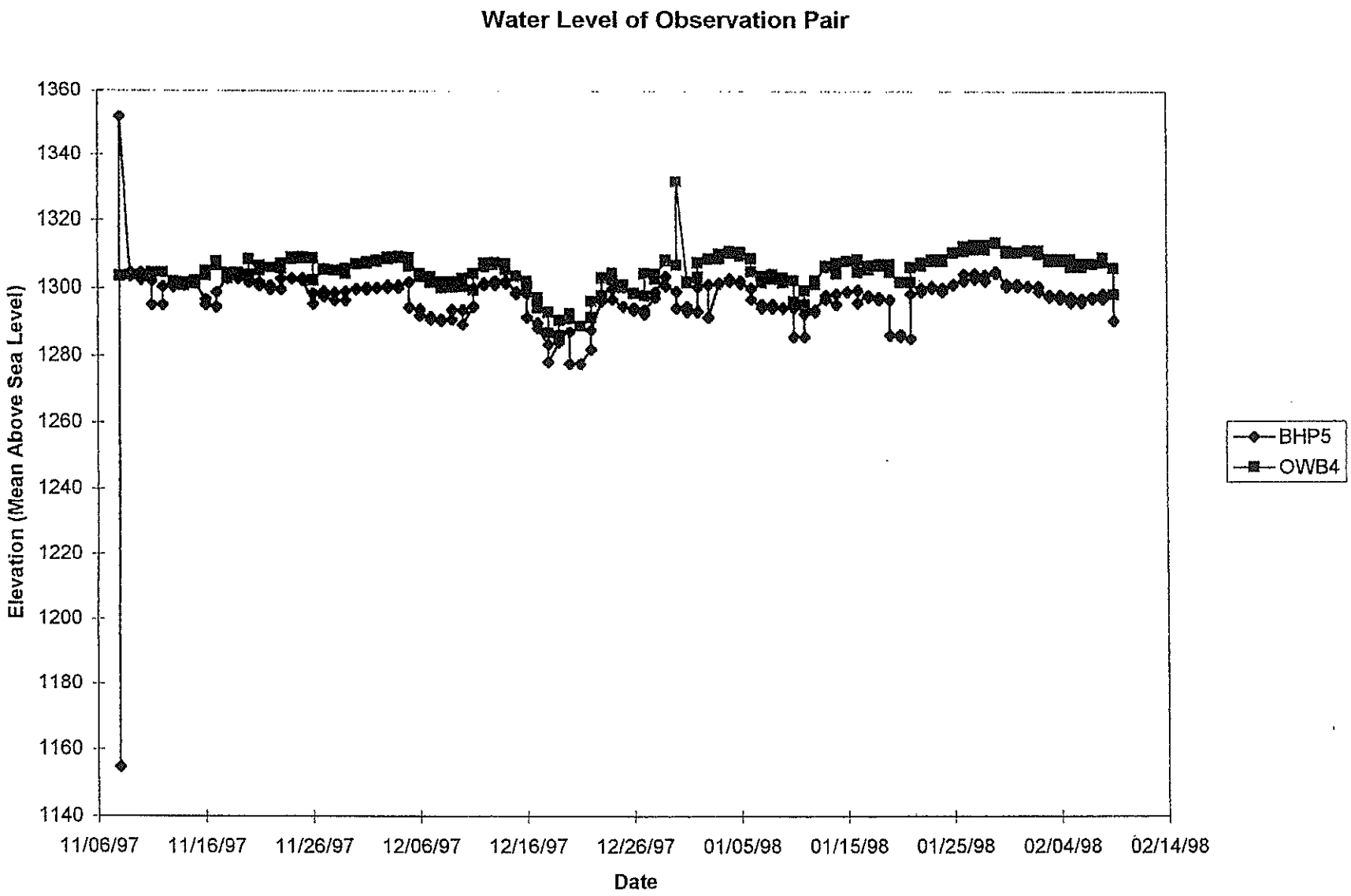
Electrical Conductivity Readings in milliSiemens/centimeter

12/31/97	4.95						
1/1/98	4.98						
1/2/98	5.14			0.86	0.98		
1/3/98	5.25						
1/4/98	5.30						
1/5/98	5.25		1.90				
1/6/98	5.42	0.97		0.88	0.97	0.94	0.90
1/7/98	5.67						
1/8/98	5.57						
1/9/98	5.43		1.88				
1/10/98	5.47						
1/11/98	5.24						
1/12/98	5.21		1.90				
1/13/98	5.41						
1/14/98	5.56						
1/15/98							
1/16/98	5.55						
1/17/98	5.37						
1/18/98	5.48						
1/19/98	5.32	1.00	1.90	0.85			
1/20/98	5.38				0.99	0.91	0.87
1/21/98	5.22						
1/22/98	5.43						
1/23/98	5.58		1.87				
1/24/98	5.63						
1/26/98	5.54	1.09	1.87				
1/27/98	5.87			0.87	0.99	0.90	
1/28/98	5.89		1.91				
1/29/98	5.83						
1/30/98	5.88						0.89
1/31/98	5.95						
2/1/98	5.71						
2/2/98	5.69	1.00	1.82	0.84			
2/3/98	5.60						
2/4/98	5.60						
2/5/98	5.49						
2/6/98	5.53	1.01					
2/7/98							
2/8/98	3.77						
2/9/98	5.15						
2/10/98	4.92						


Water Level of Observation Pair
1500.0
1450.0
1400.0
1350.0
1300.0
1250.0
Elevation (Mean Above Sea Level)
11/06/97
11/16/97
11/26/97
12/06/97
12/16/97
12/26/97
01/05/98
01/15/98
01/25/98
02/04/98
02/14/98
Date
BHP2
OWB5


Water Level of Observation Pair
Elevation (Mean Above Sea Level)
1330.0
1320.0
1310.0
1300.0
1290.0
1280.0
1270.0
1260.0
11/06/97
11/16/97
11/26/97
12/06/97
12/16/97
12/26/97
01/05/98
01/15/98
01/25/98
02/04/98
02/14/98
Date
BHP3
OWB1


Water Level of Observation Pair
Elevation (Mean Above Sea Level)
1360.0
1340.0
1320.0
1300.0
1280.0
1260.0
1240.0
1220.0
1200.0
1180.0
1160.0
11/06/97
11/16/97
11/26/97
12/06/97
12/16/97
12/26/97
01/05/98
01/15/98
01/25/98
02/04/98
02/14/98
Date
BHP4
OWB3


Water Level of Observation Pair
Elevation (Mean Above Sea Level)
1360
1340
1320
1300
1280
1260
1240
1220
1200
1180
1160
1140
11/06/97
11/16/97
11/26/97
12/06/97
12/16/97
12/26/97
01/05/98
01/15/98
01/25/98
02/04/98
02/14/98
Date
BHP5
OWB4

BHP
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12 Hour Averages

DATE	BHP4	OWB3
11/08/97	1271.3	1318.4
11/08/97	1270.2	1318.4
11/09/97	1274.0	1316.5
11/09/97	1277.9	1314.6
11/10/97	1274.8	1317.7
11/10/97	1284.9	1317.7
11/11/97	1275.8	1317.7
11/11/97	1266.8	1320.8
11/12/97	1170.7	1318.4
11/12/97	1170.7	1318.4
11/13/97	1205.5	1318.4
11/13/97	1214.3	1316.0
11/14/97	1212.3	1287.7
11/14/97	1276.9	1304.1
11/15/97	1277.4	1314.9
11/15/97	1274.9	1315.9
11/16/97	1272.9	1317.7
11/16/97	1272.0	1318.5
11/17/97	1269.7	1320.1
11/17/97	1276.5	1320.5
11/18/97	1281.0	1315.2
11/18/97	1276.2	1315.5
11/19/97	1276.0	1315.9
11/19/97	1277.1	1315.5
11/20/97	1278.1	1314.5
11/20/97	1276.7	1318.3
11/21/97	1275.1	1316.0
11/21/97	1275.6	1318.6
11/22/97	1275.6	1316.6
11/22/97	1274.0	1316.1
11/23/97	1273.5	1316.1
11/23/97	1278.3	1303.0
11/24/97	1278.3	1305.9
11/24/97	1278.3	1304.6
11/25/97	1278.3	1304.8
11/25/97	1270.9	1304.7
11/26/97	1263.6	1297.2
11/26/97	1275.1	1298.5
11/27/97	1275.3	1301.8
11/27/97	1273.1	1301.6
11/28/97	1274.7	1301.6
11/28/97	1272.0	1299.4
11/29/97	1272.0	1300.0
11/29/97	1274.8	1302.4
11/30/97	1276.5	1303.0
11/30/97	1277.6	1303.2
12/01/97	1278.3	1303.6
12/01/97	1278.7	1303.8
12/02/97	1279.0	1304.0
12/02/97	1279.0	1305.0
12/03/97	1279.0	1304.2
12/03/97	1279.1	1304.6
12/04/97	1279.1	1304.8

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12 Hour Averages

DATE	BHP4	OWB3
12/04/97	1279.2	1304.4
12/05/97	1284.4	1308.0
12/05/97	1274.0	1301.0
12/06/97	1273.8	1300.2
12/06/97	1273.3	1300.0
12/07/97	1273.3	1299.6
12/07/97	1274.8	1299.8
12/08/97	1273.8	1299.4
12/08/97	1273.8	1299.6
12/09/97	1274.1	1299.6
12/09/97	1277.7	1301.6
12/10/97	1278.7	1301.6
12/10/97	1276.1	1299.8
12/11/97	1281.4	1300.0
12/11/97	1286.9	1304.4
12/12/97	1287.4	1305.4
12/12/97	1284.9	1304.4
12/13/97	1284.8	1307.2
12/13/97	1284.8	1307.8
12/14/97	1283.0	1308.2
12/14/97	1282.0	1305.0
12/15/97	1281.1	1304.0
12/15/97	1281.2	1301.4
12/16/97	1280.0	1300.9
12/16/97	1278.9	1297.5
12/17/97	1282.5	1293.9
12/17/97	1274.3	1291.6
12/18/97	1271.5	1289.8
12/18/97	1273.8	1286.7
12/19/97	1269.5	1286.4
12/19/97	1270.1	1286.4
12/20/97	1270.4	1287.6
12/20/97	1270.9	1288.0
12/21/97	1271.4	1287.9
12/21/97	1271.8	1287.9
12/22/97	1272.3	1294.0
12/22/97	1272.7	1299.8
12/23/97	1284.0	1315.5
12/23/97	1284.6	1301.4
12/24/97	1289.2	1303.5
12/24/97	1289.2	1301.1
12/25/97	1282.6	1297.8
12/25/97	1281.4	1296.9
12/26/97	1280.7	1296.1
12/26/97	1280.0	1344.7
12/27/97	1279.4	1292.3
12/27/97	1281.9	1295.0
12/28/97	1285.3	1301.3
12/28/97	1286.9	1316.3
12/29/97	1286.8	1303.6
12/29/97	1282.3	1304.3
12/30/97	1280.5	1299.8
12/30/97	1278.0	1296.6

BHP
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12 Hour Averages

DATE	BHP4	OWB3
12/31/97	1277.7	1295.4
12/31/97	1277.5	1295.2
01/01/98	1278.0	1298.7
01/01/98	1287.2	1303.1
01/02/98	1287.7	1305.3
01/02/98	1275.7	1304.6
01/03/98	1291.7	1305.6
01/03/98	1291.7	1306.1
01/04/98	1290.4	1307.3
01/04/98	1289.1	1306.3
01/05/98	1289.1	1305.9
01/05/98	1288.4	1306.3
01/06/98	1287.9	1305.7
01/06/98	1284.7	1302.7
01/07/98	1280.1	1298.9
01/07/98	1282.6	1300.5
01/08/98	1283.8	1301.1
01/08/98	1283.3	1320.1
01/09/98	1281.9	1300.1
01/09/98	1282.4	1299.1
01/10/98	1281.9	1299.5
01/10/98	1281.7	1298.7
01/11/98	1285.7	1302.3
01/11/98	1285.7	1297.3
01/12/98	1290.4	1297.9
01/12/98	1288.7	1298.7
01/13/98	1288.7	1302.5
01/13/98	1288.7	1302.7
01/14/98	1288.7	1302.1
01/14/98	1288.7	1303.5
01/15/98	1288.7	1304.4
01/15/98	1288.7	1304.3
01/16/98	1287.9	1304.9
01/16/98	1286.8	1303.5
01/17/98	1286.8	1304.3
01/17/98	1287.5	1318.3
01/18/98	1287.5	1304.3
01/18/98	1287.4	1304.4
01/19/98	1287.4	1304.4
01/19/98	1286.9	1304.5
01/20/98	1288.1	1304.5
01/20/98	1278.9	1303.4
01/21/98	1278.9	1303.5
01/21/98	1281.4	1306.0
01/22/98	1281.2	1305.9
01/22/98	1281.9	1306.5
01/23/98	1282.6	1307.1
01/23/98	1282.2	1306.7
01/24/98	1282.6	1306.7
01/24/98	1281.5	1306.9
01/25/98	1281.2	1313.1
01/25/98	1281.2	1313.3
01/26/98	1281.2	1312.5

BHP
Florence Project

12 Hour Averages

DATE	BHP4	OWB3
01/26/98	1281.2	1313.9
01/27/98	1281.2	1314.3
01/27/98	1290.7	1310.1
01/28/98	1290.4	1309.9
01/28/98	1288.6	1311.1
01/29/98	1289.3	1311.5
01/29/98	1290.0	1311.9
01/30/98	1289.8	1311.9
01/30/98	1289.8	1311.5
01/31/98	1289.5	1311.5
01/31/98	1290.2	1311.5
02/01/98	1289.8	1311.9
02/01/98	1289.8	1311.9
02/02/98	1289.8	1312.1
02/02/98	1287.9	1311.1
02/03/98	1285.2	1308.9
02/03/98	1284.9	1308.9
02/04/98	1284.9	1308.7
02/04/98	1284.7	1308.7
02/05/98	1283.9	1308.7
02/05/98	1283.3	1306.9
02/06/98	1283.3	1306.9
02/06/98	1283.5	1307.9
02/07/98	1283.5	1307.9
02/07/98	1283.5	1307.9
02/08/98	1284.0	1308.3
02/08/98	1289.7	1311.5
02/09/98	1280.1	1306.1
02/09/98	1271.1	1299.1

BHP
Florence Project

12 Hour Averages

DATE	BHP3	OWB1
11/08/97	1299.5	1312.0
11/08/97	1297.0	1312.0
11/09/97	1302.6	1312.0
11/09/97	1267.3	1306.9
11/10/97	1309.7	1312.2
11/10/97	1260.2	1309.0
11/11/97	1277.0	1308.6
11/11/97	1293.9	1308.2
11/12/97	1294.5	1308.1
11/12/97	1296.8	1305.6
11/13/97	1297.3	1305.5
11/13/97	1297.9	1307.1
11/14/97	1308.3	1309.5
11/14/97	1300.2	1311.0
11/15/97	1300.8	1312.5
11/15/97	1297.9	1312.9
11/16/97	1296.8	1305.5
11/16/97	1295.6	1305.6
11/17/97	1293.9	1305.7
11/17/97	1297.9	1305.5
11/18/97	1303.1	1303.7
11/18/97	1298.5	1308.8
11/19/97	1298.5	1306.5
11/19/97	1300.2	1308.8
11/20/97	1301.4	1307.3
11/20/97	1299.1	1307.3
11/21/97	1298.5	1307.3
11/21/97	1298.5	1310.3
11/22/97	1298.5	1313.3
11/22/97	1297.9	1313.6
11/23/97	1297.3	1313.8
11/23/97	1301.4	1312.3
11/24/97	1300.8	1313.7
11/24/97	1301.4	1313.7
11/25/97	1301.4	1311.5
11/25/97	1301.9	1311.5
11/26/97	1295.6	1309.3
11/26/97	1299.1	1313.6
11/27/97	1299.1	1311.0
11/27/97	1298.5	1310.1
11/28/97	1298.5	1312.1
11/28/97	1295.6	1312.3
11/29/97	1295.6	1312.0
11/29/97	1298.5	1311.6
11/30/97	1299.6	1311.8
11/30/97	1299.6	1311.9
12/01/97	1300.2	1313.1
12/01/97	1300.2	1313.2
12/02/97	1300.2	1313.1
12/02/97	1300.2	1313.1

North East

BHP
Florence Project

12 Hour Averages

DATE	BHP3	OWB1
12/03/97	1299.6	1311.1
12/03/97	1300.8	1309.0
12/04/97	1300.2	1308.7
12/04/97	1299.1	1313.3
12/05/97	1301.4	1308.4
12/05/97	1294.5	1307.1
12/06/97	1293.3	1306.9
12/06/97	1293.3	1307.3
12/07/97	1292.7	1308.6
12/07/97	1292.1	1309.5
12/08/97	1291.0	1303.7
12/08/97	1291.6	1301.4
12/09/97	1291.0	1304.9
12/09/97	1293.3	1307.3
12/10/97	1293.3	1306.5
12/10/97	1292.1	1305.7
12/11/97	1290.4	1306.7
12/11/97	1295.0	1306.5
12/12/97	1294.1	1321.6
12/12/97	1293.8	1319.2
12/13/97	1293.3	1302.6
12/13/97	1293.8	1302.2
12/14/97	1293.8	1298.1
12/14/97	1292.1	1295.2
12/15/97	1291.0	1292.8
12/15/97	1290.4	1291.7
12/16/97	1290.1	1291.4
12/16/97	1288.1	1288.2
12/17/97	1286.5	1287.9
12/17/97	1284.4	1288.2
12/18/97	1288.1	1288.8
12/18/97	1288.3	1289.1
12/19/97	1283.7	1289.5
12/19/97	1276.9	1291.6
12/20/97	1277.5	1298.5
12/20/97	1278.6	1301.7
12/21/97	1279.1	1302.8
12/21/97	1279.3	1306.2
12/22/97	1282.1	1302.8
12/22/97	1288.3	1299.4
12/23/97	1289.9	1298.4
12/23/97	1291.4	1296.7
12/24/97	1294.4	1296.6
12/24/97	1289.3	1295.5
12/25/97	1287.9	1295.1
12/25/97	1286.3	1299.8
12/26/97	1285.3	1299.8
12/26/97	1284.1	1304.6
12/27/97	1283.8	1305.0
12/27/97	1283.5	1300.1

North East

BHP
Florence Project

12 Hour Averages

DATE	BHP3	OWB1
12/28/97	1291.6	1302.8
12/28/97	1292.7	1304.1
12/29/97	1294.1	1297.1
12/29/97	1294.9	1296.1
12/30/97	1291.2	1295.3
12/30/97	1284.9	1297.4
12/31/97	1282.2	1302.3
12/31/97	1282.4	1304.6
01/01/98	1282.7	1305.3
01/01/98	1288.7	1306.2
01/02/98	1290.7	1306.2
01/02/98	1290.0	1305.3
01/03/98	1291.2	1306.2
01/03/98	1290.7	1307.1
01/04/98	1292.4	1308.0
01/04/98	1286.2	1307.1
01/05/98	1290.7	1307.1
01/05/98	1289.8	1307.1
01/06/98	1289.5	1306.2
01/06/98	1286.7	1303.9
01/07/98	1283.8	1299.8
01/07/98	1285.0	1300.7
01/08/98	1286.1	1302.1
01/08/98	1285.0	1301.6
01/09/98	1284.4	1301.6
01/09/98	1284.4	1302.2
01/10/98	1284.4	1301.1
01/10/98	1282.2	1298.9
01/11/98	1281.0	1298.4
01/11/98	1281.0	1297.9
01/12/98	1280.4	1297.9
01/12/98	1281.5	1300.7
01/13/98	1285.0	1304.3
01/13/98	1285.0	1302.5
01/14/98	1284.4	1303.0
01/14/98	1285.0	1303.9
01/15/98	1285.5	1303.9
01/15/98	1285.5	1303.9
01/16/98	1286.1	1304.3
01/16/98	1285.0	1303.9
01/17/98	1285.5	1304.8
01/17/98	1285.5	1304.9
01/18/98	1285.5	1304.8
01/18/98	1286.1	1305.2
01/19/98	1286.1	1305.2
01/19/98	1286.1	1305.6
01/20/98	1285.5	1306.2
01/20/98	1285.5	1305.7
01/21/98	1285.0	1305.3
01/21/98	1286.7	1308.3

North East

BHP
Florence Project

12 Hour Averages

DATE	BHP3	OWB1
01/22/98	1287.2	1308.8
01/22/98	1287.2	1307.4
01/23/98	1287.8	1309.2
01/23/98	1287.8	1309.7
01/24/98	1287.8	1306.2
01/24/98	1287.2	1308.8
01/25/98	1289.5	1312.5
01/25/98	1290.1	1311.5
01/26/98	1288.4	1311.1
01/26/98	1290.2	1307.5
01/27/98	1290.7	1311.6
01/27/98	1288.4	1311.6
01/28/98	1288.4	1315.7
01/28/98	1290.7	1315.6
01/29/98	1290.7	1318.2
01/29/98	1291.2	1318.2
01/30/98	1291.2	1317.5
01/30/98	1291.2	1316.8
01/31/98	1291.2	1317.3
01/31/98	1290.8	1316.5
02/01/98	1291.2	1316.8
02/01/98	1291.2	1317.3
02/02/98	1291.2	1316.8
02/02/98	1290.7	1317.3
02/03/98	1286.7	1314.1
02/03/98	1287.2	1314.5
02/04/98	1287.2	1313.7
02/04/98	1286.7	1313.9
02/05/98	1287.8	1313.7
02/05/98	1286.1	1312.7
02/06/98	1286.1	1312.7
02/06/98	1286.1	1311.9
02/07/98	1286.1	1311.9
02/07/98	1286.7	1312.9
02/08/98	1287.2	1312.9
02/08/98	1288.8	1318.5
02/09/98	1292.9	1307.7
02/09/98	1285.0	1300.0

BHP
Florence Project

12 Hour Averages

DATE	BHP5	OWB4
11/08/97	1154.97	1303.454
11/08/97	1351.91	1303.454
11/09/97	1303.65	1303.749
11/09/97	1304.72	1303.749
11/10/97	1304.72	1303.749
11/10/97	1302.58	1303.719
11/11/97	1302.11	1304.11
11/11/97	1295.09	1304.5
11/12/97	1295.09	1304.5
11/12/97	1300.44	1304.5
11/13/97	1300.97	1301.853
11/13/97	1300.44	1301.691
11/14/97	1300.97	1301.605
11/14/97	1300.97	1300.762
11/15/97	1301.51	1301.38
11/15/97	1301.51	1302.124
11/16/97	1296.7	1303.551
11/16/97	1295.09	1304.99
11/17/97	1294.56	1306.381
11/17/97	1298.84	1307.844
11/18/97	1303.11	1302.806
11/18/97	1302.91	1304.294
11/19/97	1302.9	1304.219
11/19/97	1302.91	1304.406
11/20/97	1302.91	1303.957
11/20/97	1301.84	1308.387
11/21/97	1301.84	1305.148
11/21/97	1300.77	1306.67
11/22/97	1300.77	1305.962
11/22/97	1299.7	1306
11/23/97	1299.7	1305.655
11/23/97	1302.91	1307.153
11/24/97	1302.91	1308.567
11/24/97	1302.91	1308.884
11/25/97	1302.37	1308.9
11/25/97	1302.9	1309.031
11/26/97	1295.42	1308.625
11/26/97	1298.61	1302.342
11/27/97	1299.16	1305.61
11/27/97	1297.56	1305.483
11/28/97	1298.63	1305.163
11/28/97	1296.49	1305.096
11/29/97	1296.48	1304.237
11/29/97	1299.16	1305.734
11/30/97	1299.69	1306.977
11/30/97	1299.7	1307.049
12/01/97	1299.69	1307.17
12/01/97	1300.23	1307.595
12/02/97	1300.23	1307.8
12/02/97	1300.23	1308.03

BHP
Florence Project

12 Hour Averages

DATE	BHP5	OWB4
12/03/97	1300.23	1308.563
12/03/97	1300.77	1308.793
12/04/97	1300.77	1308.938
12/04/97	1300.23	1309.175
12/05/97	1301.84	1308.9
12/05/97	1294.35	1306.313
12/06/97	1293.81	1304.224
12/06/97	1292.21	1303.25
12/07/97	1291.67	1303.127
12/07/97	1290.99	1301.669
12/08/97	1290.46	1301.669
12/08/97	1290.99	1300.21
12/09/97	1290.99	1300.407
12/09/97	1293.64	1301.889
12/10/97	1293.6	1302.79
12/10/97	1289.4	1300.432
12/11/97	1294.7	1299.354
12/11/97	1300	1304.275
12/12/97	1301.06	1306.199
12/12/97	1301.59	1307.401
12/13/97	1301.06	1306.878
12/13/97	1302.12	1307.449
12/14/97	1301.59	1307.186
12/14/97	1302.12	1305.386
12/15/97	1298.94	1303.52
12/15/97	1298.41	1303.446
12/16/97	1298.41	1302.049
12/16/97	1291.52	1299.455
12/17/97	1289.93	1297.242
12/17/97	1288.34	1294.219
12/18/97	1283.53	1292.871
12/18/97	1278.27	1286.862
12/19/97	1284.1	1286.089
12/19/97	1285.16	1290.625
12/20/97	1287.28	1292.506
12/20/97	1277.74	1291.14
12/21/97	1277.74	1288.807
12/21/97	1277.74	1288.909
12/22/97	1281.98	1291.413
12/22/97	1287.81	1296.234
12/23/97	1296.29	1297.817
12/23/97	1298.41	1303.065
12/24/97	1300	1304.393
12/24/97	1296.82	1302.525
12/25/97	1294.7	1300.21
12/25/97	1294.7	1300.947
12/26/97	1294.17	1298.512
12/26/97	1293.64	1298.369
12/27/97	1292.58	1297.853
12/27/97	1293.64	1304.188

BHP
Florence Project

12 Hour Averages

DATE	BHP5	OWB4
01/22/98	1298.95	1306.5
01/22/98	1300.01	1307.36
01/23/98	1300.01	1308.22
01/23/98	1300.54	1307.79
01/24/98	1300.01	1307.79
01/24/98	1298.95	1308.22
01/25/98	1301.07	1310.37
01/25/98	1301.07	1310.37
01/26/98	1302.13	1310.8
01/26/98	1304.12	1312.09
01/27/98	1304.25	1312.52
01/27/98	1302.66	1311.23
01/28/98	1302.13	1311.23
01/28/98	1303.72	1312.52
01/29/98	1304.25	1312.95
01/29/98	1304.78	1313.38
01/30/98	1301.07	1310.8
01/30/98	1300.54	1310.37
01/31/98	1300.54	1310.37
01/31/98	1301.07	1310.37
02/01/98	1300.54	1310.8
02/01/98	1300.54	1310.8
02/02/98	1300.54	1310.8
02/02/98	1298.95	1309.94
02/03/98	1297.36	1308.22
02/03/98	1297.89	1307.82
02/04/98	1296.83	1307.79
02/04/98	1297.89	1308.22
02/05/98	1297.36	1308.22
02/05/98	1295.77	1306.07
02/06/98	1295.77	1306.07
02/06/98	1296.83	1306.93
02/07/98	1296.83	1306.93
02/07/98	1297.36	1306.93
02/08/98	1296.83	1307.36
02/08/98	1298.29	1308.74
02/09/98	1298.42	1305.64
02/09/98	1290.47	1297.9

BHP
Florence Project

12 Hour Averages

DATE	BHP2	OWB5
11/08/97	1277.4	1304.4
11/08/97	1280.0	1307.0
11/09/97	1279.3	1306.3
11/09/97	1278.7	1305.7
11/10/97	1280.3	1307.3
11/10/97	1280.5	1307.5
11/11/97	1276.2	1303.2
11/11/97	1276.5	1303.5
11/12/97	1276.9	1303.9
11/12/97	1280.5	1307.5
11/13/97	1280.8	1307.8
11/13/97	1281.2	1308.2
11/14/97	1290.6	1317.6
11/14/97	1281.0	1308.0
11/15/97	1280.0	1307.0
11/15/97	1278.8	1305.8
11/16/97	1277.9	1304.9
11/16/97	1276.9	1303.9
11/17/97	1278.6	1305.6
11/17/97	1280.3	1307.3
11/18/97	1283.9	1310.9
11/18/97	1281.0	1308.0
11/19/97	1280.8	1307.8
11/19/97	1277.0	1304.0
11/20/97	1278.1	1305.1
11/20/97	1280.8	1307.8
11/21/97	1278.6	1305.6
11/21/97	1280.5	1307.5
11/22/97	1280.3	1307.3
11/22/97	1279.3	1306.3
11/23/97	1282.4	1304.7
11/23/97	1282.2	1302.1
11/24/97	1282.7	1307.9
11/24/97	1283.2	1307.4
11/25/97	1282.7	1310.4
11/25/97	1276.7	1310.0
11/26/97	1280.5	1306.4
11/26/97	1281.2	1318.8
11/27/97	1281.0	1315.7
11/27/97	1281.2	1315.7
11/28/97	1278.8	1312.7
11/28/97	1279.6	1342.0
11/29/97	1283.2	1463.2
11/29/97	1284.3	1463.2
11/30/97	1286.3	1314.6
11/30/97	1287.2	1308.3
12/01/97	1289.4	1307.7
12/01/97	1289.9	1463.2
12/02/97	1291.8	1342.8
12/02/97	1292.7	1463.2

BHP
Florence Project

12 Hour Averages

DATE	BHP2	OWB5
12/28/97	1282.2	
12/28/97	1283.4	
12/29/97	1284.8	
12/29/97	1297.7	1336.0
12/30/97	1295.9	1299.6
12/30/97	1290.1	1298.7
12/31/97	1289.2	1299.9
12/31/97	1288.5	1304.8
01/01/98	1289.5	1306.1
01/01/98	1294.1	1306.1
01/02/98	1296.6	1306.1
01/02/98	1295.8	1306.1
01/03/98	1297.0	1307.0
01/03/98	1297.8	1307.7
01/04/98	1299.9	1308.6
01/04/98	1300.2	1308.2
01/05/98	1299.7	1308.2
01/05/98	1299.7	1307.9
01/06/98	1299.0	1307.2
01/06/98	1296.8	1304.5
01/07/98	1293.4	1301.0
01/07/98	1295.8	1302.9
01/08/98	1296.6	1303.3
01/08/98	1296.1	1302.6
01/09/98	1296.1	1302.4
01/09/98	1295.4	1303.6
01/10/98	1295.6	1304.9
01/10/98	1292.9	1305.0
01/11/98	1290.8	1300.6
01/11/98	1294.5	1301.8
01/12/98	1289.4	1302.9
01/12/98	1290.3	1302.9
01/13/98	1293.7	1307.1
01/13/98	1293.9	1307.4
01/14/98	1293.2	1304.5
01/14/98	1294.9	1305.2
01/15/98	1295.4	1305.6
01/15/98	1295.4	1305.9
01/16/98	1296.1	1306.3
01/16/98	1292.5	1303.8
01/17/98	1294.6	1305.4
01/17/98	1294.6	1304.4
01/18/98	1294.9	1304.7
01/18/98	1295.1	1304.5
01/19/98	1295.1	1304.5
01/19/98	1302.3	1305.1
01/20/98	1294.2	1303.7
01/20/98	1294.2	1303.7
01/21/98	1293.9	1303.7
01/21/98	1296.8	1305.9

BHP
Florence Project

12 Hour Averages

DATE	BHP5	OWB4
12/28/97	1297.35	1302.79
12/28/97	1298.94	1304.08
12/29/97	1303.44	1307.984
12/29/97	1300.77	1308.292
12/30/97	1299.16	1306.814
12/30/97	1294.17	1331.709
12/31/97	1293.11	1301.654
12/31/97	1294.7	1301.775
01/01/98	1293.12	1303.131
01/01/98	1300.54	1307.552
01/02/98	1301.07	1308.485
01/02/98	1291.53	1308.549
01/03/98	1301.6	1308.762
01/03/98	1301.6	1309.93
01/04/98	1302.66	1310.8
01/04/98	1302.13	1310.37
01/05/98	1302.13	1310.37
01/05/98	1301.6	1309.5
01/06/98	1300.01	1308.63
01/06/98	1296.83	1304.85
01/07/98	1294.18	1301.67
01/07/98	1295.24	1303.41
01/08/98	1295.24	1303.85
01/08/98	1294.18	1302.7
01/09/98	1294.18	1302.98
01/09/98	1294.18	1301.67
01/10/98	1294.18	1302.11
01/10/98	1285.7	1296.06
01/11/98	1285.7	1295.15
01/11/98	1292.59	1299.3
01/12/98	1293.12	1301.24
01/12/98	1293.65	1302.11
01/13/98	1297.89	1306.45
01/13/98	1296.83	1306.02
01/14/98	1295.24	1304.28
01/14/98	1298.42	1307.32
01/15/98	1298.95	1307.76
01/15/98	1298.95	1307.76
01/16/98	1299.48	1308.19
01/16/98	1295.77	1304.72
01/17/98	1297.89	1306.45
01/17/98	1297.36	1305.47
01/18/98	1297.36	1306.45
01/18/98	1296.54	1306.9
01/19/98	1296.54	1306.9
01/19/98	1286.23	1304.69
01/20/98	1286.5	1301.64
01/20/98	1285.7	1301.67
01/21/98	1285.17	1301.67
01/21/98	1298.42	1306.07

BHP
Florence Project

12 Hour Averages

DATE	BHP2	OWB5
12/03/97	1298.9	1463.2
12/03/97	1301.6	1463.2
12/04/97	1306.1	1385.7
12/04/97	1301.6	1385.7
12/05/97	1303.2	1385.7
12/05/97	1306.1	1385.7
12/06/97	1303.2	1383.4
12/06/97	1303.2	1377.2
12/07/97	1303.2	1381.9
12/07/97	1303.5	1389.1
12/08/97	1308.8	1388.1
12/08/97	1309.0	1386.6
12/09/97	1309.0	1384.6
12/09/97	1311.2	1387.1
12/10/97	1268.3	1393.0
12/10/97	1264.2	1309.2
12/11/97	1274.2	1300.1
12/11/97	1285.3	1302.5
12/12/97	1292.2	1307.0
12/12/97	1297.3	1308.1
12/13/97	1300.4	1308.6
12/13/97	1304.7	1309.6
12/14/97	1306.2	1310.1
12/14/97	1311.7	1361.0
12/15/97	1311.5	1369.3
12/15/97	1310.1	1311.0
12/16/97	1285.9	1308.1
12/16/97	1283.0	1302.9
12/17/97	1277.8	1293.5
12/17/97	1276.6	1293.1
12/18/97	1261.7	1293.1
12/18/97	1268.6	1293.4
12/19/97	1268.6	1291.0
12/19/97	1268.6	1291.5
12/20/97	1270.6	1293.3
12/20/97	1274.5	1387.4
12/21/97	1279.5	
12/21/97	1283.3	
12/22/97	1289.3	
12/22/97	1302.1	
12/23/97	1298.8	
12/23/97	1286.8	
12/24/97	1283.3	
12/24/97	1280.8	
12/25/97	1278.5	
12/25/97	1277.2	
12/26/97	1276.4	
12/26/97	1275.8	
12/27/97	1275.3	
12/27/97	1275.3	

BHP
Florence Project

12 Hour Averages

DATE	BHP2	OWB5
12/28/97	1282.2	
12/28/97	1283.4	
12/29/97	1284.8	
12/29/97	1297.7	1336.0
12/30/97	1295.9	1299.6
12/30/97	1290.1	1298.7
12/31/97	1289.2	1299.9
12/31/97	1288.5	1304.8
01/01/98	1289.5	1306.1
01/01/98	1294.1	1306.1
01/02/98	1296.6	1306.1
01/02/98	1295.8	1306.1
01/03/98	1297.0	1307.0
01/03/98	1297.8	1307.7
01/04/98	1299.9	1308.6
01/04/98	1300.2	1308.2
01/05/98	1299.7	1308.2
01/05/98	1299.7	1307.9
01/06/98	1299.0	1307.2
01/06/98	1296.8	1304.5
01/07/98	1293.4	1301.0
01/07/98	1295.8	1302.9
01/08/98	1296.6	1303.3
01/08/98	1296.1	1302.6
01/09/98	1296.1	1302.4
01/09/98	1295.4	1303.6
01/10/98	1295.6	1304.9
01/10/98	1292.9	1305.0
01/11/98	1290.8	1300.6
01/11/98	1294.5	1301.8
01/12/98	1289.4	1302.9
01/12/98	1290.3	1302.9
01/13/98	1293.7	1307.1
01/13/98	1293.9	1307.4
01/14/98	1293.2	1304.5
01/14/98	1294.9	1305.2
01/15/98	1295.4	1305.6
01/15/98	1295.4	1305.9
01/16/98	1296.1	1306.3
01/16/98	1292.5	1303.8
01/17/98	1294.6	1305.4
01/17/98	1294.6	1304.4
01/18/98	1294.9	1304.7
01/18/98	1295.1	1304.5
01/19/98	1295.1	1304.5
01/19/98	1302.3	1305.1
01/20/98	1294.2	1303.7
01/20/98	1294.2	1303.7
01/21/98	1293.9	1303.7
01/21/98	1296.8	1305.9

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
75 Hawthorne Street
San Francisco, CA 94105-3901

WTR-9

July 18, 2005

Mr. Roger Ames
Merrill Mining, LLC
975 Johnson Ferry Road, Suite 450
Atlanta, Georgia 30342

RE: Cessation of Hydraulic Control of Mine Test Block
Florence Project, UIC permit number AZ396000001

Dear Mr. Ames:

EPA has received and reviewed the water quality results sent to us in a letter from Brown and Caldwell dated June 17, 2005, and a letter from you dated January 24, 2005. Based on the reported results, Merrill Mining may cease its rinsing operations and proceed with the closure of the wells in the in-situ test field in accordance with the Well and Corehole Abandonment Plan (Appendix C of the UIC permit). Merrill Mining shall also comply with the 30-year Post-Closure monitoring program and the ACL exceedance contingency plan established at Part II, Section F and H.2.b. of the UIC permit.

Should you have any questions, please contact me at (415) 972-3971 or via email at albright.david@epa.gov.

Sincerely,

David Albright, Manager
Ground Water Office
Water Division, EPA Region 9

cc: Eric Wilson, ADEQ
Barry Rechtorovich, ADEQ
Jarrell E. Southall, Brown and Caldwell

OPTIONAL FORM 99 (7-90)

FAX TRANSMITTAL # of pages ▶ 1

To Barb Sylvester	From Nancy Rumrill
Dept./Agency	Phone # 415-972-3293
Fax # 602-567-4001	Fax #

NSN 7540-01-317-7368 5099-101 GENERAL SERVICES ADMINISTRATION

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EXHIBIT B-4

Hydraulic Conductivity of Basin Fill and Bedrock Units

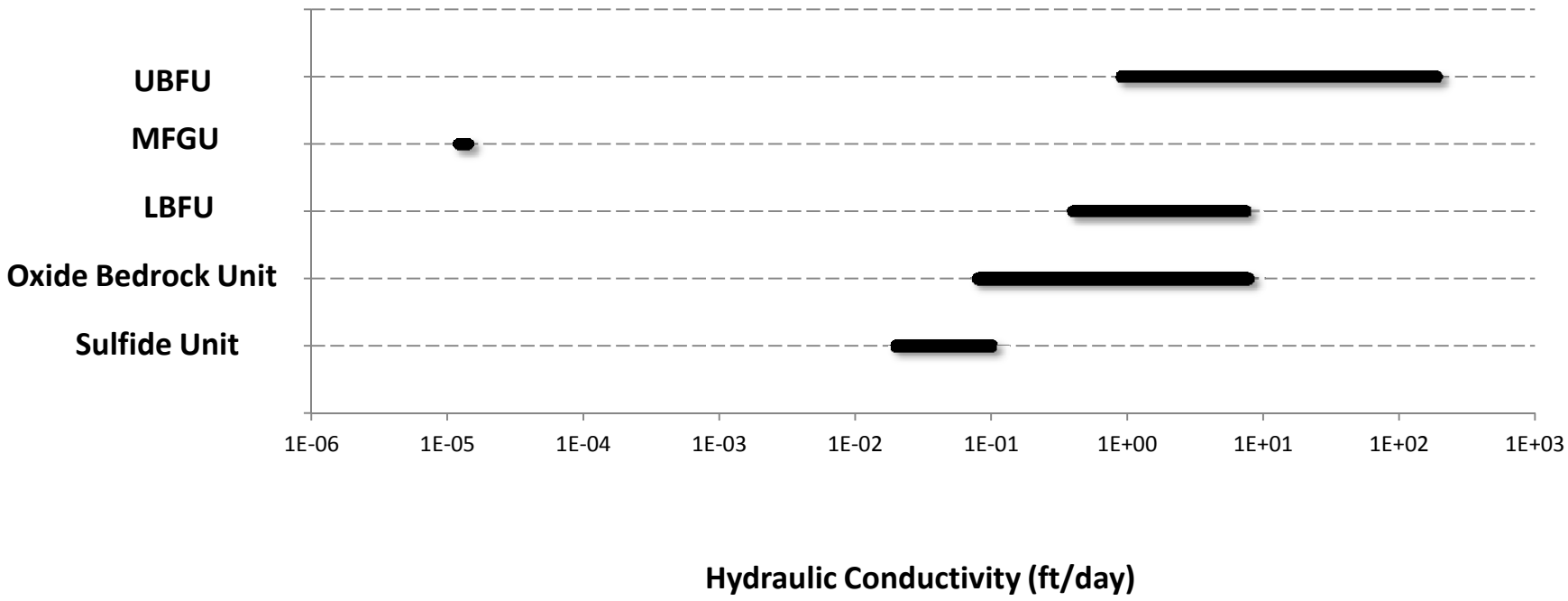

FIGURE 14A-11
HYDRAULIC CONDUCTIVITY
OF BASIN FILL AND BEDROCK UNITS

CURIS RESOURCES (ARIZONA) INC.
FLORENCE, ARIZONA

Brown AND Caldwell

J:\Hunter Dickinson\138799 - Curis Florence Copper Permitting\Working\Significant Amendment\Figures\Figure 14A-11.xlsx

EXHIBIT B-5

Florence Copper Mine Model Update
Technical Memorandum

HALEY & ALDRICH, INC.
One Arizona Center
400 E. Van Buren St., Suite 545
Phoenix, AZ 85004
602.760.2450

TECHNICAL MEMORANDUM

12 June 2019
File No. 132473-005

REGISTERED GEOLOGIST
CERTIFICATE NO. 39869
MARK D. NICHOLLS
Date Signed 6/12/19
ARIZONA, U.S.A.
Exp. 9/30/21

TO: Florence Copper Inc.
Dan Johnson, Vice President, General Manager

FROM: Haley & Aldrich, Inc.
Owen Miles, Hydrogeologist
Jacob Chu, Ph.D., P.E.
Mark Nicholls, R.G.

SUBJECT: Florence Copper Mine Model Update

A groundwater flow model was developed and documented as part of a hydrogeologic study for application for a temporary individual Aquifer Protection Permit by a predecessor to Florence Copper Inc. (Curis Resources), in 2012. The extent of the groundwater flow model is shown in Figure 1. This groundwater flow model is referred to as the original model below. The original model was set up to run from 1984 through 2010 for calibration. The original model was reviewed by the U.S. Environmental Protection Agency (USEPA) and used to assess the hypothetical, potential discharge impact resulting from the pilot operation of in-situ copper recovery (ISCR) at the Production Test Facility.

To support the permit application for the site-wide ISCR operation, the original model was updated, as described below:

- The model was extended to run from 1984 through 2018;
- Additional regional pumping well and water level data up to 2018 were incorporated into the model; and
- The extended model was calibrated against additional observed water level data through adjusting the general head and recharge boundary conditions between 2011 and 2018 to reflect variation of water exchange across the model domain.

No changes were made to the model grid, hydraulic property data, or the location of any boundary conditions. More details are provided below regarding the new data incorporated into the extended model for calibration.

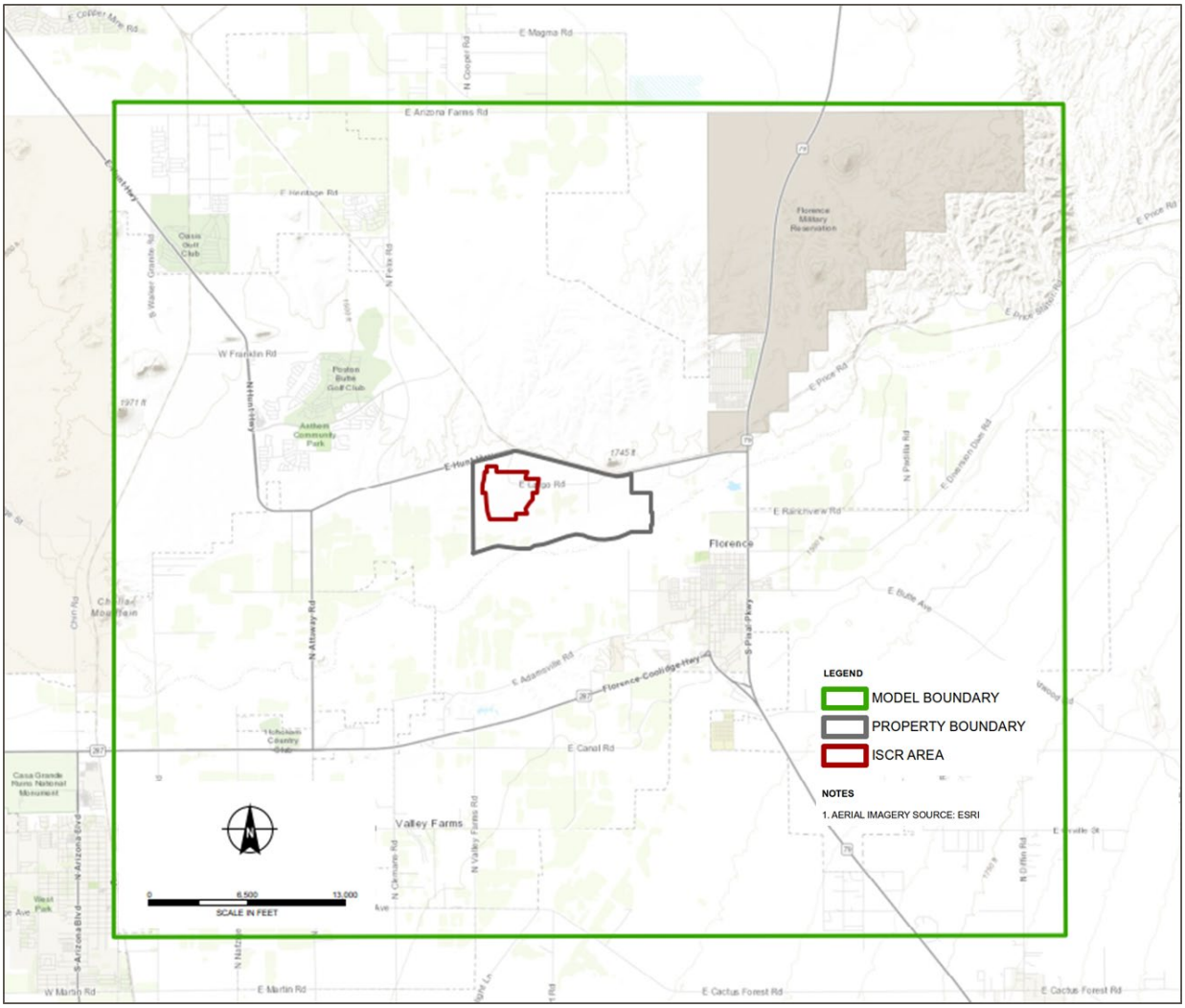

Figure 1: Model Domain, Property Boundary, and In-Situ Copper Recovery Area

MODEL UPDATE THROUGH ADDITIONAL CALIBRATION

Pumping Well Data for Additional Model Calibration

- The pumping well data was requested from Arizona Department of Water Resources (ADWR) via public information request. Pumping information was requested for all wells in the following townships for years 2010 to 2018 (T4S, R8E; T4S, R9E; T4S, R10E; T5S, R8E; T5S, R9E; and T5S, R10E).
- At the time of the request, 2018 well data were not available, so they were assumed to be the same rate as the 2017 data.
- For the San Carlos Irrigation Project wells, pumping was continued at 2010 levels since no new pumping data was available.

- The pumping rates used in the extended model between 2011 and 2018 are provided in Appendix A.

Water Level Data for Calibration Target Setup

- Water level data were collected quarterly onsite, and less frequently in the ADWR data.
- Offsite (ADWR) well data were downloaded from the ADWR website for the Eloy Basin, and data after 2011 were assessed.
- Selected ADWR and onsite water level data were used to set up targets for additional model calibration. The selected target locations cover various parts of the model domain and model layers.
- The seasonal water level fluctuations due to transient pumping of the production wells could not be simulated by the model because the resolution of the pumping volume data is yearly. The upper bound values of the water level trend at each target location were used for calibration to reduce the bias toward temporal pumping influence on regional groundwater level trends.
- The additional target locations and the calibration target data are provided in Appendix B.

Recharge

- The annual precipitation data reported near the site between 2000 and 2018 were evaluated. The results show a similar magnitude of precipitation between 2000 and 2010 (approximately 7.7 – 7.9 inches per year) and between 2011 and 2018 (approximately 8.1 – 8.2 inches per year).
- Recharge was a fitting parameter used in the calibration.
- The initial recharge conditions for 2011 through 2018 were set the same as the conditions for 2010 in the original model.
- Recharge for each stress period between 2011 and 2018 was adjusted by multiplying by a constant for that stress period. The spatial distribution and relative magnitude of recharge remained the same from the 2010 timestep.

General Head Boundaries

- The head values for the general head boundary conditions were a calibration parameter.
- The conductance values remained unchanged.
- There were three reaches of the general head boundary cells in the original model. Heads were assumed to be constant across a reach, which were the northern, southern, and western boundaries of the model. The head values for individual boundary reaches for each stress period were adjusted during the calibration process.

Hydraulic Properties

All hydraulic properties used in the original model were kept the same in the extended model.

Calibration Process

The model calibration utilized both statistical measures of model residuals and direct comparisons of simulated and observed water levels to assess whether groundwater hydraulics and observed water level trends can be adequately simulated by the extended model. Both the manual trial-and-error calibration and software-assisted calibration were used to improve the calibration results.

Calibration Results

Satisfactory calibration results were able to be attained by varying recharge and general head boundary cells at the magnitude consistent to the historical variation. The final calibration statistics are shown in Table 1 below. The calibration scatter plot is shown in Figure 2 below. The statistics of the extended model is nearly identical to those of the original model. The scatter plot shows that the extended model can reproduce the variation of the water level trends between 2011 and 2018. The results also indicate that the hydraulic properties used in the original model is adequately calibrated because no change in hydraulic properties are needed to achieve satisfactory calibration.

Table 1: Comparison of Calibration Statistics

Model Version	Model Calibration Period	Residual Mean (RM) (ft)	Absolute Residual Mean (ARM) (ft)	Residual Standard Deviation (RSD) (ft)	Simulated Range of Head Values (Range) (ft)	RM/Range (%)	ARM/Range (10%)	RSD/Range (%)
Original Model	1984 to 2010	-2.8	12.1	15.61	398	0.71%	3.0%	3.9%
Extended Model	1984 to 2018	-2.8	12.0	15.47	398	0.7%	3.0%	3.9%

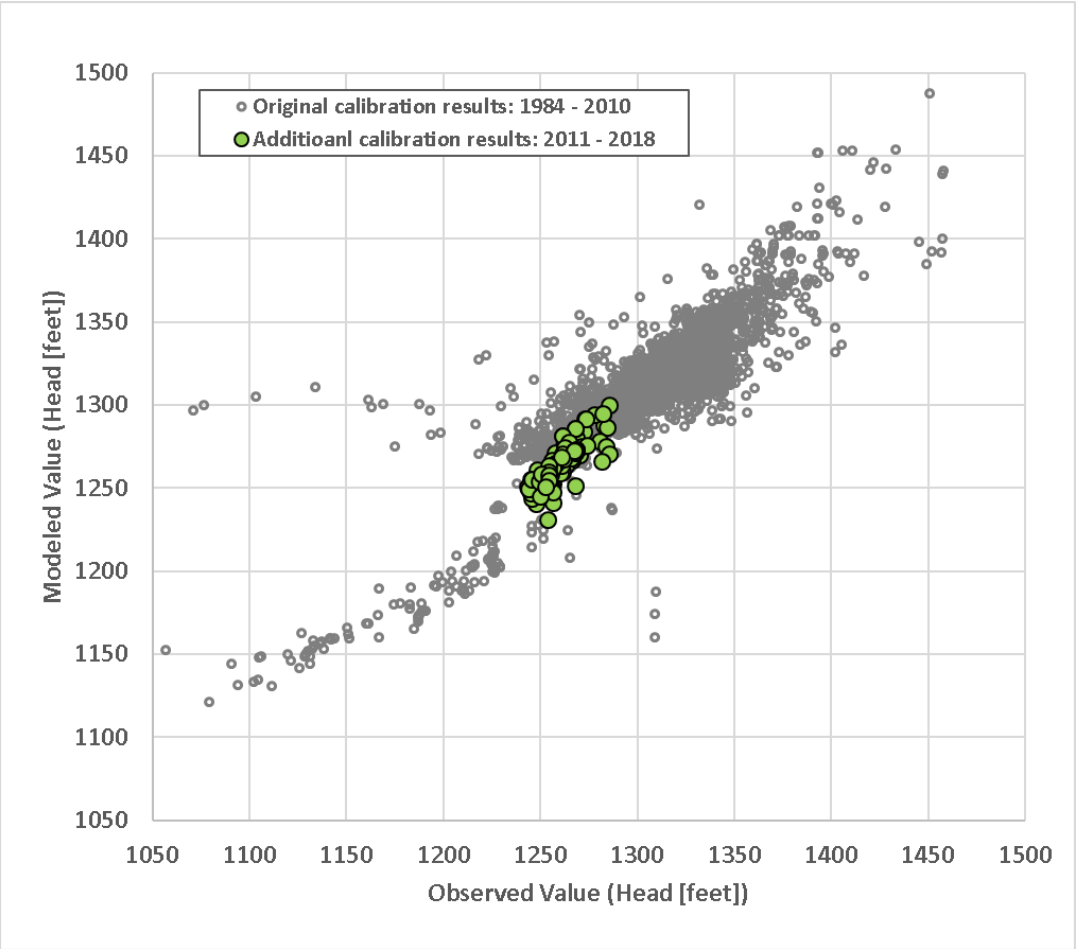

Figure 2: Calibration Scatter Plot

PREDICTIVE TRANSPORT MODEL SETUP

The calibrated extended model was used to perform predictive transport evaluation. The purpose of the predictive transport evaluation is to delineate the potential discharge impacts resulting from the site-wide ISCR operation. The transport model setup for the predictive evaluation is summarized below.

Hydraulic Properties

The hydraulic property values are the same as those used in the calibrated extended model except that the hydraulic conductivity values for the faults in the model was increased to 6 feet per day, which is at least 10 times higher than the representative hydraulic conductivity values used for the oxide bedrock layers (Model Layers 7-10) for the extended model.

Porosity

The following porosity values are used: A porosity value of 0.12 was assigned to Model Layers 1 through 5 (basin fill); a porosity value of 0.08 was assigned to Model Layers 6 through 10 (oxide layers); and a porosity value of 0.2 was assigned to the faults.

Recharge

The recharge pattern for the transport model was set to be the same as the pattern for the last stress period in the original model except that the magnitude of the recharge was reduced by 16 percent, which is the average recharge decrease between 2011 and 2018 in the calibrated extended model in comparison to the 2010 recharge in the original model.

General Head Boundaries

The head value for each general head boundary cell in the transport model were set to be the average value of the head values for the last stress period (2018) in the calibrated extended model.

Pumping Wells

The pumping conditions used to simulate Year 2018 in the calibrated extended model were used in the transport model except that the pumping wells within the ISCR area were removed.

Initial Heads

The head distribution of the last time step of the calibrated extended model was used as the initial head distribution for the transport simulation.

Initial Concentrations

A conservative solute in Model Layers 7 through 10 at a concentration of 750 milligrams per liter (mg/L) in the ISCR area (Figure 1) was set as initial conditions.

Simulation Time

The simulation period for the transport model is 30 years.

Other Transport Parameters and Solver Settings

All other transport parameters and solver settings were kept the same as those used for previous discharge impact assessments using the original model.

PREDICTIVE TRANSPORT MODELING RESULTS

The simulated extent of migration after the 30-year transport modeling is shown in Figure 3. The extent of migration is defined by the maximum extent of the 2 mg/L concentration contours for all the layers. The faults, which were assigned a hydraulic conductivity ten times higher than the surrounding bedrock, appear to slightly enhance migration northward. The maximum distance of the 2 mg/L contour away from the ISCR area boundary is approximately 2,000 feet. The model results indicate that relatively low concentrations of sulfate migrate vertically into Model Layers 6, 5, and 4 (in that order) by dispersion. Very low concentrations of sulfate migrate into Model Layer 4, the upper portion of the Lower Basin Fill Unit (LBFU), but stayed generally within the ISCR area during the 30-year simulation. The greatest horizontal transport occurred in Model Layer 5, the lowest portion of the LBFU. Most of the solute mass remains in the oxide zone within the ISCR footprint after 30-year transport.

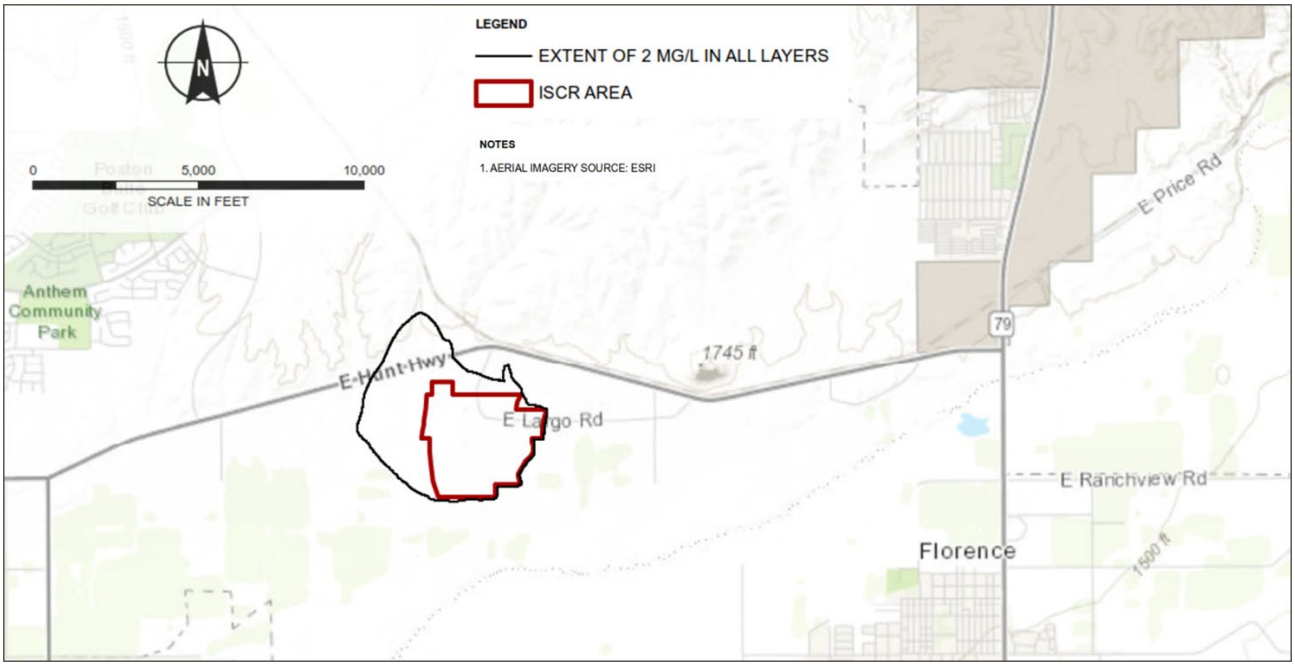

Figure 3: The Simulated Discharge Impact Area 30 Years After Closure

Attachments:

Appendix A — 2011 — 2018 Targets

Appendix B — 2011 — 2018 Pumping Well Rates

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\132473 Florence Groundwater Permitting\Working\101704 Significant Amendment\Attachment 14\Exhibit 14-10 HA Model Memo\2019-0612_Technical_Memo_Update_F.docx

APPENDIX A

2011 — 2018 Targets

Name	X	Y	Target	Layer	Sublayer	Row	Column	Weight	Group	Type	Time
P49-O	647611.87	744202.71	1275.8	8	1	293	147	1	1	Head	9545
P49-O	647611.87	744202.71	1273.8	8	1	293	147	1	1	Head	9887
P49-O	647611.87	744202.71	1268.3	8	1	293	147	1	1	Head	10188
P49-O	647611.87	744202.71	1268.6	8	1	293	147	1	1	Head	10200
P49-O	647611.87	744202.71	1268.0	8	1	293	147	1	1	Head	10230
P49-O	647611.87	744202.71	1267.6	8	1	293	147	1	1	Head	10239
P49-O	647611.87	744202.71	1267.3	8	1	293	147	1	1	Head	10270
P49-O	647611.87	744202.71	1260.9	8	1	293	147	1	1	Head	10629
P49-O	647611.87	744202.71	1254.3	8	1	293	147	1	1	Head	10992
P49-O	647611.87	744202.71	1254.1	8	1	293	147	1	1	Head	11355
P49-O	647611.87	744202.71	1250.2	8	1	293	147	1	1	Head	11635
P49-O	647611.87	744202.71	1254.4	8	1	293	147	1	1	Head	11736
P49-O	647611.87	744202.71	1254.3	8	1	293	147	1	1	Head	12087
P49-O	647611.87	744202.71	1252.5	8	1	293	147	1	1	Head	12471
P49-O	647611.87	744202.71	1249.1	8	1	293	147	1	1	Head	12790
M22-O	646962.22	746467.66	1265.7	7	1	200	102	1	1	Head	10188
M22-O	646962.22	746467.66	1265.7	7	1	200	102	1	1	Head	10193
M22-O	646962.22	746467.66	1260.8	7	1	200	102	1	1	Head	10631
M22-O	646962.22	746467.66	1255.6	7	1	200	102	1	1	Head	10991
M22-O	646962.22	746467.66	1251.5	7	1	200	102	1	1	Head	11355
M22-O	646962.22	746467.66	1245.4	7	1	200	102	1	1	Head	11533
M22-O	646962.22	746467.66	1254.2	7	1	200	102	1	1	Head	11734
M22-O	646962.22	746467.66	1253.1	7	1	200	102	1	1	Head	12084
M22-O	646962.22	746467.66	1256.3	7	1	200	102	1	1	Head	12483
M22-O	646962.22	746467.66	1249.7	7	1	200	102	1	1	Head	12714
M22-O	646962.22	746467.66	1249.8	7	1	200	102	1	1	Head	12799
M4-O	651635.22	743717.36	1282.3	7	1	303	430	1	1	Head	9888
M4-O	651635.22	743717.36	1273.2	7	1	303	430	1	1	Head	10188
M4-O	651635.22	743717.36	1268.1	7	1	303	430	1	1	Head	10631
M4-O	651635.22	743717.36	1261.3	7	1	303	430	1	1	Head	10991
M4-O	651635.22	743717.36	1264.6	7	1	303	430	1	1	Head	11362
M4-O	651635.22	743717.36	1262.6	7	1	303	430	1	1	Head	11741

Name	X	Y	Target	Layer	Sublayer	Row	Column	Weight	Group	Type	Time
M4-O	651635.22	743717.36	1261.6	7	1	303	430	1	1	Head	12091
M4-O	651635.22	743717.36	1258.0	7	1	303	430	1	1	Head	12482
M4-O	651635.22	743717.36	1255.7	7	1	303	430	1	1	Head	12790
M20-O	648921.15	747382.65	1271.4	7	1	136	252	1	1	Head	9887
M20-O	648921.15	747382.65	1267.7	7	1	136	252	1	1	Head	10241
M20-O	648921.15	747382.65	1261.9	7	1	136	252	1	1	Head	10631
M20-O	648921.15	747382.65	1256.4	7	1	136	252	1	1	Head	10988
M20-O	648921.15	747382.65	1252.7	7	1	136	252	1	1	Head	11635
M20-O	648921.15	747382.65	1249.2	7	1	136	252	1	1	Head	12000
M17-GL	647017.02	744976.8	1267.3	5	1	278	103	1	1	Head	9889
M17-GL	647017.02	744976.8	1267.7	5	1	278	103	1	1	Head	10188
M17-GL	647017.02	744976.8	1263.3	5	1	278	103	1	1	Head	10631
M17-GL	647017.02	744976.8	1254.7	5	1	278	103	1	1	Head	10995
M17-GL	647017.02	744976.8	1257.7	5	1	278	103	1	1	Head	11362
M17-GL	647017.02	744976.8	1256.6	5	1	278	103	1	1	Head	11740
M17-GL	647017.02	744976.8	1256.3	5	1	278	103	1	1	Head	12090
M17-GL	647017.02	744976.8	1254.2	5	1	278	103	1	1	Head	12470
M17-GL	647017.02	744976.8	1251.5	5	1	278	103	1	1	Head	12797
M28-LBF	647751.71	747746.97	1270.0	5	1	129	159	1	1	Head	9887
M28-LBF	647751.71	747746.97	1266.5	5	1	129	159	1	1	Head	10241
M28-LBF	647751.71	747746.97	1260.0	5	1	129	159	1	1	Head	10631
M28-LBF	647751.71	747746.97	1255.9	5	1	129	159	1	1	Head	10988
M28-LBF	647751.71	747746.97	1254.4	5	1	129	159	1	1	Head	11356
M28-LBF	647751.71	747746.97	1255.3	5	1	129	159	1	1	Head	11734
M28-LBF	647751.71	747746.97	1252.5	5	1	129	159	1	1	Head	12087
M28-LBF	647751.71	747746.97	1250.0	5	1	129	159	1	1	Head	12454
M28-LBF	647751.71	747746.97	1249.6	5	1	129	159	1	1	Head	12792
M31-LBF	649976.91	747333.4	1272.1	4	1	137	337	1	1	Head	9887
M31-LBF	649976.91	747333.4	1268.4	4	1	137	337	1	1	Head	10241
M31-LBF	649976.91	747333.4	1261.7	4	1	137	337	1	1	Head	10642
M31-LBF	649976.91	747333.4	1257.8	4	1	137	337	1	1	Head	10988
M31-LBF	649976.91	747333.4	1255.9	4	1	137	337	1	1	Head	11362

Name	X	Y	Target	Layer	Sublayer	Row	Column	Weight	Group	Type	Time
M31-LBF	649976.91	747333.4	1257.1	4	1	137	337	1	1	Head	11735
M31-LBF	649976.91	747333.4	1253.8	4	1	137	337	1	1	Head	12084
M31-LBF	649976.91	747333.4	1251.9	4	1	137	337	1	1	Head	12463
M31-LBF	649976.91	747333.4	1251.3	4	1	137	337	1	1	Head	12791
M3-GL	651636.79	743685.56	1282.0	4	1	304	430	1	1	Head	9888
M3-GL	651636.79	743685.56	1273.0	4	1	304	430	1	1	Head	10194
M3-GL	651636.79	743685.56	1268.0	4	1	304	430	1	1	Head	10631
M3-GL	651636.79	743685.56	1261.2	4	1	304	430	1	1	Head	10991
M3-GL	651636.79	743685.56	1264.7	4	1	304	430	1	1	Head	11362
M3-GL	651636.79	743685.56	1262.5	4	1	304	430	1	1	Head	11741
M3-GL	651636.79	743685.56	1261.4	4	1	304	430	1	1	Head	12091
M3-GL	651636.79	743685.56	1257.7	4	1	304	430	1	1	Head	12482
M3-GL	651636.79	743685.56	1255.4	4	1	304	430	1	1	Head	12790
330257111271901	641132.3	745826	1256.5	5	1	251	37	1	3	Head	12763
330457111271901	641113.3	757852.1	1253.7	5	1	28	37	1	3	Head	12763
325848111251101	652401.4	720875.3	1266.4	5	1	384	446	1	3	Head	10930
325848111251101	652401.4	720875.3	1263.7	5	1	384	446	1	3	Head	11273
325848111251101	652401.4	720875.3	1263.0	5	1	384	446	1	3	Head	11636
325848111251101	652401.4	720875.3	1261.6	5	1	384	446	1	3	Head	12000
325848111251101	652401.4	720875.3	1267.7	5	1	384	446	1	3	Head	12366
325940111241001	657064	725516.3	1280.9	5	1	374	483	1	3	Head	9818
325940111241001	657064	725516.3	1282.7	5	1	374	483	1	3	Head	10173
325940111241001	657064	725516.3	1284.5	5	1	374	483	1	3	Head	10544
325940111241001	657064	725516.3	1280.3	5	1	374	483	1	3	Head	10929
325940111241001	657064	725516.3	1283.9	5	1	374	483	1	3	Head	11273
325940111241001	657064	725516.3	1285.2	5	1	374	483	1	3	Head	11636
325940111241001	657064	725516.3	1281.6	5	1	374	483	1	3	Head	12000
325940111241001	657064	725516.3	1248.3	5	1	374	483	1	3	Head	12365
325940111241001	657064	725516.3	1244.8	5	1	374	483	1	3	Head	12736
325944111275001	638415.7	726400.7	1283.0	5	1	373	32	1	3	Head	9818
325944111275001	638415.7	726400.7	1285.6	5	1	373	32	1	3	Head	10173
325944111275001	638415.7	726400.7	1277.9	5	1	373	32	1	3	Head	10544

Name	X	Y	Target	Layer	Sublayer	Row	Column	Weight	Group	Type	Time
325944111275001	638415.7	726400.7	1264.5	5	1	373	32	1	3	Head	10930
325944111275001	638415.7	726400.7	1262.9	5	1	373	32	1	3	Head	11273
325944111275001	638415.7	726400.7	1261.5	5	1	373	32	1	3	Head	11636
325944111275001	638415.7	726400.7	1260.3	5	1	373	32	1	3	Head	12000
325944111275001	638415.7	726400.7	1253.9	5	1	373	32	1	3	Head	12365
325944111275001	638415.7	726400.7	1247.5	5	1	373	32	1	3	Head	12735
330515111245601	653220.5	759767.2	1249.4	5	1	24	462	1	3	Head	9837
330515111245601	653220.5	759767.2	1249.0	5	1	24	462	1	3	Head	10252
330515111245601	653220.5	759767.2	1248.3	5	1	24	462	1	3	Head	10546
330515111245601	653220.5	759767.2	1247.8	5	1	24	462	1	3	Head	10945
330515111245601	653220.5	759767.2	1245.6	5	1	24	462	1	3	Head	11278
330515111245601	653220.5	759767.2	1244.8	5	1	24	462	1	3	Head	11639
330515111245601	653220.5	759767.2	1244.0	5	1	24	462	1	3	Head	12001
330515111245601	653220.5	759767.2	1243.5	5	1	24	462	1	3	Head	12357
330515111245601	653220.5	759767.2	1243.9	5	1	24	462	1	3	Head	12724

APPENDIX B

2011 — 2018 Pumping Well Rates

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	29	29
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	30	30
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	31	31
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	32	32
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	33	33
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	34	34
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	35	35
SCIP_1	680116.25	749620.72	-17901	5	4	91	529	36	36
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	29	29
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	30	30
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	31	31
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	32	32
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	33	33
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	34	34
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	35	35
SCIP_2	677529.93	746957.19	-63490	5	4	161	524	36	36
SCIP_10	650572.02	746861.8	0	2	2	169	384	29	29
SCIP_10	650572.02	746861.8	0	2	2	169	384	30	30
SCIP_10	650572.02	746861.8	0	2	2	169	384	31	31
SCIP_10	650572.02	746861.8	0	2	2	169	384	32	32
SCIP_10	650572.02	746861.8	0	2	2	169	384	33	33
SCIP_10	650572.02	746861.8	0	2	2	169	384	34	34
SCIP_10	650572.02	746861.8	0	2	2	169	384	35	35
SCIP_10	650572.02	746861.8	0	2	2	169	384	36	36
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	29	29
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	30	30
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	31	31
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	32	32
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	33	33
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	35	35
SCIP_11	641392.77	745512.58	-22556	5	4	267	38	36	36
SCIP_9	647291.82	745527.32	-80000	2	2	267	122	29	29
SCIP_9	647291.82	745527.32	-80000	2	2	267	122	30	30
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	31	31
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	32	32
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	33	33
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	34	34
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	35	35
SCIP_9	647291.82	745527.32	-100000	2	2	267	122	36	36
SCIP_10b	648603.29	745530.27	-80000	2	2	267	227	29	29
SCIP_10b	648603.29	745530.27	-80000	2	2	267	227	30	30
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	31	31
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	32	32
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	33	33
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	34	34
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	35	35
SCIP_10b	648603.29	745530.27	-100000	2	2	267	227	36	36
SCIP_8	657172.36	745527.88	0	5	4	267	483	29	29
SCIP_8	657172.36	745527.88	0	5	4	267	483	30	30
SCIP_8	657172.36	745527.88	0	5	4	267	483	31	31
SCIP_8	657172.36	745527.88	0	5	4	267	483	32	32
SCIP_8	657172.36	745527.88	0	5	4	267	483	33	33
SCIP_8	657172.36	745527.88	0	5	4	267	483	34	34
SCIP_8	657172.36	745527.88	0	5	4	267	483	35	35
SCIP_8	657172.36	745527.88	0	5	4	267	483	36	36
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	29	29
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	30	30
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	31	31
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	33	33
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	34	34
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	35	35
SCIP_3b	674940.18	744315.59	-64922	5	4	291	519	36	36
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	29	29
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	30	30
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	31	31
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	32	32
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	33	33
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	34	34
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	35	35
SCIP_5	670324.55	744278.24	-43321	5	4	292	510	36	36
SCIP_3	674611.95	743986.57	0	2	2	298	518	29	29
SCIP_3	674611.95	743986.57	0	2	2	298	518	30	30
SCIP_3	674611.95	743986.57	0	2	2	298	518	31	31
SCIP_3	674611.95	743986.57	0	2	2	298	518	32	32
SCIP_3	674611.95	743986.57	0	2	2	298	518	33	33
SCIP_3	674611.95	743986.57	0	2	2	298	518	34	34
SCIP_3	674611.95	743986.57	0	2	2	298	518	35	35
SCIP_3	674611.95	743986.57	0	2	2	298	518	36	36
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	29	29
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	30	30
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	31	31
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	32	32
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	33	33
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	34	34
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	35	35
SCIP_4b	670024.43	741965.49	-76499	2	2	333	509	36	36
SCIP_4	672334.11	741662.8	0	2	2	336	514	29	29
SCIP_4	672334.11	741662.8	0	2	2	336	514	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_4	672334.11	741662.8	0	2	2	336	514	31	31
SCIP_4	672334.11	741662.8	0	2	2	336	514	32	32
SCIP_4	672334.11	741662.8	0	2	2	336	514	33	33
SCIP_4	672334.11	741662.8	0	2	2	336	514	34	34
SCIP_4	672334.11	741662.8	0	2	2	336	514	35	35
SCIP_4	672334.11	741662.8	0	2	2	336	514	36	36
SCIP_13	630300.43	738870.43	-477	5	4	348	16	29	29
SCIP_13	630300.43	738870.43	-477	5	4	348	16	30	30
SCIP_13	630300.43	738870.43	-477	5	4	348	16	31	31
SCIP_13	630300.43	738870.43	-477	5	4	348	16	32	32
SCIP_13	630300.43	738870.43	-477	5	4	348	16	33	33
SCIP_13	630300.43	738870.43	-477	5	4	348	16	34	34
SCIP_13	630300.43	738870.43	-477	5	4	348	16	35	35
SCIP_13	630300.43	738870.43	-477	5	4	348	16	36	36
SCIP_110	662524.58	733014.79	0	2	2	359	494	29	29
SCIP_110	662524.58	733014.79	0	2	2	359	494	30	30
SCIP_110	662524.58	733014.79	0	2	2	359	494	31	31
SCIP_110	662524.58	733014.79	0	2	2	359	494	32	32
SCIP_110	662524.58	733014.79	0	2	2	359	494	33	33
SCIP_110	662524.58	733014.79	0	2	2	359	494	34	34
SCIP_110	662524.58	733014.79	0	2	2	359	494	35	35
SCIP_110	662524.58	733014.79	0	2	2	359	494	36	36
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	29	29
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	30	30
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	31	31
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	32	32
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	33	33
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	34	34
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	35	35
SCIP_110a	662524.6	733015.64	-53823	2	2	359	494	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	29	29
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	30	30
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	31	31
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	32	32
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	33	33
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	34	34
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	35	35
SCIP_110b	662527.8	732351.78	-74350	2	2	361	494	36	36
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	29	29
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	30	30
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	31	31
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	32	32
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	33	33
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	34	34
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	35	35
SCIP_80	658731.77	729151.31	-63490	2	2	367	486	36	36
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	29	29
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	30	30
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	31	31
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	32	32
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	33	33
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	34	34
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	35	35
SCIP_89	657431.12	725874.8	-38070	2	2	374	484	36	36
SCIP_21	627708.03	725465.05	0	2	2	375	10	29	29
SCIP_21	627708.03	725465.05	0	2	2	375	10	30	30
SCIP_21	627708.03	725465.05	0	2	2	375	10	31	31
SCIP_21	627708.03	725465.05	0	2	2	375	10	32	32
SCIP_21	627708.03	725465.05	0	2	2	375	10	33	33
SCIP_21	627708.03	725465.05	0	2	2	375	10	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_21	627708.03	725465.05	0	2	2	375	10	35	35
SCIP_21	627708.03	725465.05	0	2	2	375	10	36	36
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	29	29
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	30	30
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	31	31
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	32	32
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	33	33
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	34	34
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	35	35
SCIP_79	654805.24	725220.46	-127219	2	2	375	476	36	36
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	29	29
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	30	30
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	31	31
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	32	32
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	33	33
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	34	34
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	35	35
SCIP_21b	627060.5	724798.58	-85807	2	2	376	9	36	36
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	29	29
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	30	30
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	31	31
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	32	32
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	33	33
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	34	34
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	35	35
SCIP_20	633775.21	724533.23	-31268	2	2	376	23	36	36
SCIP_20b	633775.21	724533.23	0	2	2	376	23	29	29
SCIP_20b	633775.21	724533.23	0	2	2	376	23	30	30
SCIP_20b	633775.21	724533.23	0	2	2	376	23	31	31
SCIP_20b	633775.21	724533.23	0	2	2	376	23	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_20b	633775.21	724533.23	0	2	2	376	23	33	33
SCIP_20b	633775.21	724533.23	0	2	2	376	23	34	34
SCIP_20b	633775.21	724533.23	0	2	2	376	23	35	35
SCIP_20b	633775.21	724533.23	0	2	2	376	23	36	36
SCIP_22	625100.85	724106.64	0	3	3	377	5	29	29
SCIP_22	625100.85	724106.64	0	3	3	377	5	30	30
SCIP_22	625100.85	724106.64	0	3	3	377	5	31	31
SCIP_22	625100.85	724106.64	0	3	3	377	5	32	32
SCIP_22	625100.85	724106.64	0	3	3	377	5	33	33
SCIP_22	625100.85	724106.64	0	3	3	377	5	34	34
SCIP_22	625100.85	724106.64	0	3	3	377	5	35	35
SCIP_22	625100.85	724106.64	0	3	3	377	5	36	36
SCIP_16	628997.95	724173.4	0	2	2	377	13	29	29
SCIP_16	628997.95	724173.4	0	2	2	377	13	30	30
SCIP_16	628997.95	724173.4	0	2	2	377	13	31	31
SCIP_16	628997.95	724173.4	0	2	2	377	13	32	32
SCIP_16	628997.95	724173.4	0	2	2	377	13	33	33
SCIP_16	628997.95	724173.4	0	2	2	377	13	34	34
SCIP_16	628997.95	724173.4	0	2	2	377	13	35	35
SCIP_16	628997.95	724173.4	0	2	2	377	13	36	36
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	29	29
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	30	30
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	31	31
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	32	32
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	33	33
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	34	34
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	35	35
SCIP_111	640308.04	723260.4	-60984	2	2	379	36	36	36
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	29	29
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	31	31
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	32	32
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	33	33
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	34	34
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	35	35
SCIP_74b	650227.89	720570.42	-87955	2	2	384	357	36	36
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	29	29
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	30	30
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	31	31
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	32	32
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	33	33
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	34	34
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	35	35
SCIP_112	652193.09	720546.18	-75186	2	2	384	441	36	36
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	29	29
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	30	30
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	31	31
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	32	32
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	33	33
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	34	34
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	35	35
SCIP_23b	626084.6	720484.24	-15156	2	2	385	7	36	36
SCIP_23	626406.99	720160.15	0	2	2	385	8	29	29
SCIP_23	626406.99	720160.15	0	2	2	385	8	30	30
SCIP_23	626406.99	720160.15	0	2	2	385	8	31	31
SCIP_23	626406.99	720160.15	0	2	2	385	8	32	32
SCIP_23	626406.99	720160.15	0	2	2	385	8	33	33
SCIP_23	626406.99	720160.15	0	2	2	385	8	34	34
SCIP_23	626406.99	720160.15	0	2	2	385	8	35	35
SCIP_23	626406.99	720160.15	0	2	2	385	8	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_122b	663206	720079.15	-169824	3	3	385	495	29	29
SCIP_122b	663206	720079.15	-169824	3	3	385	495	30	30
SCIP_122b	663206	720079.15	-169824	3	3	385	495	31	31
SCIP_122b	663206	720079.15	-169824	3	3	385	495	32	32
SCIP_122b	663206	720079.15	-169824	3	3	385	495	33	33
SCIP_122b	663206	720079.15	-169824	3	3	385	495	34	34
SCIP_122b	663206	720079.15	-169824	3	3	385	495	35	35
SCIP_122b	663206	720079.15	-169824	3	3	385	495	36	36
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	29	29
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	30	30
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	31	31
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	32	32
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	33	33
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	34	34
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	35	35
SCIP_19	633150.04	719934.44	-56210	2	2	386	21	36	36
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	29	29
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	30	30
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	31	31
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	32	32
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	33	33
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	34	34
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	35	35
SCIP_25	646324.65	719953.83	-19811	2	2	386	89	36	36
SCIP_26	631580.34	717602.72	0	3	3	390	18	29	29
SCIP_26	631580.34	717602.72	0	3	3	390	18	30	30
SCIP_26	631580.34	717602.72	0	3	3	390	18	31	31
SCIP_26	631580.34	717602.72	0	3	3	390	18	32	32
SCIP_26	631580.34	717602.72	0	3	3	390	18	33	33
SCIP_26	631580.34	717602.72	0	3	3	390	18	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
SCIP_26	631580.34	717602.72	0	3	3	390	18	35	35
SCIP_26	631580.34	717602.72	0	3	3	390	18	36	36
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	29	29
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	30	30
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	31	31
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	32	32
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	33	33
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	34	34
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	35	35
SCIP_24b	628672.71	717220.34	-60	2	2	391	12	36	36
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	29	29
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	30	30
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	31	31
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	32	32
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	33	33
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	34	34
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	35	35
SCIP_26b	631266.06	717267.57	-23868	2	2	391	18	36	36
201420	625188.02	734891.42	-6202	5	4	356	5	29	29
201420	625188.02	734891.42	-4890	5	4	356	5	30	30
201420	625188.02	734891.42	-5605	5	4	356	5	31	31
201420	625188.02	734891.42	-10042	5	4	356	5	32	32
201420	625188.02	734891.42	-8360	5	4	356	5	33	33
201420	625188.02	734891.42	-9791	5	4	356	5	34	34
201420	625188.02	734891.42	-8871	5	4	356	5	35	35
201420	625188.02	734891.42	-8871	5	4	356	5	36	36
211602	638045.77	754766.74	-33906	5	4	34	31	29	29
211602	638045.77	754766.74	-32463	5	4	34	31	30	30
211602	638045.77	754766.74	-43649	5	4	34	31	31	31
211602	638045.77	754766.74	-48587	5	4	34	31	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
211602	638045.77	754766.74	-43148	5	4	34	31	33	33
211602	638045.77	754766.74	-59702	5	4	34	31	34	34
211602	638045.77	754766.74	-76112	5	4	34	31	35	35
211602	638045.77	754766.74	-76112	5	4	34	31	36	36
212514	636775.28	748828.65	-26142	5	4	107	29	29	29
212514	636775.28	748828.65	-34788	5	4	107	29	30	30
212514	636775.28	748828.65	-34848	5	4	107	29	31	31
212514	636775.28	748828.65	-27859	5	4	107	29	32	32
212514	636775.28	748828.65	-26082	5	4	107	29	33	33
212514	636775.28	748828.65	-41502	5	4	107	29	34	34
212514	636775.28	748828.65	-19964	5	4	107	29	35	35
212514	636775.28	748828.65	-19964	5	4	107	29	36	36
523132	668906.1	736982.44	-47465	5	4	352	507	29	29
523132	668906.1	736982.44	-60226	5	4	352	507	30	30
523132	668906.1	736982.44	-48825	5	4	352	507	31	31
523132	668906.1	736982.44	-41883	5	4	352	507	32	32
523132	668906.1	736982.44	-45864	5	4	352	507	33	33
523132	668906.1	736982.44	-58405	5	4	352	507	34	34
523132	668906.1	736982.44	-45200	5	4	352	507	35	35
523132	668906.1	736982.44	-45200	5	4	352	507	36	36
523133	665756.82	736997.65	-40906	5	4	352	501	29	29
523133	665756.82	736997.65	-55694	5	4	352	501	30	30
523133	665756.82	736997.65	-42528	5	4	352	501	31	31
523133	665756.82	736997.65	-40279	5	4	352	501	32	32
523133	665756.82	736997.65	-39307	5	4	352	501	33	33
523133	665756.82	736997.65	-27301	5	4	352	501	34	34
523133	665756.82	736997.65	-40071	5	4	352	501	35	35
523133	665756.82	736997.65	-40071	5	4	352	501	36	36
676953.01	676953.01	740380.47	-97072	5	4	343	523	29	29
676953.01	676953.01	740380.47	-78616	5	4	343	523	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
676953.01	676953.01	740380.47	-89276	5	4	343	523	31	31
676953.01	676953.01	740380.47	-99821	5	4	343	523	32	32
676953.01	676953.01	740380.47	-96481	5	4	343	523	33	33
676953.01	676953.01	740380.47	-103518	5	4	343	523	34	34
676953.01	676953.01	740380.47	-118067	5	4	343	523	35	35
676953.01	676953.01	740380.47	-118067	5	4	343	523	36	36
562121	649259.53	744868.1	0	8	4	280	279	29	29
562121	649259.53	744868.1	-1	8	4	280	279	30	30
562121	649259.53	744868.1	0	8	4	280	279	31	31
562121	649259.53	744868.1	0	8	4	280	279	32	32
562121	649259.53	744868.1	0	8	4	280	279	33	33
562121	649259.53	744868.1	0	8	4	280	279	34	34
562121	649259.53	744868.1	0	8	4	280	279	35	35
562121	649259.53	744868.1	0	8	4	280	279	36	36
569177	632238.71	744788.52	-21956	5	4	282	19	29	29
569177	632238.71	744788.52	-15456	5	4	282	19	30	30
569177	632238.71	744788.52	-7096	5	4	282	19	31	31
569177	632238.71	744788.52	-14311	5	4	282	19	32	32
569177	632238.71	744788.52	-31270	5	4	282	19	33	33
569177	632238.71	744788.52	-3113	5	4	282	19	34	34
569177	632238.71	744788.52	-17984	5	4	282	19	35	35
569177	632238.71	744788.52	-17984	5	4	282	19	36	36
571198	640650.65	760709.93	-18163	5	4	22	36	29	29
571198	640650.65	760709.93	-19034	5	4	22	36	30	30
571198	640650.65	760709.93	-28459	5	4	22	36	31	31
571198	640650.65	760709.93	-25164	5	4	22	36	32	32
571198	640650.65	760709.93	-33703	5	4	22	36	33	33
571198	640650.65	760709.93	-33834	5	4	22	36	34	34
571198	640650.65	760709.93	-27239	5	4	22	36	35	35
571198	640650.65	760709.93	-27239	5	4	22	36	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
574011	638809.67	738912.28	0	3	3	348	33	29	29
574011	638809.67	738912.28	0	3	3	348	33	30	30
574011	638809.67	738912.28	0	3	3	348	33	31	31
574011	638809.67	738912.28	0	3	3	348	33	32	32
574011	638809.67	738912.28	0	3	3	348	33	33	33
574011	638809.67	738912.28	-7517	3	3	348	33	34	34
574011	638809.67	738912.28	0	3	3	348	33	35	35
574011	638809.67	738912.28	0	3	3	348	33	36	36
583151	632228.61	746773.93	-17639	5	4	176	19	29	29
583151	632228.61	746773.93	-28181	5	4	176	19	30	30
583151	632228.61	746773.93	-29076	5	4	176	19	31	31
583151	632228.61	746773.93	-43768	5	4	176	19	32	32
583151	632228.61	746773.93	-24961	5	4	176	19	33	33
583151	632228.61	746773.93	-26690	5	4	176	19	34	34
583151	632228.61	746773.93	-24544	5	4	176	19	35	35
583151	632228.61	746773.93	-24544	5	4	176	19	36	36
594058	630286.89	739523.86	-11383	5	4	346	16	29	29
594058	630286.89	739523.86	-3123	5	4	346	16	30	30
594058	630286.89	739523.86	-4252	5	4	346	16	31	31
594058	630286.89	739523.86	-5349	5	4	346	16	32	32
594058	630286.89	739523.86	-11385	5	4	346	16	33	33
594058	630286.89	739523.86	-11807	5	4	346	16	34	34
594058	630286.89	739523.86	-12642	5	4	346	16	35	35
594058	630286.89	739523.86	-12642	5	4	346	16	36	36
600577	638118.09	744186.73	-54158	5	4	294	31	29	29
600577	638118.09	744186.73	-57959	5	4	294	31	30	30
600577	638118.09	744186.73	-65569	5	4	294	31	31	31
600577	638118.09	744186.73	-68196	5	4	294	31	32	32
600577	638118.09	744186.73	-43687	5	4	294	31	33	33
600577	638118.09	744186.73	-56040	5	4	294	31	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
600577	638118.09	744186.73	-56776	5	4	294	31	35	35
600577	638118.09	744186.73	-56776	5	4	294	31	36	36
600579	636805.93	744188.41	-72152	5	4	294	29	29	29
600579	636805.93	744188.41	-80250	5	4	294	29	30	30
600579	636805.93	744188.41	-79365	5	4	294	29	31	31
600579	636805.93	744188.41	-73693	5	4	294	29	32	32
600579	636805.93	744188.41	-39178	5	4	294	29	33	33
600579	636805.93	744188.41	-74417	5	4	294	29	34	34
600579	636805.93	744188.41	-72004	5	4	294	29	35	35
600579	636805.93	744188.41	-72004	5	4	294	29	36	36
601789	638288.88	726518.81	-39981	5	4	372	32	29	29
601789	638288.88	726518.81	-92427	5	4	372	32	30	30
601789	638288.88	726518.81	-35897	5	4	372	32	31	31
601789	638288.88	726518.81	-33512	5	4	372	32	32	32
601789	638288.88	726518.81	-39475	5	4	372	32	33	33
601789	638288.88	726518.81	-61799	5	4	372	32	34	34
601789	638288.88	726518.81	-19715	5	4	372	32	35	35
601789	638288.88	726518.81	-19715	5	4	372	32	36	36
601790	638287.42	727175.16	-79630	5	4	371	32	29	29
601790	638287.42	727175.16	-74538	5	4	371	32	30	30
601790	638287.42	727175.16	-77042	5	4	371	32	31	31
601790	638287.42	727175.16	-76446	5	4	371	32	32	32
601790	638287.42	727175.16	-95289	5	4	371	32	33	33
601790	638287.42	727175.16	-74753	5	4	371	32	34	34
601790	638287.42	727175.16	-52727	5	4	371	32	35	35
601790	638287.42	727175.16	-52727	5	4	371	32	36	36
601791	631914.69	727145.89	-25822	3	3	371	19	29	29
601791	631914.69	727145.89	0	3	3	371	19	30	30
601791	631914.69	727145.89	-25760	3	3	371	19	31	31
601791	631914.69	727145.89	-32081	3	3	371	19	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
601791	631914.69	727145.89	-24329	3	3	371	19	33	33
601791	631914.69	727145.89	0	3	3	371	19	34	34
601791	631914.69	727145.89	-15516	3	3	371	19	35	35
601791	631914.69	727145.89	-15516	3	3	371	19	36	36
601792	638288.88	726518.81	-66713	3	3	372	32	29	29
601792	638288.88	726518.81	-56768	3	3	372	32	30	30
601792	638288.88	726518.81	-48897	3	3	372	32	31	31
601792	638288.88	726518.81	-53071	3	3	372	32	32	32
601792	638288.88	726518.81	-79189	3	3	372	32	33	33
601792	638288.88	726518.81	-82198	3	3	372	32	34	34
601792	638288.88	726518.81	-39012	3	3	372	32	35	35
601792	638288.88	726518.81	-39012	3	3	372	32	36	36
603850	655910.37	736314.49	-67380	5	4	353	480	29	29
603850	655910.37	736314.49	-98747	5	4	353	480	30	30
603850	655910.37	736314.49	-70125	5	4	353	480	31	31
603850	655910.37	736314.49	-64639	5	4	353	480	32	32
603850	655910.37	736314.49	-94096	5	4	353	480	33	33
603850	655910.37	736314.49	-55456	5	4	353	480	34	34
603850	655910.37	736314.49	-59511	5	4	353	480	35	35
603850	655910.37	736314.49	-59511	5	4	353	480	36	36
603851	651318.54	733632.55	-7443	5	4	358	424	29	29
603851	651318.54	733632.55	-52713	5	4	358	424	30	30
603851	651318.54	733632.55	-13834	5	4	358	424	31	31
603851	651318.54	733632.55	-12642	5	4	358	424	32	32
603851	651318.54	733632.55	-21109	5	4	358	424	33	33
603851	651318.54	733632.55	-13238	5	4	358	424	34	34
603851	651318.54	733632.55	-7752	5	4	358	424	35	35
603851	651318.54	733632.55	-7752	5	4	358	424	36	36
604492	638170.12	738260.18	-49505	5	4	349	31	29	29
604492	638170.12	738260.18	-68715	5	4	349	31	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
604492	638170.12	738260.18	-52545	5	4	349	31	31	31
604492	638170.12	738260.18	-53291	5	4	349	31	32	32
604492	638170.12	738260.18	-44411	5	4	349	31	33	33
604492	638170.12	738260.18	-50776	5	4	349	31	34	34
604492	638170.12	738260.18	-67737	5	4	349	31	35	35
604492	638170.12	738260.18	-67737	5	4	349	31	36	36
605133	651494.4	730476.93	-89004	5	4	365	427	29	29
605133	651494.4	730476.93	-59809	5	4	365	427	30	30
605133	651494.4	730476.93	-69141	5	4	365	427	31	31
605133	651494.4	730476.93	-46807	5	4	365	427	32	32
605133	651494.4	730476.93	-27668	5	4	365	427	33	33
605133	651494.4	730476.93	-32439	5	4	365	427	34	34
605133	651494.4	730476.93	-10495	5	4	365	427	35	35
605133	651494.4	730476.93	-10495	5	4	365	427	36	36
605134	651546.18	721219.24	-61345	5	4	383	428	29	29
605134	651546.18	721219.24	-65702	5	4	383	428	30	30
605134	651546.18	721219.24	-57960	5	4	383	428	31	31
605134	651546.18	721219.24	-62254	5	4	383	428	32	32
605134	651546.18	721219.24	-80381	5	4	383	428	33	33
605134	651546.18	721219.24	-137984	5	4	383	428	34	34
605134	651546.18	721219.24	-65116	5	4	383	428	35	35
605134	651546.18	721219.24	-65116	5	4	383	428	36	36
605529	679485.53	751584.08	-59407	5	4	53	528	29	29
605529	679485.53	751584.08	-68641	5	4	53	528	30	30
605529	679485.53	751584.08	-58557	5	4	53	528	31	31
605529	679485.53	751584.08	-30054	5	4	53	528	32	32
605529	679485.53	751584.08	-29457	5	4	53	528	33	33
605529	679485.53	751584.08	-46034	5	4	53	528	34	34
605529	679485.53	751584.08	-32025	5	4	53	528	35	35
605529	679485.53	751584.08	-32025	5	4	53	528	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
605530	669649.98	747573.07	-51860	5	4	132	508	29	29
605530	669649.98	747573.07	-63845	5	4	132	508	30	30
605530	669649.98	747573.07	-49016	5	4	132	508	31	31
605530	669649.98	747573.07	-22421	5	4	132	508	32	32
605530	669649.98	747573.07	-33274	5	4	132	508	33	33
605530	669649.98	747573.07	-63804	5	4	132	508	34	34
605530	669649.98	747573.07	-36626	5	4	132	508	35	35
605530	669649.98	747573.07	-36626	5	4	132	508	36	36
606372	635601.12	732369.87	-13227	5	4	361	26	29	29
606372	635601.12	732369.87	-8482	5	4	361	26	30	30
606372	635601.12	732369.87	0	5	4	361	26	31	31
606372	635601.12	732369.87	0	5	4	361	26	32	32
606372	635601.12	732369.87	-11410	5	4	361	26	33	33
606372	635601.12	732369.87	-10727	5	4	361	26	34	34
606372	635601.12	732369.87	-7591	5	4	361	26	35	35
606372	635601.12	732369.87	-7591	5	4	361	26	36	36
606373	635608.98	730413.96	0	3	3	365	26	29	29
606373	635608.98	730413.96	0	3	3	365	26	30	30
606373	635608.98	730413.96	0	3	3	365	26	31	31
606373	635608.98	730413.96	0	3	3	365	26	32	32
606373	635608.98	730413.96	-1732	3	3	365	26	33	33
606373	635608.98	730413.96	0	3	3	365	26	34	34
606373	635608.98	730413.96	0	3	3	365	26	35	35
606373	635608.98	730413.96	0	3	3	365	26	36	36
606374	634327.21	733668.21	-1808	5	4	358	24	29	29
606374	634327.21	733668.21	-120	5	4	358	24	30	30
606374	634327.21	733668.21	0	5	4	358	24	31	31
606374	634327.21	733668.21	0	5	4	358	24	32	32
606374	634327.21	733668.21	0	5	4	358	24	33	33
606374	634327.21	733668.21	0	5	4	358	24	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
606374	634327.21	733668.21	0	5	4	358	24	35	35
606374	634327.21	733668.21	0	5	4	358	24	36	36
608009	634611.61	735305.04	-54374	5	4	355	24	29	29
608009	634611.61	735305.04	-67917	5	4	355	24	30	30
608009	634611.61	735305.04	-68217	5	4	355	24	31	31
608009	634611.61	735305.04	-53786	5	4	355	24	32	32
608009	634611.61	735305.04	-44126	5	4	355	24	33	33
608009	634611.61	735305.04	-31604	5	4	355	24	34	34
608009	634611.61	735305.04	-14311	5	4	355	24	35	35
608009	634611.61	735305.04	-14311	5	4	355	24	36	36
608010	634288.62	734970.76	-71923	5	4	356	24	29	29
608010	634288.62	734970.76	-83828	5	4	356	24	30	30
608010	634288.62	734970.76	-81574	5	4	356	24	31	31
608010	634288.62	734970.76	-75015	5	4	356	24	32	32
608010	634288.62	734970.76	-50328	5	4	356	24	33	33
608010	634288.62	734970.76	-75611	5	4	356	24	34	34
608010	634288.62	734970.76	-40429	5	4	356	24	35	35
608010	634288.62	734970.76	-40429	5	4	356	24	36	36
608734	652140.01	730472.71	-15405	3	3	365	440	29	29
608734	652140.01	730472.71	-6296	3	3	365	440	30	30
608734	652140.01	730472.71	-9779	3	3	365	440	31	31
608734	652140.01	730472.71	0	3	3	365	440	32	32
608734	652140.01	730472.71	0	3	3	365	440	33	33
608734	652140.01	730472.71	-4532	3	3	365	440	34	34
608734	652140.01	730472.71	0	3	3	365	440	35	35
608734	652140.01	730472.71	0	3	3	365	440	36	36
609668	642727.21	740892.58	-103775	3	3	341	42	29	29
609668	642727.21	740892.58	-84233	3	3	341	42	30	30
609668	642727.21	740892.58	-72659	3	3	341	42	31	31
609668	642727.21	740892.58	-89230	3	3	341	42	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
609668	642727.21	740892.58	-54934	3	3	341	42	33	33
609668	642727.21	740892.58	-30513	3	3	341	42	34	34
609668	642727.21	740892.58	-27171	3	3	341	42	35	35
609668	642727.21	740892.58	-27171	3	3	341	42	36	36
609670	642061.44	742869.01	-99419	5	4	320	40	29	29
609670	642061.44	742869.01	-84925	5	4	320	40	30	30
609670	642061.44	742869.01	-76504	5	4	320	40	31	31
609670	642061.44	742869.01	-74782	5	4	320	40	32	32
609670	642061.44	742869.01	-54108	5	4	320	40	33	33
609670	642061.44	742869.01	0	5	4	320	40	34	34
609670	642061.44	742869.01	0	5	4	320	40	35	35
609670	642061.44	742869.01	0	5	4	320	40	36	36
609672	643369.95	744189.88	-70695	5	4	294	45	29	29
609672	643369.95	744189.88	-71724	5	4	294	45	30	30
609672	643369.95	744189.88	-66497	5	4	294	45	31	31
609672	643369.95	744189.88	-54769	5	4	294	45	32	32
609672	643369.95	744189.88	-35619	5	4	294	45	33	33
609672	643369.95	744189.88	-30703	5	4	294	45	34	34
609672	643369.95	744189.88	-23673	5	4	294	45	35	35
609672	643369.95	744189.88	-23673	5	4	294	45	36	36
609760	623972.56	731631.83	-1121	5	4	362	3	29	29
609760	623972.56	731631.83	-1121	5	4	362	3	30	30
609760	623972.56	731631.83	0	5	4	362	3	31	31
609760	623972.56	731631.83	0	5	4	362	3	32	32
609760	623972.56	731631.83	0	5	4	362	3	33	33
609760	623972.56	731631.83	-1121	5	4	362	3	34	34
609760	623972.56	731631.83	-1121	5	4	362	3	35	35
609760	623972.56	731631.83	-1121	5	4	362	3	36	36
609761	625301.64	731646.7	-16748	5	4	362	6	29	29
609761	625301.64	731646.7	-30217	5	4	362	6	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
609761	625301.64	731646.7	-21765	5	4	362	6	31	31
609761	625301.64	731646.7	-26285	5	4	362	6	32	32
609761	625301.64	731646.7	-25531	5	4	362	6	33	33
609761	625301.64	731646.7	-24407	5	4	362	6	34	34
609761	625301.64	731646.7	-9182	5	4	362	6	35	35
609761	625301.64	731646.7	-9182	5	4	362	6	36	36
610135	672344.46	741003.22	-63135	5	4	340	514	29	29
610135	672344.46	741003.22	-64674	5	4	340	514	30	30
610135	672344.46	741003.22	-43530	5	4	340	514	31	31
610135	672344.46	741003.22	-12284	5	4	340	514	32	32
610135	672344.46	741003.22	-57006	5	4	340	514	33	33
610135	672344.46	741003.22	-47346	5	4	340	514	34	34
610135	672344.46	741003.22	-27311	5	4	340	514	35	35
610135	672344.46	741003.22	-27311	5	4	340	514	36	36
610136	667692.51	736968.58	-42182	5	4	352	504	29	29
610136	667692.51	736968.58	-36878	5	4	352	504	30	30
610136	667692.51	736968.58	-43430	5	4	352	504	31	31
610136	667692.51	736968.58	-48658	5	4	352	504	32	32
610136	667692.51	736968.58	-49851	5	4	352	504	33	33
610136	667692.51	736968.58	0	5	4	352	504	34	34
610136	667692.51	736968.58	-85449	5	4	352	504	35	35
610136	667692.51	736968.58	-85449	5	4	352	504	36	36
610141	674884.59	747608.9	-117029	5	4	131	519	29	29
610141	674884.59	747608.9	-96733	5	4	131	519	30	30
610141	674884.59	747608.9	-113297	5	4	131	519	31	31
610141	674884.59	747608.9	-74180	5	4	131	519	32	32
610141	674884.59	747608.9	-97316	5	4	131	519	33	33
610141	674884.59	747608.9	-113774	5	4	131	519	34	34
610141	674884.59	747608.9	-100536	5	4	131	519	35	35
610141	674884.59	747608.9	-100536	5	4	131	519	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
610432	663108.53	747493.01	-138059	5	4	134	495	29	29
610432	663108.53	747493.01	-124724	5	4	134	495	30	30
610432	663108.53	747493.01	-140943	5	4	134	495	31	31
610432	663108.53	747493.01	-145616	5	4	134	495	32	32
610432	663108.53	747493.01	-63840	5	4	134	495	33	33
610432	663108.53	747493.01	-38998	5	4	134	495	34	34
610432	663108.53	747493.01	-30888	5	4	134	495	35	35
610432	663108.53	747493.01	-30888	5	4	134	495	36	36
610523	629999.4	729095.01	-650	2	2	367	15	29	29
610523	629999.4	729095.01	-1920	2	2	367	15	30	30
610523	629999.4	729095.01	-1312	2	2	367	15	31	31
610523	629999.4	729095.01	-1146	2	2	367	15	32	32
610523	629999.4	729095.01	-594	2	2	367	15	33	33
610523	629999.4	729095.01	-1283	2	2	367	15	34	34
610523	629999.4	729095.01	-1710	2	2	367	15	35	35
610523	629999.4	729095.01	-1710	2	2	367	15	36	36
610621	636616.85	770612.09	0	5	4	2	28	29	29
610621	636616.85	770612.09	-12367	5	4	2	28	30	30
610621	636616.85	770612.09	-56389	5	4	2	28	31	31
610621	636616.85	770612.09	-48016	5	4	2	28	32	32
610621	636616.85	770612.09	-46019	5	4	2	28	33	33
610621	636616.85	770612.09	-40785	5	4	2	28	34	34
610621	636616.85	770612.09	-58707	5	4	2	28	35	35
610621	636616.85	770612.09	-58707	5	4	2	28	36	36
610622	639240.52	770608.77	0	5	4	2	33	29	29
610622	639240.52	770608.77	0	5	4	2	33	30	30
610622	639240.52	770608.77	-66536	5	4	2	33	31	31
610622	639240.52	770608.77	-52092	5	4	2	33	32	32
610622	639240.52	770608.77	-47597	5	4	2	33	33	33
610622	639240.52	770608.77	-62007	5	4	2	33	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
610622	639240.52	770608.77	-44503	5	4	2	33	35	35
610622	639240.52	770608.77	-44503	5	4	2	33	36	36
610623	640552.38	770603.83	0	5	4	2	36	29	29
610623	640552.38	770603.83	0	5	4	2	36	30	30
610623	640552.38	770603.83	-50941	5	4	2	36	31	31
610623	640552.38	770603.83	-56514	5	4	2	36	32	32
610623	640552.38	770603.83	-49719	5	4	2	36	33	33
610623	640552.38	770603.83	-64066	5	4	2	36	34	34
610623	640552.38	770603.83	-9977	5	4	2	36	35	35
610623	640552.38	770603.83	-9977	5	4	2	36	36	36
610624	637928.68	770610.43	-85760	5	4	2	31	29	29
610624	637928.68	770610.43	-97658	5	4	2	31	30	30
610624	637928.68	770610.43	0	5	4	2	31	31	31
610624	637928.68	770610.43	0	5	4	2	31	32	32
610624	637928.68	770610.43	0	5	4	2	31	33	33
610624	637928.68	770610.43	0	5	4	2	31	34	34
610624	637928.68	770610.43	0	5	4	2	31	35	35
610624	637928.68	770610.43	0	5	4	2	31	36	36
610632	640567.49	769287.94	-61962	5	4	5	36	29	29
610632	640567.49	769287.94	-102087	5	4	5	36	30	30
610632	640567.49	769287.94	0	5	4	5	36	31	31
610632	640567.49	769287.94	0	5	4	5	36	32	32
610632	640567.49	769287.94	0	5	4	5	36	33	33
610632	640567.49	769287.94	0	5	4	5	36	34	34
610632	640567.49	769287.94	0	5	4	5	36	35	35
610632	640567.49	769287.94	0	5	4	5	36	36	36
610636	646351.5	717285	-20296	3	3	391	90	29	29
610636	646351.5	717285	-23839	3	3	391	90	30	30
610636	646351.5	717285	-26356	3	3	391	90	31	31
610636	646351.5	717285	-23017	3	3	391	90	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
610636	646351.5	717285	-23613	3	3	391	90	33	33
610636	646351.5	717285	-23136	3	3	391	90	34	34
610636	646351.5	717285	-10018	3	3	391	90	35	35
610636	646351.5	717285	-10018	3	3	391	90	36	36
612195	659332.96	730433.66	-64601	5	4	365	488	29	29
612195	659332.96	730433.66	-45557	5	4	365	488	30	30
612195	659332.96	730433.66	-34824	5	4	365	488	31	31
612195	659332.96	730433.66	-5724	5	4	365	488	32	32
612195	659332.96	730433.66	-29219	5	4	365	488	33	33
612195	659332.96	730433.66	-77996	5	4	365	488	34	34
612195	659332.96	730433.66	-43768	5	4	365	488	35	35
612195	659332.96	730433.66	-43768	5	4	365	488	36	36
612196	659302.51	731742.87	-93036	5	4	362	488	29	29
612196	659302.51	731742.87	-76565	5	4	362	488	30	30
612196	659302.51	731742.87	-56291	5	4	362	488	31	31
612196	659302.51	731742.87	-33512	5	4	362	488	32	32
612196	659302.51	731742.87	-89564	5	4	362	488	33	33
612196	659302.51	731742.87	-89564	5	4	362	488	34	34
612196	659302.51	731742.87	-56649	5	4	362	488	35	35
612196	659302.51	731742.87	-56649	5	4	362	488	36	36
612197	659302.51	731742.87	-101915	5	4	362	488	29	29
612197	659302.51	731742.87	-61061	5	4	362	488	30	30
612197	659302.51	731742.87	-68097	5	4	362	488	31	31
612197	659302.51	731742.87	-16339	5	4	362	488	32	32
612197	659302.51	731742.87	-60107	5	4	362	488	33	33
612197	659302.51	731742.87	-99105	5	4	362	488	34	34
612197	659302.51	731742.87	-65712	5	4	362	488	35	35
612197	659302.51	731742.87	-65712	5	4	362	488	36	36
612198	657456.56	729836.42	-81816	5	4	366	484	29	29
612198	657456.56	729836.42	-81335	5	4	366	484	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
612198	657456.56	729836.42	-73226	5	4	366	484	31	31
612198	657456.56	729836.42	-29099	5	4	366	484	32	32
612198	657456.56	729836.42	-65474	5	4	366	484	33	33
612198	657456.56	729836.42	-117590	5	4	366	484	34	34
612198	657456.56	729836.42	-65593	5	4	366	484	35	35
612198	657456.56	729836.42	-65593	5	4	366	484	36	36
612515	672980.13	742328.1	-118698	5	4	329	515	29	29
612515	672980.13	742328.1	-112556	5	4	329	515	30	30
612515	672980.13	742328.1	-103637	5	4	329	515	31	31
612515	672980.13	742328.1	-49970	5	4	329	515	32	32
612515	672980.13	742328.1	-61061	5	4	329	515	33	33
612515	672980.13	742328.1	-98628	5	4	329	515	34	34
612515	672980.13	742328.1	-57006	5	4	329	515	35	35
612515	672980.13	742328.1	-57006	5	4	329	515	36	36
612516	669723.91	739664.32	-4246	5	4	346	508	29	29
612516	669723.91	739664.32	-5627	5	4	346	508	30	30
612516	669723.91	739664.32	0	5	4	346	508	31	31
612516	669723.91	739664.32	0	5	4	346	508	32	32
612516	669723.91	739664.32	0	5	4	346	508	33	33
612516	669723.91	739664.32	-20871	5	4	346	508	34	34
612516	669723.91	739664.32	-18485	5	4	346	508	35	35
612516	669723.91	739664.32	-18485	5	4	346	508	36	36
612517	679484.72	748292.3	-26150	5	4	118	528	29	29
612517	679484.72	748292.3	-23955	5	4	118	528	30	30
612517	679484.72	748292.3	-23375	5	4	118	528	31	31
612517	679484.72	748292.3	-26476	5	4	118	528	32	32
612517	679484.72	748292.3	-36613	5	4	118	528	33	33
612517	679484.72	748292.3	-57006	5	4	118	528	34	34
612517	679484.72	748292.3	-31008	5	4	118	528	35	35
612517	679484.72	748292.3	-31008	5	4	118	528	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
612518	654789.46	723219.89	-124457	5	4	379	476	29	29
612518	654789.46	723219.89	-130120	5	4	379	476	30	30
612518	654789.46	723219.89	-139176	5	4	379	476	31	31
612518	654789.46	723219.89	-123315	5	4	379	476	32	32
612518	654789.46	723219.89	-105903	5	4	379	476	33	33
612518	654789.46	723219.89	-132140	5	4	379	476	34	34
612518	654789.46	723219.89	-37328	5	4	379	476	35	35
612518	654789.46	723219.89	-37328	5	4	379	476	36	36
612747	626063.22	729067.27	-41189	5	4	367	7	29	29
612747	626063.22	729067.27	-38144	5	4	367	7	30	30
612747	626063.22	729067.27	-44007	5	4	367	7	31	31
612747	626063.22	729067.27	-49851	5	4	367	7	32	32
612747	626063.22	729067.27	-38044	5	4	367	7	33	33
612747	626063.22	729067.27	-48658	5	4	367	7	34	34
612747	626063.22	729067.27	-32509	5	4	367	7	35	35
612747	626063.22	729067.27	-32509	5	4	367	7	36	36
612748	628029.99	729081.13	-44341	5	4	367	11	29	29
612748	628029.99	729081.13	-43636	5	4	367	11	30	30
612748	628029.99	729081.13	-51043	5	4	367	11	31	31
612748	628029.99	729081.13	-53071	5	4	367	11	32	32
612748	628029.99	729081.13	-49374	5	4	367	11	33	33
612748	628029.99	729081.13	-69767	5	4	367	11	34	34
612748	628029.99	729081.13	-53183	5	4	367	11	35	35
612748	628029.99	729081.13	-53183	5	4	367	11	36	36
612749	629343.02	729092.57	-57761	5	4	367	14	29	29
612749	629343.02	729092.57	-30566	5	4	367	14	30	30
612749	629343.02	729092.57	-49016	5	4	367	14	31	31
612749	629343.02	729092.57	-55098	5	4	367	14	32	32
612749	629343.02	729092.57	-49254	5	4	367	14	33	33
612749	629343.02	729092.57	-52355	5	4	367	14	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
612749	629343.02	729092.57	-48819	5	4	367	14	35	35
612749	629343.02	729092.57	-48819	5	4	367	14	36	36
616515	676929.62	744981.52	-50991	5	4	278	523	29	29
616515	676929.62	744981.52	-44842	5	4	278	523	30	30
616515	676929.62	744981.52	-23494	5	4	278	523	31	31
616515	676929.62	744981.52	-25283	5	4	278	523	32	32
616515	676929.62	744981.52	-21467	5	4	278	523	33	33
616515	676929.62	744981.52	-27549	5	4	278	523	34	34
616515	676929.62	744981.52	-24901	5	4	278	523	35	35
616515	676929.62	744981.52	-24901	5	4	278	523	36	36
616516	680169.1	747645.17	-45869	5	4	131	529	29	29
616516	680169.1	747645.17	-66786	5	4	131	529	30	30
616516	680169.1	747645.17	-37448	5	4	131	529	31	31
616516	680169.1	747645.17	-29576	5	4	131	529	32	32
616516	680169.1	747645.17	-59869	5	4	131	529	33	33
616516	680169.1	747645.17	-29099	5	4	131	529	34	34
616516	680169.1	747645.17	-24901	5	4	131	529	35	35
616516	680169.1	747645.17	-24901	5	4	131	529	36	36
616686	642959.42	723930.74	-5738	3	3	378	43	29	29
616686	642959.42	723930.74	-11177	3	3	378	43	30	30
616686	642959.42	723930.74	-10039	3	3	378	43	31	31
616686	642959.42	723930.74	-9963	3	3	378	43	32	32
616686	642959.42	723930.74	-8946	3	3	378	43	33	33
616686	642959.42	723930.74	-13207	3	3	378	43	34	34
616686	642959.42	723930.74	-1304	3	3	378	43	35	35
616686	642959.42	723930.74	-1304	3	3	378	43	36	36
616687	642959.42	723930.74	-5534	5	4	378	43	29	29
616687	642959.42	723930.74	-361	5	4	378	43	30	30
616687	642959.42	723930.74	0	5	4	378	43	31	31
616687	642959.42	723930.74	0	5	4	378	43	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
616687	642959.42	723930.74	-5980	5	4	378	43	33	33
616687	642959.42	723930.74	-7002	5	4	378	43	34	34
616687	642959.42	723930.74	-9639	5	4	378	43	35	35
616687	642959.42	723930.74	-9639	5	4	378	43	36	36
616763	628091.89	736551.08	-112	5	4	352	11	29	29
616763	628091.89	736551.08	0	5	4	352	11	30	30
616763	628091.89	736551.08	-9589	5	4	352	11	31	31
616763	628091.89	736551.08	0	5	4	352	11	32	32
616763	628091.89	736551.08	0	5	4	352	11	33	33
616763	628091.89	736551.08	0	5	4	352	11	34	34
616763	628091.89	736551.08	-140	5	4	352	11	35	35
616763	628091.89	736551.08	-140	5	4	352	11	36	36
616764	628091.89	736551.08	-74	5	4	352	11	29	29
616764	628091.89	736551.08	-12	5	4	352	11	30	30
616764	628091.89	736551.08	0	5	4	352	11	31	31
616764	628091.89	736551.08	0	5	4	352	11	32	32
616764	628091.89	736551.08	0	5	4	352	11	33	33
616764	628091.89	736551.08	0	5	4	352	11	34	34
616764	628091.89	736551.08	-218	5	4	352	11	35	35
616764	628091.89	736551.08	-218	5	4	352	11	36	36
616927	634194.01	744162.34	-73073	5	4	294	23	29	29
616927	634194.01	744162.34	-67778	5	4	294	23	30	30
616927	634194.01	744162.34	-49929	5	4	294	23	31	31
616927	634194.01	744162.34	-42447	5	4	294	23	32	32
616927	634194.01	744162.34	-50780	5	4	294	23	33	33
616927	634194.01	744162.34	-61081	5	4	294	23	34	34
616927	634194.01	744162.34	-45033	5	4	294	23	35	35
616927	634194.01	744162.34	-45033	5	4	294	23	36	36
617189	674900.45	756883.73	-45685	5	4	30	519	29	29
617189	674900.45	756883.73	-48211	5	4	30	519	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
617189	674900.45	756883.73	-30241	5	4	30	519	31	31
617189	674900.45	756883.73	0	5	4	30	519	32	32
617189	674900.45	756883.73	0	5	4	30	519	33	33
617189	674900.45	756883.73	0	5	4	30	519	34	34
617189	674900.45	756883.73	-5605	5	4	30	519	35	35
617189	674900.45	756883.73	-5605	5	4	30	519	36	36
618023	636470.72	745179.88	-4656	5	4	274	28	29	29
618023	636470.72	745179.88	-3635	5	4	274	28	30	30
618023	636470.72	745179.88	-5141	5	4	274	28	31	31
618023	636470.72	745179.88	-5394	5	4	274	28	32	32
618023	636470.72	745179.88	-2811	5	4	274	28	33	33
618023	636470.72	745179.88	-1044	5	4	274	28	34	34
618023	636470.72	745179.88	-883	5	4	274	28	35	35
618023	636470.72	745179.88	-883	5	4	274	28	36	36
618027	677596.15	743671.29	0	5	4	304	524	29	29
618027	677596.15	743671.29	0	5	4	304	524	30	30
618027	677596.15	743671.29	0	5	4	304	524	31	31
618027	677596.15	743671.29	0	5	4	304	524	32	32
618027	677596.15	743671.29	0	5	4	304	524	33	33
618027	677596.15	743671.29	-217	5	4	304	524	34	34
618027	677596.15	743671.29	-50806	5	4	304	524	35	35
618027	677596.15	743671.29	-50806	5	4	304	524	36	36
618508	656680.99	718536.72	-74125	5	4	388	482	29	29
618508	656680.99	718536.72	-45479	5	4	388	482	30	30
618508	656680.99	718536.72	-67024	5	4	388	482	31	31
618508	656680.99	718536.72	-68097	5	4	388	482	32	32
618508	656680.99	718536.72	0	5	4	388	482	33	33
618508	656680.99	718536.72	-68097	5	4	388	482	34	34
618508	656680.99	718536.72	-66800	5	4	388	482	35	35
618508	656680.99	718536.72	-66800	5	4	388	482	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
618509	656680.99	718536.72	-51442	5	4	388	482	29	29
618509	656680.99	718536.72	-41840	5	4	388	482	30	30
618509	656680.99	718536.72	-42218	5	4	388	482	31	31
618509	656680.99	718536.72	-52832	5	4	388	482	32	32
618509	656680.99	718536.72	0	5	4	388	482	33	33
618509	656680.99	718536.72	-58557	5	4	388	482	34	34
618509	656680.99	718536.72	-53797	5	4	388	482	35	35
618509	656680.99	718536.72	-53797	5	4	388	482	36	36
619401	654989.72	770602.04	-16422	5	4	2	476	29	29
619401	654989.72	770602.04	-14502	5	4	2	476	30	30
619401	654989.72	770602.04	-15430	5	4	2	476	31	31
619401	654989.72	770602.04	-16207	5	4	2	476	32	32
619401	654989.72	770602.04	-15697	5	4	2	476	33	33
619401	654989.72	770602.04	-15964	5	4	2	476	34	34
619401	654989.72	770602.04	-10483	5	4	2	476	35	35
619401	654989.72	770602.04	-10483	5	4	2	476	36	36
619533	663791.88	740945.04	-1259	5	4	341	497	29	29
619533	663791.88	740945.04	-2383	5	4	341	497	30	30
619533	663791.88	740945.04	-1013	5	4	341	497	31	31
619533	663791.88	740945.04	-477	5	4	341	497	32	32
619533	663791.88	740945.04	-19006	5	4	341	497	33	33
619533	663791.88	740945.04	-54979	5	4	341	497	34	34
619533	663791.88	740945.04	-7990	5	4	341	497	35	35
619533	663791.88	740945.04	-7990	5	4	341	497	36	36
619534	661849.47	737642.93	-126806	5	4	350	493	29	29
619534	661849.47	737642.93	-103257	5	4	350	493	30	30
619534	661849.47	737642.93	-60594	5	4	350	493	31	31
619534	661849.47	737642.93	-59511	5	4	350	493	32	32
619534	661849.47	737642.93	-99061	5	4	350	493	33	33
619534	661849.47	737642.93	-76224	5	4	350	493	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
619534	661849.47	737642.93	-150625	5	4	350	493	35	35
619534	661849.47	737642.93	-150625	5	4	350	493	36	36
621536	631594.46	742154.16	-67963	5	4	331	18	29	29
621536	631594.46	742154.16	-51938	5	4	331	18	30	30
621536	631594.46	742154.16	0	5	4	331	18	31	31
621536	631594.46	742154.16	0	5	4	331	18	32	32
621536	631594.46	742154.16	0	5	4	331	18	33	33
621536	631594.46	742154.16	0	5	4	331	18	34	34
621536	631594.46	742154.16	0	5	4	331	18	35	35
621536	631594.46	742154.16	0	5	4	331	18	36	36
621537	630285.55	741483.09	-2442	5	4	338	16	29	29
621537	630285.55	741483.09	-40374	5	4	338	16	30	30
621537	630285.55	741483.09	-21692	5	4	338	16	31	31
621537	630285.55	741483.09	-21925	5	4	338	16	32	32
621537	630285.55	741483.09	-23970	5	4	338	16	33	33
621537	630285.55	741483.09	-25235	5	4	338	16	34	34
621537	630285.55	741483.09	-26237	5	4	338	16	35	35
621537	630285.55	741483.09	-26237	5	4	338	16	36	36
621538	630286.44	740176.94	-107600	5	4	344	16	29	29
621538	630286.44	740176.94	-87400	5	4	344	16	30	30
621538	630286.44	740176.94	-28503	5	4	344	16	31	31
621538	630286.44	740176.94	-33989	5	4	344	16	32	32
621538	630286.44	740176.94	-57562	5	4	344	16	33	33
621538	630286.44	740176.94	-25402	5	4	344	16	34	34
621538	630286.44	740176.94	-26428	5	4	344	16	35	35
621538	630286.44	740176.94	-26428	5	4	344	16	36	36
622483	633420.84	731395.85	-799	5	4	363	22	29	29
622483	633420.84	731395.85	-799	5	4	363	22	30	30
622483	633420.84	731395.85	0	5	4	363	22	31	31
622483	633420.84	731395.85	-799	5	4	363	22	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
622483	633420.84	731395.85	-799	5	4	363	22	33	33
622483	633420.84	731395.85	-799	5	4	363	22	34	34
622483	633420.84	731395.85	0	5	4	363	22	35	35
622483	633420.84	731395.85	0	5	4	363	22	36	36
623918	659160.68	746838.29	-27346	5	4	170	487	29	29
623918	659160.68	746838.29	-22063	5	4	170	487	30	30
623918	659160.68	746838.29	-26356	5	4	170	487	31	31
623918	659160.68	746838.29	-24568	5	4	170	487	32	32
623918	659160.68	746838.29	-10972	5	4	170	487	33	33
623918	659160.68	746838.29	-15146	5	4	170	487	34	34
623918	659160.68	746838.29	-9064	5	4	170	487	35	35
623918	659160.68	746838.29	-9064	5	4	170	487	36	36
624355	648736.5	734355.02	-63266	5	4	357	237	29	29
624355	648736.5	734355.02	-71109	5	4	357	237	30	30
624355	648736.5	734355.02	-67501	5	4	357	237	31	31
624355	648736.5	734355.02	-52832	5	4	357	237	32	32
624355	648736.5	734355.02	-49493	5	4	357	237	33	33
624355	648736.5	734355.02	-66666	5	4	357	237	34	34
624355	648736.5	734355.02	-51052	5	4	357	237	35	35
624355	648736.5	734355.02	-51052	5	4	357	237	36	36
624356	648723.26	735008	-63761	3	3	355	236	29	29
624356	648723.26	735008	-50875	3	3	355	236	30	30
624356	648723.26	735008	-61419	3	3	355	236	31	31
624356	648723.26	735008	-44365	3	3	355	236	32	32
624356	648723.26	735008	-30173	3	3	355	236	33	33
624356	648723.26	735008	-29338	3	3	355	236	34	34
624356	648723.26	735008	-42177	3	3	355	236	35	35
624356	648723.26	735008	-42177	3	3	355	236	36	36
624357	644835.63	735692.83	-55377	5	4	354	59	29	29
624357	644835.63	735692.83	-50162	5	4	354	59	30	30

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
624357	644835.63	735692.83	-59749	5	4	354	59	31	31
624357	644835.63	735692.83	-47108	5	4	354	59	32	32
624357	644835.63	735692.83	-58914	5	4	354	59	33	33
624357	644835.63	735692.83	-62254	5	4	354	59	34	34
624357	644835.63	735692.83	-59295	5	4	354	59	35	35
624357	644835.63	735692.83	-59295	5	4	354	59	36	36
624358	642234.37	734367.26	-40274	2	2	357	40	29	29
624358	642234.37	734367.26	-45618	2	2	357	40	30	30
624358	642234.37	734367.26	-42099	2	2	357	40	31	31
624358	642234.37	734367.26	-46988	2	2	357	40	32	32
624358	642234.37	734367.26	-58199	2	2	357	40	33	33
624358	642234.37	734367.26	-60465	2	2	357	40	34	34
624358	642234.37	734367.26	-62504	2	2	357	40	35	35
624358	642234.37	734367.26	-62504	2	2	357	40	36	36
624359	651318.54	733632.55	-106784	5	4	358	424	29	29
624359	651318.54	733632.55	-88879	5	4	358	424	30	30
624359	651318.54	733632.55	-110196	5	4	358	424	31	31
624359	651318.54	733632.55	-105903	5	4	358	424	32	32
624359	651318.54	733632.55	-94931	5	4	358	424	33	33
624359	651318.54	733632.55	-117352	5	4	358	424	34	34
624359	651318.54	733632.55	-99829	5	4	358	424	35	35
624359	651318.54	733632.55	-99829	5	4	358	424	36	36
624360	646228.62	733122.16	-72527	5	4	359	87	29	29
624360	646228.62	733122.16	-52358	5	4	359	87	30	30
624360	646228.62	733122.16	-63327	5	4	359	87	31	31
624360	646228.62	733122.16	-42457	5	4	359	87	32	32
624360	646228.62	733122.16	-52474	5	4	359	87	33	33
624360	646228.62	733122.16	-58199	5	4	359	87	34	34
624360	646228.62	733122.16	-59672	5	4	359	87	35	35
624360	646228.62	733122.16	-59672	5	4	359	87	36	36

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
627605	640693.73	755439.67	-73786	5	4	33	36	29	29
627605	640693.73	755439.67	-73562	5	4	33	36	30	30
627605	640693.73	755439.67	-74628	5	4	33	36	31	31
627605	640693.73	755439.67	-70999	5	4	33	36	32	32
627605	640693.73	755439.67	-63962	5	4	33	36	33	33
627605	640693.73	755439.67	-71643	5	4	33	36	34	34
627605	640693.73	755439.67	-71643	5	4	33	36	35	35
627605	640693.73	755439.67	-71643	5	4	33	36	36	36
627608	647947.51	745529.43	-88593	8	4	267	174	29	29
627608	647947.51	745529.43	-81320	8	4	267	174	30	30
627608	647947.51	745529.43	-72103	8	4	267	174	31	31
627608	647947.51	745529.43	-78382	8	4	267	174	32	32
627608	647947.51	745529.43	-53777	8	4	267	174	33	33
627608	647947.51	745529.43	-69170	8	4	267	174	34	34
627608	647947.51	745529.43	-36331	8	4	267	174	35	35
627608	647947.51	745529.43	-36331	8	4	267	174	36	36
627609	651233.01	743552.88	0	8	4	306	422	29	29
627609	651233.01	743552.88	0	8	4	306	422	30	30
627609	651233.01	743552.88	0	8	4	306	422	31	31
627609	651233.01	743552.88	0	8	4	306	422	32	32
627609	651233.01	743552.88	0	8	4	306	422	33	33
627609	651233.01	743552.88	0	8	4	306	422	34	34
627609	651233.01	743552.88	-10051	8	4	306	422	35	35
627609	651233.01	743552.88	-10051	8	4	306	422	36	36
627610	644675.74	745520.58	-81649	5	4	267	57	29	29
627610	644675.74	745520.58	-73340	5	4	267	57	30	30
627610	644675.74	745520.58	-63143	5	4	267	57	31	31
627610	644675.74	745520.58	-76256	5	4	267	57	32	32
627610	644675.74	745520.58	-59818	5	4	267	57	33	33
627610	644675.74	745520.58	-57595	5	4	267	57	34	34

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
627610	644675.74	745520.58	-52739	5	4	267	57	35	35
627610	644675.74	745520.58	-52739	5	4	267	57	36	36
627611	656502.31	744872.22	-97476	8	4	280	482	29	29
627611	656502.31	744872.22	-81103	8	4	280	482	30	30
627611	656502.31	744872.22	-57934	8	4	280	482	31	31
627611	656502.31	744872.22	-58072	8	4	280	482	32	32
627611	656502.31	744872.22	-33631	8	4	280	482	33	33
627611	656502.31	744872.22	-45913	8	4	280	482	34	34
627611	656502.31	744872.22	-35394	8	4	280	482	35	35
627611	656502.31	744872.22	-35394	8	4	280	482	36	36
627613	654884.22	749163.92	-119	6	4	100	476	29	29
627613	654884.22	749163.92	-119	6	4	100	476	30	30
627613	654884.22	749163.92	-1	6	4	100	476	31	31
627613	654884.22	749163.92	-105	6	4	100	476	32	32
627613	654884.22	749163.92	-21	6	4	100	476	33	33
627613	654884.22	749163.92	-37	6	4	100	476	34	34
627613	654884.22	749163.92	-225	6	4	100	476	35	35
627613	654884.22	749163.92	-225	6	4	100	476	36	36
627614	653870.38	746194.82	-107	7	4	222	469	29	29
627614	653870.38	746194.82	-129	7	4	222	469	30	30
627614	653870.38	746194.82	-186	7	4	222	469	31	31
627614	653870.38	746194.82	0	7	4	222	469	32	32
627614	653870.38	746194.82	-38	7	4	222	469	33	33
627614	653870.38	746194.82	-104	7	4	222	469	34	34
627614	653870.38	746194.82	-372	7	4	222	469	35	35
627614	653870.38	746194.82	-372	7	4	222	469	36	36
627615	641329.75	758073.98	-1840	5	4	27	38	29	29
627615	641329.75	758073.98	-1351	5	4	27	38	30	30
627615	641329.75	758073.98	-5077	5	4	27	38	31	31
627615	641329.75	758073.98	-3797	5	4	27	38	32	32

Name	X	Y	Q - Pumping Rate (cubic feet per day)	Bottom Layer	Top Layer	Row	Column	Start Stress Period	End Stress Period
627615	641329.75	758073.98	-10626	5	4	27	38	33	33
627615	641329.75	758073.98	-6769	5	4	27	38	34	34
627615	641329.75	758073.98	-19512	5	4	27	38	35	35
627615	641329.75	758073.98	-19512	5	4	27	38	36	36
627617	640735.42	745512.45	-70834	5	4	267	36	29	29
627617	640735.42	745512.45	-73705	5	4	267	36	30	30
627617	640735.42	745512.45	-51790	5	4	267	36	31	31
627617	640735.42	745512.45	-75235	5	4	267	36	32	32
627617	640735.42	745512.45	-43504	5	4	267	36	33	33
627617	640735.42	745512.45	-41504	5	4	267	36	34	34
627617	640735.42	745512.45	-39302	5	4	267	36	35	35
627617	640735.42	745512.45	-39302	5	4	267	36	36	36

EXHIBIT B-6

Pre-Operational Report –
Production Test Facility

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PRE-OPERATIONAL REPORT
PRODUCTION TEST FACILITY
FLORENCE, ARIZONA

by Haley & Aldrich, Inc.
Phoenix, Arizona

for Florence Copper Inc.
Florence, Arizona

File No. 129687
September 2018

Executive Summary

Florence Copper, Inc. (Florence Copper) has constructed the Production Test Facility (PTF) to demonstrate In-Situ Copper Recovery at the Florence Copper Project site in Florence, Arizona. This PTF Pre-Operational Report summarizes the details of the pre-operational requirements required under the site permits including the United States Environmental Protection Agency (USEPA) Underground Injection Control Permit No. R9-AZ3-FY11-1 (UIC Permit) and the Arizona Department of Environmental Quality (ADEQ) Temporary Aquifer Protection Permit (APP) No. 106360.

Formation testing completed at the site conformed to requirements of both the UIC Permit and the APP. Results of the testing and the porosity data supported the parameters used in the site model.

Wells and coreholes existing within the Area of Review (AOR) of the PTF were abandoned as required in the UIC Permit and APP. All wells and coreholes were sealed using more than the calculated volume and were perforated across lithologic intervals as required in the permits.

Once construction and equipping of the PTF was complete, a demonstration of the hydraulic capture and cone of depression was completed by injecting and recovering clean water. Hydraulic capture was demonstrated by the drawdown at each PTF recovery well exceeding the drawdown at its adjacent PTF observation well by more than 1 foot. To demonstrate the cone of depression, water level elevations were observed at the edge of the APP Pollutant Management Area (PMA) at monitoring well M54-O, a distance of approximately 500 feet from the wellfield during the recovery and injection period. The water level elevation at downgradient monitoring well M54-O was higher than the elevation at both downgradient observation wells.

Ambient mine block water quality data was collected form all PTF mine block wells and initial discharge characterization was completed at the underground workings at the site; results are summarized in this report.

Bulk electrical conductivity sensors were installed on all PTF observation wells and background electrical conductivity data was collected at the site. Statistical analysis of the data was completed and alert levels for the electrical conductivity sensors are proposed to monitor for excursion of mining solutions into the Lower Basin Fill Unit.

All PTF wellfield wells and monitoring wells associated with the PTF that were completed within the AOR were completed in accordance with the Class III well requirements. Wells located outside the AOR were completed as designed. Class III wells were drilled, constructed, and tested in accordance with the construction procedures included in the UIC Permit. The only deviations from the well design were:

- PTF Observation Well O-05. During grouting of the well, the contractor lost power to the rig and grout pump and was unable to install the grout in one continuous lift. After installation, the cement interval was evaluated and deemed to be insufficient. The well was abandoned by perforating across the compromised grout zone and replaced approximately 20 feet away. The replacement well O-05B was built in accordance with the construction procedures included in the UIC Permit.
- PTF Injection Well I-03. During development, a pipe separated and compromised the endcap of the well. No other damage was identified, but a sand-filled rubber plug was installed to approximately 1,130 feet.

- Recovery Well R-06. Grout intruded into the screened zone during installation of the grout seal. The mechanical integrity of the well was evaluated to ensure the grout lost into the well did not compromise the seal; the integrity was confirmed by both Standard Annular Pressure Testing and geophysical logging inspections. During efforts to remove the grout from the well, the screen was compromised. In order to ensure the stability of the well, the well was equipped with a 3-inch liner from 570 feet to the total depth that could be achieved after the cleanout (1,090 feet).

All PTF wellfield wells passed standard annular pressure tests to evaluate the mechanical integrity of the wells. Further details are provided in Appendices E through J.

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1. Introduction

This report has been prepared in accordance with Pre-Operational requirements set forth in Section 2.7.4.3 of Aquifer Protection Permit (APP) No. P-106360 (APP) and to transmit Production Test Facility (PTF) wellfield completion data to the United States Environmental Protection Agency (USEPA) in accordance with requirements of Part II of the Underground Injection Control Permit No. R9UIC-AZ3-FY11-1 (UIC Permit).

2. Aquifer Testing

Aquifer testing and injection testing was completed in accordance with Section 2.2.3 of the APP, as well as Part II.C.8 of the UIC Permit. The results of the testing are summarized in the Formation Testing Report, Production Test Facility. The report is provided as Appendix A of this report for reference but was previously submitted to both the Arizona Department of Environmental Quality (ADEQ) and the USEPA. Data and analysis generated during aquifer testing were compared to those included in the groundwater model that was prepared in support of the permit applications. Aquifer testing and geophysical logging produced site-specific hydraulic conductivity and porosity values. The groundwater flow model was created using values derived from testing on the Florence Copper property, but at locations other than the PTF well field. This testing showed that the hydraulic conductivity and porosity values used in the groundwater flow model are representative of site-specific values measured at the PTF site. Consequently, no changes to the existing groundwater model are necessary at this time based on results of the formation testing.

2.1 NEUTRON POROSITY EVALUATION

Neutron logging was conducted in the boreholes for wells R-01, I-01, I-02, I-03, and I-04 in the PTF wellfield in accordance with Part II.C.2 of the UIC Permit. Porosity values were calculated from the neutron-density data by the geophysical contractor that conducted the testing (Southwest Exploration LLC). The porosity values calculated from the compensated neutron-density data and the porosity values used in the groundwater flow model are shown in Table 1.

The porosity values applied in the groundwater flow model are comparable to the average of the measured porosity values using neutron logging. The porosity values applied in the model for the bedrock oxide unit model layers range from 5 to 8 percent and are representative of the oxide unit porosity values calculated from neutron data.

The calculated porosity values for the bedrock oxide unit are very close to those used in the model based on data collected at other locations on the project site in the 1990s. The porosity values calculated for the alluvial units however were slightly lower but still representative of values determined by previous site-wide testing. This variation between the calculated neutron porosity and the value used in the model is the result of conditions under which the data was collected. The neutron-density logging tool is designed to be operated in a borehole with a nominal diameter of 8 to 10 inches. However, the upper portion of the boreholes logged for neutron-density are 20 inches in diameter. Operating the tool outside of the design parameters likely dissipated a portion of the signal which could cause the values to be lower than actual values in the formation. The lower portion of the boreholes logged (below 500 feet) that is the majority of the bedrock interval is 12¼-inch in diameter, which is

closer to the conditions in which the tool is designed to operate. The resulting calculated porosity values align very closely with those used in the model.

During aquifer testing, a spinner-flowmeter survey was run in well R-01. The correlation between the calculated flow contribution from various depth intervals under pumping conditions and the vertical porosity profile measured by neutron logging was evaluated to establish the relationship between porosity and observed flow. As shown in Figure 1, the depth intervals that contribute a larger percentage of the groundwater flow to the well under the pumping conditions do not necessarily coincide with the higher porosity intervals. This indicates that the vertical porosity profile calculated for the formation from compensated neutron-density data is not likely to be a useful tool to identify intervals that are relatively more permeable in the bedrock oxide unit at the site.

3. Well Abandonment

The PTF Well and Corehole Abandonment Report prepared by Haley & Aldrich and dated 13 September 2018 is provided as Appendix B.

4. Inward Hydraulic Gradient Demonstration

Florence Copper operated the PTF wellfield from 27 to 31 August 2018 to establish a cone of depression under injection conditions to demonstrate hydraulic control could be established at the PTF. Injection was conducted with clean formation water; no lixiviant or additives were included in the injected water. The recovery wells were turned on at 10:30 AM on 27 August 2018 and extraction rates were adjusted. Injection commenced at the injection wells at 11:55 AM on 27 August 2018. The water extracted from the recovery wells was pumped to the process area through the pipeline and back to the wellfield using the constructed facilities. Flow rates were adjusted during the first day of the test. After the first 24 hours, the wellfield was extracting at rates ranging from 264 to 268 gallons per minute (gpm), and injecting at rates ranging from 181 to 223 gpm.

A contour map was generated using data collected during the afternoon of 30 August 2018, approximately 3 days after pumping and injection commenced. The contours reflect a period when the extraction rate was 267 gpm and the injection rate averaged 209 gpm. The over-pumping equates to 127 percent of the injection rate; a contour map is provided in Figure 2.

The contour map shows that a cone of depression was established around the PTF, with groundwater flowing into the wellfield from all directions. In addition, the water levels at each of the observation wells met the minimum 1-foot differential requirement. A summary of water levels and differential for each recovery/observation well pair is included as Table 2.

4.1 ESTABLISHMENT OF THE CONE OF DEPRESSION

Section 2.2.2.f of the APP requires the demonstration of a cone of a depression by confirmation of a higher water level elevation at the edge of the Pollutant Management Area (PMA), as defined by the APP, than at the downgradient PTF observation well. Table 3 summarizes water level elevations at the two PTF observation wells and downgradient monitoring wells in the bedrock oxide unit out to well M54-O located outside of the PMA. During the hydraulic connection test, water level elevations were

collected at downgradient monitoring wells MW-01-O and M54-O. Both demonstrated higher water level elevations than the PTF observation wells located on the downgradient side of the wellfield, wells O-07 and O-06. The water levels at these wells are summarized in Table 4.

5. Ambient Mine Block Groundwater Concentrations and Initial Discharge Characterization of the Underground Workings

Results of the ambient groundwater characterization of the PTF mine block and the results of the initial discharge characterization of the underground workings are included in the memorandum titled *PTF Mine Block Ambient Groundwater Concentrations and Initial Discharge Characterization of the Underground Workings*, prepared by Brown and Caldwell and provided as Appendix C to this report.

6. Ambient LBFU Bulk Electrical Conductivity Results

The results of the Ambient Bulk Electrical Conductivity ambient monitoring and proposed alert levels are included in the report titled *Procedures for Determining Bulk Electrical Conductivity Levels, Production Test Facility* prepared by Haley & Aldrich. This report is provided as Appendix D of this report, and was previously submitted to both the ADEQ and the USEPA.

7. Well Installation Details for All PTF Wellfield and Monitoring Wells

Technical Memorandums summarizing the drilling and installation for each of the PTF wellfield and monitoring wells are included in the following appendices:

- Appendix E, Point-of-Compliance Wells;
- Appendix F, PTF Supplemental Monitoring Wells;
- Appendix G, PTF Operational Monitoring Wells;
- Appendix H, PTF Injection and Recovery Wells;
- Appendix I, PTF Westbay Wells; and
- Appendix J, PTF Observation Wells.

The Technical Memorandums for all Class III wells include USEPA form 7520-9 and supporting documentation including results of the demonstration for mechanical integrity.

8. Closing

This report conforms to requirements describing a PTF Pre-Operational Report set forth in Section 2.7.3 of the APP. The content also conforms to requirements of the UIC Permit set forth in Part II.C.1(b), Part II.C.3, Part II.C.9(a), Part II.C.9(b), and Part II.G.4.

TABLES

TABLE 1
COMPARISON BETWEEN MODELED POROSITY AND AVERAGE POROSITY MEASURED BY NEUTRON LOGGING
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Model Layer or Unit	Range of Modeled Porosity Values	Average Porosity Measured by Neutron Logging (I-01, I-02, I-03, I-04, and R-01)
Model Layers 1 and 2 (UBFU)	0.13 - 0.2	0.12
Model Layer 3 (MFGU/UBFU)	0.15 - 0.2	0.12
Model Layer 4 and 5 (LBFU)	0.2	0.12
Model Layers 6-10 (Bedrock Oxide)	0.08 for Model Layers 6-8 0.05 for Model Layers 9-10	0.08

Notes:
LBFU = Lower Basin Fill Unit
MFGU = Middle Fine-Grained Unit
UBFU = Upper Basin Fill Unit

TABLE 2
RECOVERY AND OBSERVATION WELL
PAIRS WATER LEVEL DIFFERENTIAL
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Outer Recovery Well ID	Date/Time	Water Level Elevation (feet amsl)	Paired Observation Well ID	Date/Time	Water Level Elevation (feet amsl)	Water Level Differential (feet)
R-01	8/30/2018 15:58	1231.68	O-07	8/30/2018 16:49	1235.98	4.3
R-01	8/30/2018 15:58	1231.68	O-01	8/30/2018 15:36	1235.35	3.67
R-02	8/30/2018 16:06	1229.22	O-01	8/30/2018 15:36	1235.35	6.13
R-02	8/30/2018 16:06	1229.22	O-02	8/30/2018 16:03	1235.06	5.84
R-03	8/30/2018 16:12	1223.10	O-02	8/30/2018 16:03	1235.06	11.96
R-03	8/30/2018 16:12	1223.10	O-03	8/30/2018 16:12	1233.45	10.35
R-04	8/30/2018 16:19	1226.13	O-03	8/30/2018 16:12	1233.45	7.32
R-05	8/30/2018 16:25	1224.05	O-04	8/30/2018 16:25	1235.57	11.52
R-06	8/30/2018 16:32	1225.72	O-04	8/30/2018 16:25	1235.57	9.85
R-06	8/30/2018 16:32	1225.72	O-05	8/30/2018 16:37	1235.27	9.55
R-07	8/30/2018 16:43	1233.41	O-05	8/30/2018 16:37	1235.27	1.86
R-07	8/30/2018 16:43	1233.41	O-06	8/30/2018 16:44	1235.58	2.17
R-08	8/30/2018 16:49	1232.32	O-06	8/30/2018 16:44	1235.58	3.26
R-08	8/30/2018 16:49	1232.32	O-07	8/30/2018 16:49	1235.98	3.66

Note:

amsl - above mean sea level

TABLE 3
PTF WELL COMPLETION SUMMARY
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Well ID	Well Registry ID	Well Drilling and Construction Timeline		Well Development Completion Date	Well Type	Cadastral Location	Survey Data (State Plane)				Borehole Depth (ft bgs)	Well Depth (ft bgs)	Top Cement Interval (ft bgs)	Bottom Cement Interval (ft bgs)	Top Bentonite & Sand Seal Interval (Intermediate Sand Seal Intervals for Recovery, Injection, Westbay Wells) (ft bgs)	Bottom Bentonite & Sand Seal Interval (Intermediate Sand Seal Intervals for Recovery, Injection, Westbay Wells) (ft bgs)	Top Filter Pack Interval (ft bgs)	Bottom Filter Pack Interval (ft bgs)	Top Screened Interval (ft bgs)	Bottom Screened Interval (ft bgs)	Casing Type	Casing Diameter		Screen Type	Screen Slot Size (in.)	Screen Diameter		Unit Contacts		
		Start	End				Northing (NAD83)	Easting (NAD83)	Ground Surface Elevation (NAVD88)	Measuring Point Elevation/Top of Casing Elevation for POC & Monitoring Wells (NAVD88)												Outside (in.)	Inside (in.)			Outside (in.)	Inside (in.)	Unit	Bottom of Unit Depth (ft bgs)	Bottom of Unit Elevation (ft-amsl)
POINT OF COMPLIANCE WELLS																													
M52-UBF	55-226788	1/26/2017	1/27/2017	2/14/2017	Point-of-Compliance	D (4-9) 28 DAA	774178.00	851092.00	1,483.43	1,485.04	280	274	0	187	187	197	197	280	198	274	Schedule 80 PVC	5.56	4.81	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	---	---
M54-LBF	55-226792	2/8/2017	2/12/2017	2/15/2017	Point-of-Compliance	D (4-9) 28 CBA	746682.61	847331.96	1,480.18	1,481.92	640	629	0	285	285	300	300	640	310	629	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	287	1,193
																												Middle Fine-Grained Unit	300	1,180
																												Lower Basin Fill Unit	---	---
M54-O	55-226798	1/29/2017	2/6/2017	5/15/2017	Point-of-Compliance	D (4-9) 28 CBD	746702.36	847342.99	1,480.20	1,482.42	1,210	1,199	0	649	649	659	659	1,210	668	1,199	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	286	1,194
																												Middle Fine-Grained Unit	300	1,180
																												Lower Basin Fill Unit	740	740
																												Bedrock Oxide Unit	---	---
OPERATIONAL MONITORING WELLS																													
MW-01-LBF	55-226789	11/21/2017	12/19/2017	12/29/2017	Operational Monitoring	D (4-9) 28 CBD	746360.54	847487.97	---	1,478.99	444	440	0	310	310	320	320	444	330	440	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	280	1,199
																												Middle Fine-Grained Unit	299	1,180
																												Lower Basin Fill Unit	---	---
MW-01-O	55-226793	11/20/2017	12/14/2017	12/27/2017	Operational Monitoring	D (4-9) 28 CBD	746369.31	847499.04	---	1,479.14	1,210	1,200	0	480	480	490	490	1,210	500	1,200	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	281	1,198
																												Middle Fine-Grained Unit	297	1,182
																												Lower Basin Fill Unit	445	1,034
																												Bedrock Oxide Unit	---	---
SUPPLEMENTAL MONITORING WELLS																													
M55-UBF	55-226797	4/10/2017	4/12/2017	5/2/2017	Class III Supplemental Monitoring	D (4-9) 28 CBD	746280.63	847541.46	1,478.00	1,479.14	272	261	0	216	216	230	230	272	240	261	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	---	---
M56-LBF	55-226795	4/13/2017	4/14/2017	5/1/2017	Class III Supplemental Monitoring	D (4-9) 28 CBD	746303.41	847518.70	1,477.32	1,478.65	352	340	0	297	297	310	310	352	320	340	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	282	1,195
																												Middle Fine-Grained Unit	302	1,175
																												Lower Basin Fill Unit	---	---
M57-O	55-226790	3/3/2017	3/10/2017	4/3/2017	Class III Supplemental Monitoring	D (4-9) 28 CBD	746248.93	847378.37	1,476.77	1,478.71	1,210	1,200	0	504	504	515	515	1,210	523	1,200	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	283	1,194
																												Middle Fine-Grained Unit	302	1,175
																												Lower Basin Fill Unit	545	932
																												Bedrock Oxide Unit	---	---
M58-O	55-226794	3/11/2017	3/19/2017	4/17/2017	Class III Supplemental Monitoring	D (4-9) 28 CBD	746595.97	847672.23	1,479.48	1,481.08	1,213	1,200	0	563	563	584	584	1,213	594	1,200	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	285	1,194
																												Middle Fine-Grained Unit	300	1,179
																												Lower Basin Fill Unit	530	949
																												Bedrock Oxide Unit	---	---
M59-O	55-226791	3/21/2017	3/28/2017	4/10/2017	Class III Supplemental Monitoring	D (4-9) 28 CAC	746218.89	847934.95	1,478.55	1,480.19	1,213	1,200	0	512	512	524	524	1,213	534	1,200	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	285	1,194
																												Middle Fine-Grained Unit	305	1,174
																												Lower Basin Fill Unit	465	1,014
																												Bedrock Oxide Unit	---	---
M60-O	55-226796	3/30/2017	4/9/2017	4/24/2017	Class III Supplemental Monitoring	D (4-9) 28 CBD	745903.70	847599.37	1,475.46	1,477.36	1,213	1,201	0	415	415	435	435	1,213	444	1,201	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	290	1,185
																												Middle Fine-Grained Unit	310	1,165
																												Lower Basin Fill Unit	380	1,095
																												Bedrock Oxide Unit	---	---
M61-LBF	55-226799	4/15/2017	4/19/2017	5/8/2017	Class III Supplemental Monitoring	D (4-9) 28 CAC	746148.88	848184.46	1,478.91	1,480.78	646	630	0	410	410	420	420	646	429	630	Mild Steel	5.66	5.05	Schedule 80 PVC	0.020	5.56	4.81	Upper Basin Fill	282	1,197
																												Middle Fine-Grained Unit	305	1,174
																												Lower Basin Fill Unit	615	864
																												Bedrock Oxide Unit	---	---
OBSERVATION WELLS																													
O-01	55-227230	2/19/2018	3/3/2018	3/26/2018	Class III Observation	D (4-9) 28 CAC	746272.70	847765.50	---	1,481.08	1,220	1,201	0	485	485	493	493	1,220	500	1,201	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	280	1,201
																												Middle Fine-Grained Unit	300	1,181
																												Lower Basin Fill Unit	440	1,041
																												Bedrock Exclusion Zone	480	1,001
																												Bedrock Oxide Unit	---	---
O-02	55-227231	2/22/2018	3/7/2018	3/25/2018	Class III Observation	D (4-9) 28 CAC	746202.32	847836.29	---	1,479.36	1,224	1,201	0	478	478	488	488	1,224	501	1,201	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	281	1,198
																												Middle Fine-Grained Unit	300	1,179
																												Lower Basin Fill Unit	430	1,049
																												Bedrock Exclusion Zone	470	1,009
																												Bedrock Oxide Unit	---	---
O-03	55-227232	4/27/2017	5/7/2017	5/22/2017	Class III Observation	D (4-9) 28 CAC	746053.02	847831.43	---	1,478.83	1,208	1,201	0	430	430	440	440	1,208	450	1,201	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	282	1,197
																												Middle Fine-Grained Unit	302	1,177
																												Lower Basin Fill Unit	385	1,094
																												Bedrock Exclusion Zone	425	1,054
																												Bedrock Oxide Unit	---	---
O-04	55-2527233	1/4/2018	1/20/2018	3/5/2018	Class III Observation	D (4-9) 28 CBD	745988.60	847624.06	---	1,478.05	1,208	1,200	0	473	473	485	485	1,208	498	1,200	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	280	1,198
																												Middle Fine-Grained Unit	302	1,176
																												Lower Basin Fill Unit	390	1,088
																												Bedrock Exclusion Zone	430	1,048
																												Bedrock Oxide Unit	---	---
O-05B	55-227234	6/9/2017	6/19/2017	6/28/2017	Class III Observation	D (4-9) 28 CBD	746042.91	847534.95	---	1,478.57	1,220	1,201	0	429	429	439	439	1,220	450	1,201	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	282	1,197
																												Middle Fine-Grained Unit	303	1,176
																												Lower Basin Fill Unit	384	1,095
																												Bedrock Exclusion Zone	424	1,055
																												Bedrock Oxide Unit	---	---
O-06	55-227235	1/22/2018	2/9/2018	3/2/2018	Class III Observation	D (4-9) 28 CBD	746201.82	847553.01	---	1,479.16	1,220	1,201	0	474	474	490	490	1,220	499	1,201	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	278	1,201
																												Middle Fine-Grained Unit	298	1,181
																												Lower Basin Fill Unit	365	1,114
																												Bedrock Exclusion Zone	405	1,074
																												Bedrock Oxide Unit	---	---
O-07	55-227236	5/8/2017	5/20/2017	6/1/2017	Class III Observation	D (4-9) 28 CBD	746270.61	847623.88	---	1,479.13	1,210	1,198	0	428	428	437	437	1,210	446	1,198	Fiberglass Reinforced Plastic	5.47	4.74	Schedule 80 PVC	0.020	5.56	4.77	Upper Basin Fill	284	1,195
																												Middle Fine-Grained Unit	301	1,178
																												Lower Basin Fill Unit	380	1,099
																												Bedrock Exclusion Zone	420	1,059
																												Bedrock Oxide Unit	---	---

TABLE 3
PTF WELL COMPLETION SUMMARY
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Well ID	Well Registry ID	Well Drilling and Construction Timeline		Well Development Completion Date	Well Type	Cadastral Location	Survey Data (State Plane)				Borehole Depth (ft bgs)	Well Depth (ft bgs)	Top Cement Interval (ft bgs)	Bottom Cement Interval (ft bgs)	Top Bentonite & Sand Seal Interval (Intermediate Sand Seal Intervals for Recovery, Injection, Westbay Wells) (ft bgs)	Bottom Bentonite & Sand Seal Interval (Intermediate Sand Seal Intervals for Recovery, Injection, Westbay Wells) (ft bgs)	Top Filter Pack Interval (ft bgs)	Bottom Filter Pack Interval (ft bgs)	Top Screened Interval (ft bgs)	Bottom Screened Interval (ft bgs)	Casing Type	Casing Diameter		Screen Type	Screen Slot Size (in.)	Screen Diameter		Unit Contacts		
		Start	End				Northing (NAD83)	Easting (NAD83)	Ground Surface Elevation (NAVD88)	Measuring Point Elevation/Top of Casing Elevation for POC & Monitoring Wells (NAVD88)												Outside (in.)	Inside (in.)			Outside (in.)	Inside (in.)	Unit	Bottom of Unit Depth (ft bgs)	Bottom of Unit Elevation (ft-amsl)
RECOVERY WELLS																															
R-01	55-227700	10/27/2017	12/18/2017	1/19/2018	Class III Recovery	D (4-9) 28 CAC	746273.07	847694.41	---	1,481.90	1,220	1,205	0	499	499	511	511	645	521	641	Fiberglass Reinforced Plastic (0 - 521)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	283	1,199
															645	658	658	888	663	883	Stainless steel (641 - 663)	5.56	5.05					Middle Fine-Grained Unit	302	1,180
															888	900	900	1,220	905	1,205	Stainless steel (883 - 905)	5.56	5.05					Lower Basin Fill Unit	414	1,068
																												Bedrock Exclusion Zone	454	1,028
																												Bedrock Oxide Unit	---	---
R-02	55-227701	1/13/2018	1/19/2018	4/3/2018	Class III Recovery	D (4-9) 28 CAC	746202.30	847765.32	---	1,481.81	1,225	1,202	0	496	496	517	517	646	521	641	Fiberglass Reinforced Plastic (0 - 521)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	283	1,199
															646	656	656	881	661	881	Schedule 80 PVC blank (641 - 661)	5.56	4.81					Middle Fine-Grained Unit	302	1,180
															881	901	901	1,225	901	1,202	Schedule 80 PVC blank (881 - 901)	5.56	4.81					Lower Basin Fill Unit	400	1,082
																												Bedrock Exclusion Zone	440	1,042
																												Bedrock Oxide Unit	---	---
R-03	55-227702	11/30/2017	1/12/2018	2/5/2018	Class III Recovery	D (4-9) 28 CAC	746131.72	847836.12	---	1,481.87	1,225	1,202	0	494	494	511	511	644	522	642	Fiberglass Reinforced Plastic (0 - 522)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	281	1,201
															644	657	657	886	662	882	Schedule 80 PVC blank (642 - 662)	5.56	4.81					Middle Fine-Grained Unit	302	1,180
															886	897	897	1,225	902	1,202	Schedule 80 PVC blank (882 - 902)	5.56	4.81					Lower Basin Fill Unit	422	1,060
																												Bedrock Exclusion Zone	462	1,020
																												Bedrock Oxide Unit	---	---
R-04	55-227703	1/15/2018	2/6/2018	3/20/2018	Class III Recovery	D (4-9) 28 CAC	746060.98	847765.04	---	1,481.84	1,225	1,201	0	488	488	500	500	645	520	640	Fiberglass Reinforced Plastic (0 - 520)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	280	1,202
															645	658	658	1,225	660	880	Schedule 80 PVC blank (640 - 660)	5.56	4.81					Middle Fine-Grained Unit	302	1,180
																			900	1,201	Schedule 80 PVC blank (880 - 900)	5.56	4.81					Lower Basin Fill Unit	375	1,107
																												Bedrock Exclusion Zone	415	1,067
																												Bedrock Oxide Unit	---	---
R-05	55-227704	1/20/2018	2/5/2018	2/26/2018	Class III Recovery	D (4-9) 28 CAC	745990.04	847694.30	---	1,480.41	1,223	1,202	0	493	493	509	509	646	521	641	Fiberglass Reinforced Plastic (0 - 521)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	279	1,201
															646	656	656	883	661	881	Schedule 80 PVC blank (641 - 661)	5.56	4.81					Middle Fine-Grained Unit	302	1,178
															883	895	895	1,223	901	1,202	Schedule 80 PVC blank (881 - 901)	5.56	4.81					Lower Basin Fill Unit	380	1,100
																												Bedrock Exclusion Zone	420	1,060
																												Bedrock Oxide Unit	---	---
R-06	55-227705	11/24/2017	3/29/2018	5/12/2018	Class III Recovery	D (4-9) 28 CBD	746060.76	847623.95	---	1,481.52	1,210	1,200	0	500	500	514	514	648	519	640	Fiberglass Reinforced Plastic (0 - 519)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	280	1,202
															648	658	658	886	660	879	Schedule 80 PVC blank (640 - 660)	5.56	4.81					Middle Fine-Grained Unit	301	1,181
															886	896	896	1,210	900	1,200	Schedule 80 PVC blank (879 - 900)	5.56	4.81					Lower Basin Fill Unit	380	1,102
																												Bedrock Exclusion Zone	420	1,062
																												Bedrock Oxide Unit	---	---
R-07	55-227706	12/27/2017	1/9/2018	1/26/2018	Class III Recovery	D (4-9) 28 CBD	746131.57	847552.95	---	1,480.51	1,244	1,204	0	505	505	518	518	648	523	643	Fiberglass Reinforced Plastic (0 - 523)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	281	1,200
															648	659	659	889	663	884	Schedule 80 PVC blank (643 - 663)	5.56	4.81					Middle Fine-Grained Unit	301	1,180
															889	896	896	1,244	904	1,204	Schedule 80 PVC blank (884 - 904)	5.56	4.81					Lower Basin Fill Unit	370	1,111
																												Bedrock Exclusion Zone	410	1,071
																												Bedrock Oxide Unit	---	---
R-08	55-227707	1/3/2018	1/18/2018	3/31/2018	Class III Recovery	D (4-9) 28 CBD	746202.32	847623.59	---	1,480.51	1,225	1,205	0	497	497	510	510	648	524	644	Fiberglass Reinforced Plastic (0 - 524)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	283	1,198
															648	658	658	886	665	885	Schedule 80 PVC blank (644 - 665)	5.56	4.81					Middle Fine-Grained Unit	302	1,179
															886	896	896	1,225	905	1,205	Schedule 80 PVC blank (885 - 905)	5.56	4.81					Lower Basin Fill Unit	365	1,116
																												Bedrock Exclusion Zone	405	1,076
																												Bedrock Oxide Unit	---	---
R-09	55-227708	3/1/2018	3/12/2018	4/23/2018	Class III Recovery	D (4-9) 28 CAC	746132.08	847694.65	---	1,481.37	1,236	1,205	0	501	501	509	509	662	520	658	Fiberglass Reinforced Plastic (0 - 520)	8.46	7.74	Schedule 80 PVC	0.080	8.63	7.63	Upper Basin Fill	283	1,198
															662	671	671	895	676	892	Stainless steel (658 - 676)	8.63	7.99					Middle Fine-Grained Unit	301	1,180
															895	906	906	1,236	911	1,205	Stainless steel (892 - 911)	8.63	7.99					Lower Basin Fill Unit	378	1,103
																												Bedrock Exclusion Zone	418	1,063
																												Bedrock Oxide Unit	---	---
INJECTION WELLS																															
I-01	55-227963	2/13/2018	3/16/2018	4/11/2018	Class III Injection	D (4-9) 28 CAC	746202.46	847694.70	---	1,482.67	1,235	1,201	0	490	490	510	510	646	521	642	Fiberglass Reinforced Plastic (0 - 521)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	283	1,200
															646	656	656	887	661	881	Stainless steel (642 - 661)	5.56	5.47					Middle Fine-Grained Unit	300	1,183
															887	897	897	1,235	901	1,201	Stainless steel (881 - 901)	5.56	5.47					Lower Basin Fill Unit	378	1,105
																												Bedrock Exclusion Zone	418	1,065
																												Bedrock Oxide Unit	---	---
I-02	55-227964	11/12/2017	2/19/2018	3/16/2018	Class III Injection	D (4-9) 28 CAC	746131.73	847765.01	---	1,482.61	1,219	1,201	0	490	490	506	506	645	520	641	Fiberglass Reinforced Plastic (0 - 520)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	280	1,203
															645	656	656	886	660	881	Stainless steel (641 - 660)	5.56	5.47					Middle Fine-Grained Unit	300	1,183
															886	896	896	1,219	900	1,201	Stainless steel (881 - 900)	5.56	5.47					Lower Basin Fill Unit	380	1,103
																												Bedrock Exclusion Zone	420	1,063
																												Bedrock Oxide Unit	---	---
I-03	55-227965	2/28/2018	3/11/2018	5/1/2018	Class III Injection	D (4-9) 28 CAC	746061.32	847694.57	---	1,480.71	1,225	1,200	0	490	490	509	509	645	521	641	Fiberglass Reinforced Plastic (0 - 521)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	281	1,200
															645	655	655	883	660	880	Stainless steel (641 - 660)	5.56	5.47					Middle Fine-Grained Unit	302	1,179
															883	895	895	1,225	900	1,200	Stainless steel (880 - 900)	5.56	5.47					Lower Basin Fill Unit	385	1,096
																												Bedrock Exclusion Zone	425	1,056
																												Bedrock Oxide Unit	---	---
I-04	55-227966	3/15/2018	3/30/2018	4/19/2018	Class III Injection	D (4-9) 28 CBD	746131.37	847623.89	---	1,482.16	1,225	1,199	0	488	488	505	505	646	520	640	Fiberglass Reinforced Plastic (0 - 520)	5.47	4.74	Schedule 80 PVC	0.080	5.56	4.81	Upper Basin Fill	280	1,202
															646	654	654	882	659	879	Stainless steel (640 - 659)	5.56	5.47					Middle Fine-Grained Unit	300	1,182
															882	894	894	1,225	899	1,199	Stainless steel (879 - 899)	5.56	5.47					Lower Basin Fill Unit	365	1,117
																												Bedrock Exclusion Zone	405	1,077
																												Bedrock Oxide Unit	---	---
WESTBAY WELLS																															
WB-01	55-227226	3/19/2018	3/31/2018	4/10/2018	Class III Multi-Level Sampling	D (4-9) 28 CAC	746167.50	847695.07	---	1,479.34	1,203	1,174	0	474	474	498	498	589	562	572	Fiberglass Reinforced Plastic (0 - 497)	4.5	3.75	Schedule 80 PVC	0.020	4.5	3.83	Upper Basin Fill	282	1,197
															589	663	663	727	702	712	Schedule 80 PVC blank (497-562, 572-702, 712-843, 853-983, 993-1123 1133-1174)	4.5	3.83					Middle Fine-Grained Unit	302	1,177
															727	827	827	858	843	853								Lower Basin Fill Unit	377	1,102
															858	968	968	1,005	983	993								Bedrock Exclusion Zone	417	1,062
															1,005	1,104	1,104	1,203	1,123	1,133								Bedrock Oxide Unit	---	---
WB-02	55-227227	3/17/2018	4/11/2018	4/18/2018	Class III Multi-Level Sampling	D (4-9) 28 CAC	746131.33	847730.23	---	1,478.75	1,204	1,175	0	484	484	500	500	584	563	574	Fiberglass Reinforced Plastic (0 - 498)	4.5	3.75	Schedule 80 PVC	0.020	4.5	3.83	Upper Basin Fill	283	1,196
															584	683	683	710	704	714	Schedule 80 PVC blank (498-563, 574-704, 714-844, 854-984, 994-1124 1134-1175)	4.5	3.83					Middle Fine-Grained Unit	300	1,179
															710	824	824	857	844	854								Lower Basin Fill Unit	385	1,094
															857	968	968	1,005	984	994								Bedrock Exclusion Zone	425	1,054
															1,005	1,114	1,114	1,204	1,124	1,134								Bedrock Oxide Unit	---	---
WB-03	55-227228	2/7/2018	2/24/2018	3/30/2018	Class III Multi-Level Sampling	D (4-9) 28 CAC	746096.50	847694.08	---	1,478.99	1,220	1,174	0	489	489	501	501	582	563	573	Fiberglass Reinforced Plastic (0 - 498)	4.5	3.75	Schedule 80 PVC	0.020	4.5	3.83	Upper Basin Fill	280	1,199
															582	665	665	721	703	713	Schedule 80 PVC blank (498-563, 573-703, 713-843, 853-984, 994-1124 1134-1174)	4.5	3.83					Middle Fine-Grained Unit	300	1,179
															721	823	823	864	843	853								Lower Basin Fill Unit	385	1,094
															864	953	953	1,010	984	994								Bedrock Exclusion Zone	425	1,054
															1,010	1,088	1,088	1,220	1,124	1,134								Bedrock Oxide Unit	---	---
WB-04	55-227229	2/5/2018	2/25/2018	4/5/2018	Class III Multi-Level Sampling	D (4-9) 28 CAC	746131.41	847659.81	---	1,479.79	1,219	1,175	0	486	486	498	498	594	564	574	Fiberglass Reinforced Plastic (0 - 498)	4.5	3.75	Schedule 80 PVC	0.020	4.5	3.83	Upper Basin Fill	280	1,200
															594	689	689	730	704	714	Schedule 80 PVC blank (498-564, 574-704, 714-844, 854-984, 995 - 1125, 1135-1175)	4.5	3.83					Middle Fine-Grained Unit	300	1,180
															730	829	829	869	844	854								Lower Basin Fill Unit	375	1,105
															869	967	967	1,010	984	995								Bedrock Exclusion Zone	415	1,065
															1,010	1,109	1,109	1,219	1,125	1,135								Bedrock Oxide Unit	---	---

NOTES:

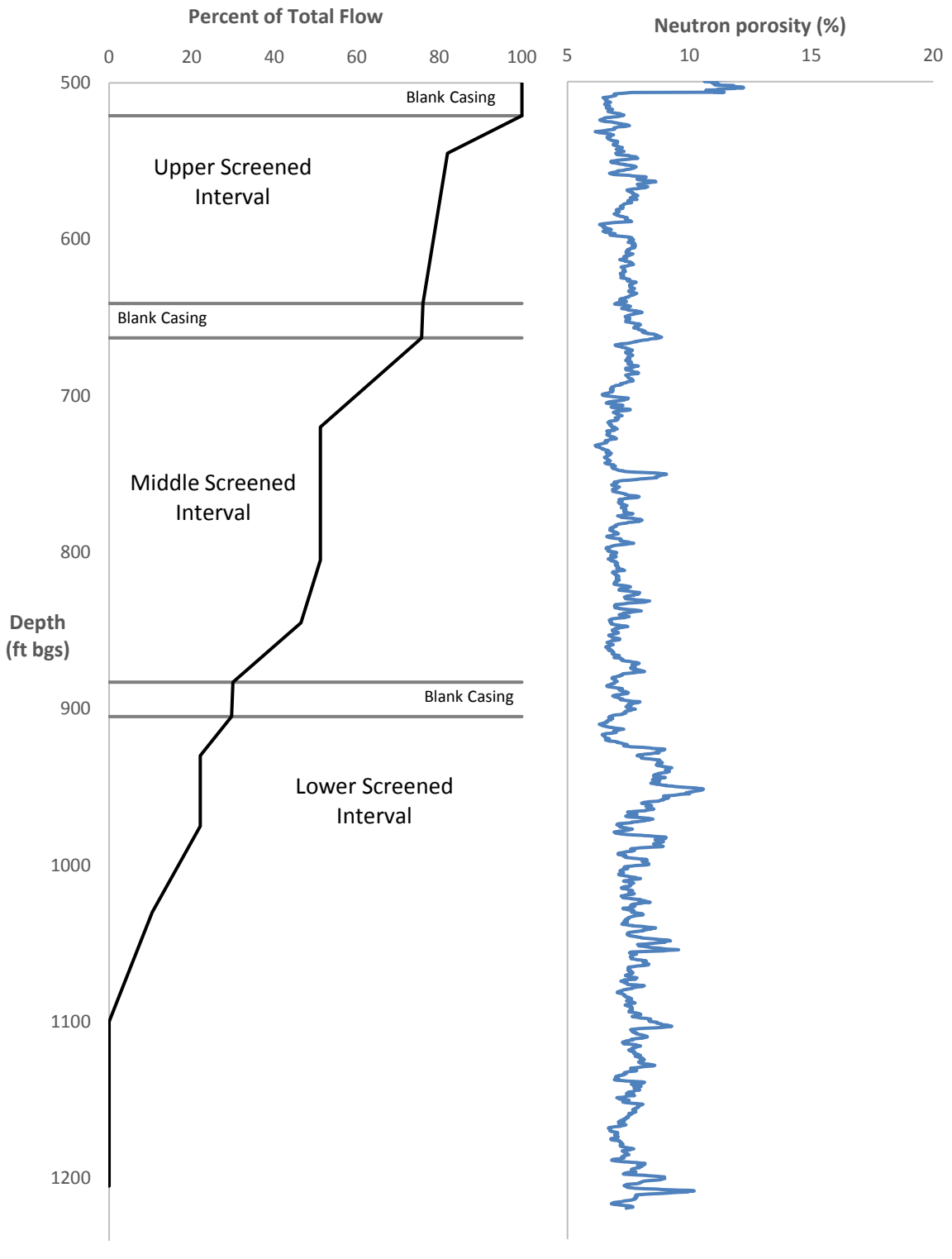
1. Information taken from the pipe tally, annular materials and well development field forms; the automated casing layout; and the drill tracking spreadsheet for each well.
ft. amsl = feet above mean sea level
ft. bgs = feet below ground surface
in. = inches
NAD83 = North American Datum 1983
NAVD88 = North American Vertical Datum of 1988
POC = Point of Compliance Well
PVC = polyvinyl chloride

TABLE 4
WATER LEVEL ELEVATIONS DOWNGRADIENT
OF THE PTF WELLFIELD
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Well ID	Well Type	Location	Distance from Wellfield (feet)	Water Level Elevation 8/30/2018 (feet amsl)	Calculated Gradient between MW and Wellfield (feet/foot)
O-07	PTF Observation	Downgradient edge of wellfield	0	1235.98	NA
O-06	PTF Observation	Downgradient edge of wellfield	0	1235.57	NA
MW-01-O	Operational Monitoring	Downgradient of wellfield	145	1236.20	0.004
M54-O	Point-of-Compliance Well	Downgradient of wellfield at PMA boundary	500	1238.27	0.005

Notes:
amsl - above mean sea level
NA - not applicable
PTF - Production Test Facility

FIGURES



NOTES

bgs = below ground surface

HALEY ALDRICH

FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

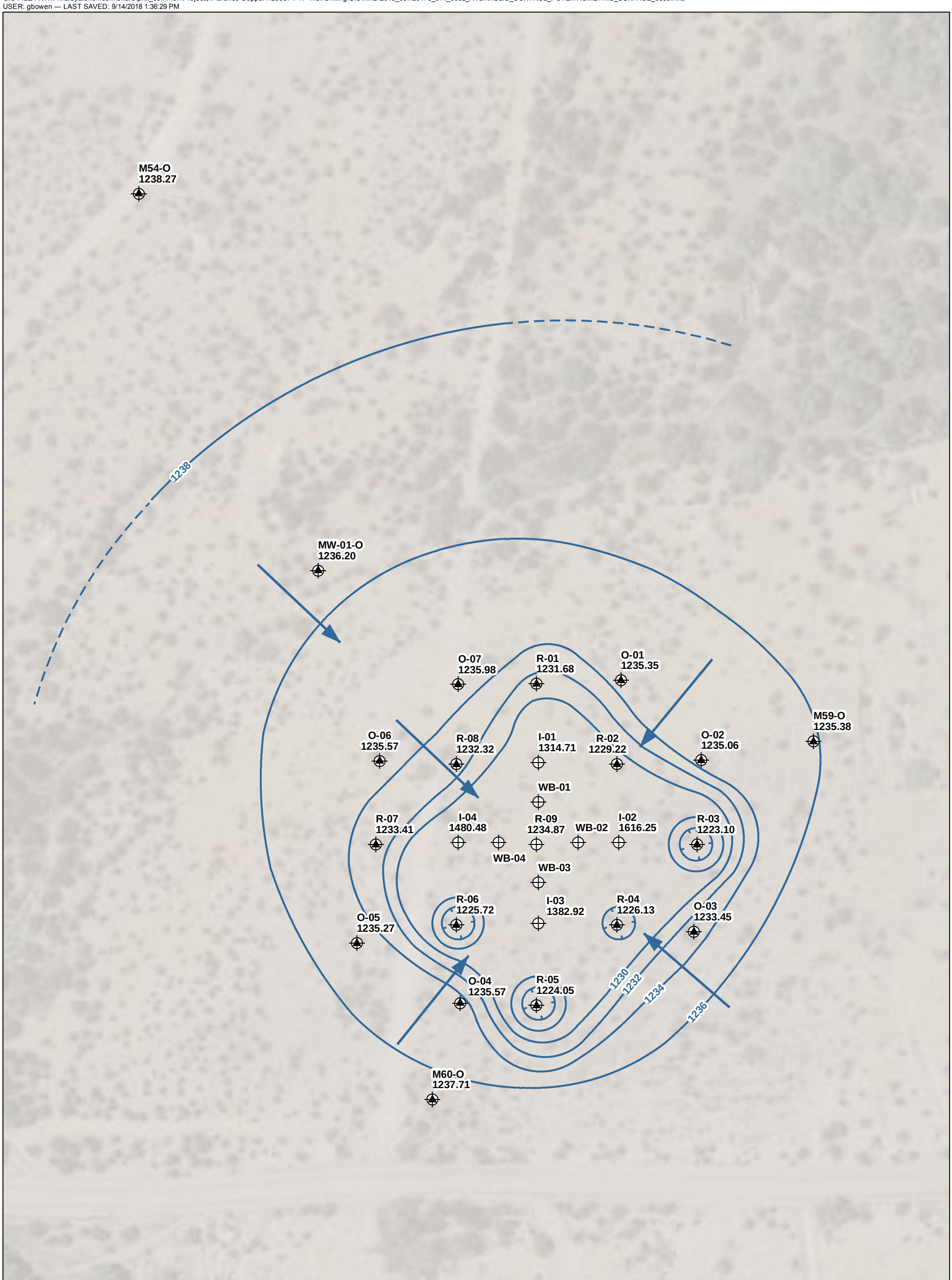
R-01 SPINNER FLOW AND POROSITY PROFILES

SEPTEMBER 2018

FIGURE 1

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Pre-Operational Report\[Figure 1_R-01_Spinner Flow Porosity Profiling.xlsx]Figure

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\GIS\MXD\2018_09\129473_011_0002_HYDRAULIC_CONTROL_POTENTIOMETRIC_SURFACE_0830.mxd
USER: gbowen — LAST SAVED: 9/14/2018 1:36:29 PM



LEGEND

- WELL USED FOR CONTOURING
- WELL NOT USED FOR CONTOURING
- POTENTIOMETRIC SURFACE CONTOUR, 2-FT INTERVAL (DASHED WHERE INFERRED)
- POTENTIOMETRIC SURFACE FLOW DIRECTION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. RECOVERY WELLLS ARE PUMPING.
3. INJECTION WELLS ARE INJECTING CLEAN WATER.
4. AERIAL IMAGERY SOURCE: ESRI

N

0 80 160
SCALE IN FEET

HALEY ALDRICH

FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

HYDRAULIC CONTROL
POTENTIOMETRIC SURFACE MAP
30 AUGUST 2018

FLORENCE COPPER INC.

SEPTEMBER 2018

FIGURE 2

EXHIBIT B-7

Excerpt from Brown and Caldwell 1996B Report

- **Volume II of V Site Characterization Report, Magma Florence In-Situ Project**

Excerpt From:

Brown and Caldwell, 1996b. Volume II of V Site Characterization Report, Magma Florence In-Situ Project

2.3.6 Hydraulic Corehole Testing

Hydraulic fracturing and slug tests were conducted in selected coreholes at the in-situ mine area to obtain fracture gradient values of the oxide bedrock zone. A summary of the corehole testing program is included in Table 2.3-7. These tests were conducted to establish wellhead injection pressure criteria as a requirement of the Underground Injection Control (UIC) program and for future development of the ore body. The fracture gradient values obtained represent the pressure per foot of depth required to initiate a fracture in the host bedrock. A total of 5 coreholes were tested that were considered representative of the lithologic conditions found throughout the oxide zone. These inclm;led a 6-inch diameter corehole (MCC-533), and 4 HX (approximately 3-inch diameter) coreholes (MCC-537, MCC-540, MCC-541, and MCC-544). The location of these coreholes are shown on Sheet l .2-2[II]. Coreholes in the Florence -Project Area are discussed further in Section 4.1.2. Lithologic and geophysical logs compiled for the coreholes during this investigation, as well as analyses results, are on file at the Florence Project field office.

2.3.6.1 Field Procedures

After completion of coring activities, a geophysical logging survey was conducted by Welenco, Inc., Chandler, Arizona. The geophysical logs and the corehole log descriptions were used to select test intervals based on characteristics such as lithology, fracture intensity, rock competency, and hole roughness. Geophysical logs obtained for the coreholes included caliper, electric, gamma ray-neutron, sonic, and borehole televiewer (BHT) logs. The BHT tool is an acoustic scanner. The BHT log displays an oriented, 360-degree acoustic image of the corehole wall as if it were split vertically and laid flat. Features that can be identified include fractures, faults, vugs, and intrusions. Fractures dipping between vertical and horizontal appear as sinusoidal images.

After the geophysical surveys were completed, the drilling fluid remaining in the coreholes was displaced with clean water. A Failing 1500 workover rig was used to install a workstring of 2 7/8-inch diameter steel tubing into the corehole. Water was pumped down the tubing and up the annulus until the drilling fluid was displaced. Circulation was continued after reaching total depth until the returning water at the surface was as free of sediment as possible. Because of unstable hole conditions, coreholes MCC-533, MCC-537, and MCC-541 could not be developed to their total depth.

The test intervals selected for each corehole were isolated using a balanced piston (BP) straddle washtool operated by TAM International, Houston, Texas. The BP straddle washtool consisted of 2 inflatable rubber packers mechanically connected to form a single unit. The packer elements were approximately 2 1/2 feet in length and hydraulically actuated to produce a positive seal on the corehole wall. Perforated tubing was installed between the packers to straddle the selected depth interval and control fluid injection. A pressure transducer, rated to 2,000 psi, was installed to the top of the test interval to record hydraulic pressure and temperature. Two turbine flow meters, with ranges of 3 to 15 gpm and 5 to 50 gpm, were used to measure water injection rates.

2.3.6.2 Methods of Analysis

Fracture gradient values obtained for the oxide bedrock zone were determined from pressure buildup and step-rate injection tests. Prior to conducting either of these tests, slug tests were run on most of the test intervals for background hydraulic conductivity data. The results of all the tests are discussed in Section 4.0.

The pressure build-up test involved the raising of the fluid pressure in the sealed-off interval between the 2 packers by injecting water at a constant rate until the corehole wall rock was fractured. Then, as water continued to be injected into the zone, the pressure stabilized, at which time the fracture continued to be extended. When injection was stopped, the pressure quickly stabilized to the instantaneous shut-in pressure (ISIP); the pressure reached when the induced fracture closes. The fracturing (breakdown) pressure of the formation is represented by the peak of the pressure-time curve. The fracture gradient was determined by the ratio of the breakdown pressure (the applied hydraulic pressure plus the pressure exerted by the water column) and the depth interval given in pounds per square inch per foot (psi/ft). Pressure buildup tests were run on 4 zones in corehole MCC-533 within the quartz monzonite porphyry of the oxide bedrock zone. The fracture gradient values ranged from 0.71 psi/ft to 0.82 psi/ft.

Step-rate injection testing consisted of injecting fluid in an isolated interval between the packers at a series of increasing rates, with each rate lasting approximately the same length of time. The bottom hole injection pressure at the end of each rate versus the injection rate was plotted. The plot consisted of 2 straight-line segments with different slopes, with the point where the 2 lines intersect indicating formation fracture pressure. The fracture gradient was determined by dividing the fracture pressure by the depth. A total of 12 step-rate injection tests were conducted in coreholes MCC-537, MCC-540, MCC-541, and MCC-544. The fracture gradient values for the step-rate injection tests ranged from 0.71 psi/ft. to 1.19 psi/ft.

Slug tests were conducted prior to performance of the fracture gradient tests in the coreholes to establish background hydraulic conductivity values for the oxide bedrock zone. These tests were also used as a guideline in establishing injection rates at the beginning of the fracture tests. The slug test method consisted of quickly adding a known volume of water to the formation, and monitoring the rate of water level decline as indicated by change in hydrostatic head. The tests were analyzed using the Hvorslev method (1951) as presented in Fetter (1994). The slug test results are discussed in Section 4.0.

The Hvorslev method consists of computing the ratio of the water levels during the test and plotting that versus time on semi-logarithmic paper. The time fall-off plot will yield a straight

line. Because the length of the test interval was significantly greater than the radius of the corehole (L/R>8), the following formula presented by Hvorslev was applied.

$$K = \frac{r^2 \ 1n \ (L/R)}{2LT_0}$$

where:

K = hydraulic conductivity (ft/day);
r = radius of tubing (ft);
R = radius of corehole (ft);
L = length of test interval (ft); and
T_0 = time for the water level to fall 37 percent of the initial value (day).

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program					
Well/Corehole ID[a]	**Miscellaneous Well Information**	**Oxide Fracture Class[b]**	**Aquifer Characteristics of[c]**	**Oxide Structure Test**	**Hydrogeologic Unit Connection Between[d]**
Aquifer Test Wells					
O3-GL	NA	B	LBFU, O	NA	NA
Note[e]	NA				
P8.1-O	NA	C	UBFU, O	NA	UBFU/LBFU LBFU/O
P8.2-O	NA				
O8-O	NA				
P8-GU	NA				
O8-GU	NA				
P12-O	NA	F	LBFU, O	NA	LBFU/O
O12-O	NA				
O12-GL	NA				
P13.1-O	Fault Zone	A	LBFU, O	Yes	LBFU/O
P13.2-O	Fault Zone				
O13-O	Fault Zone				
P13-GL	NA				
P15-O	Hanging Wall	H	LBFU, O	Yes	LBFU/O
O15-O	Foot Wall				
P15-GL	NA				
P19.1-O	Hanging Wall	E	LBFU, O	Yes	LBFU/O
P19.2-O	Hanging Wall				
O19-O	Hanging Wall				
O19-GL	NA				

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program					
Well/Corehole ID[a]	**Miscellaneous Well Information**	**Oxide Fracture Class[b]**	**Aquifer Characteristics of[c]**	**Oxide Structure Test**	**Hydrogeologic Unit Connection Between[d]**
P28.1-O	Hanging Wall				
P28.2-O	Fault Zone				
O28.1-O	Fault Zone	G	LBFU, O	Yes	LBFU/O
O28.2-O	Foot Wall				
P28-GL	NA				
O28-GL	NA				
P39-O	Fault Zone	D	O	Yes	NA
O39-O	Fault Zone				
P49-O	Hanging Wall	NA	LBFU, O	Yes	LBFU/O
O49-O	Hanging Wall				
O49-GL	NA				
Monitor Wells					
M2-GU	NA	NA	UBFU, LBFU O,S	NA	UBFU/LBFU LBFU/O O/S
M3-GL	NA				
M4-O	NA				
M5-S	NA				
M18-GU	NA	NA	UBFU, LBFU	NA	UBFU/LBFU
M1-GL	NA				
M14-GL	NA	NA	LBFU	NA	NA
M15-GU	NA				

Table 2.3-7 Summary of Current Aquifer and Corehole Hydraulic Conductivity Testing Program					
Well/Corehole ID[a]	**Miscellaneous Well Information**	**Oxide Fracture Class[b]**	**Aquifer Characteristics of[c]**	**Oxide Structure Test**	**Hydrogeologic Unit Connection Between[d]**
Irrigation Wells					
BIA-9	Note[f]	H	NA	NA	NA
WW-3	Note[f]	F/H	NA	NA	NA
Coreholes					
MCC-533	Oxide	F	O	NA	NA
MCC-537	Oxide	F	O	NA	NA
MCC-540	Oxide	F	O	NA	NA
MCC-541	Oxide	F	O	NA	NA
MCC-544	Oxide, Sulfide	A	O, S	NA	NA

[a]See Table 2.3-3 for well completion data, and Sheet 1.2-2 and Figure 2.1-2 for locations.

[b]Oxide Fracture Class Descriptions:

A - Fracture Intensity Index 3 and 4 in various proportions.
B - Fracture Intensity Index 1, 2, 3, 4 similar proportions.
C - Fracture Intensity Index 2 near block centers and 3, 4, 5 on block edges.
D - Fracture Intensity Index 3, 4 greater than 70 percent 3.
E - Fracture Intensity Index 3 and 4 on west 3/4 of blocks and 2 on east 1/4.
F - Fracture Intensity Index 4 primarily.
G - Fracture Intensity Index 2, 3, 4 various proportions on east side of in-situ mine area.
H - Fracture Intensity Index 2, 3, 4 various proportions on west side of in-situ mine area.

Fracture Intensity Index Descriptions

1 - 0 to 5 fractures per foot; 2 - 6 to 10 fractures per foot; 3 - 11 to 15 fractures per foot; 4 - More than 15 fractures per foot; 5 - Intensely fractured, brecciated, fault zone.

[c]Includes, where applicable: specific capacity (SC), transmissivity (T), hydraulic conductivity (K), and leakage factor (LF) for the following hydrogeologic units:

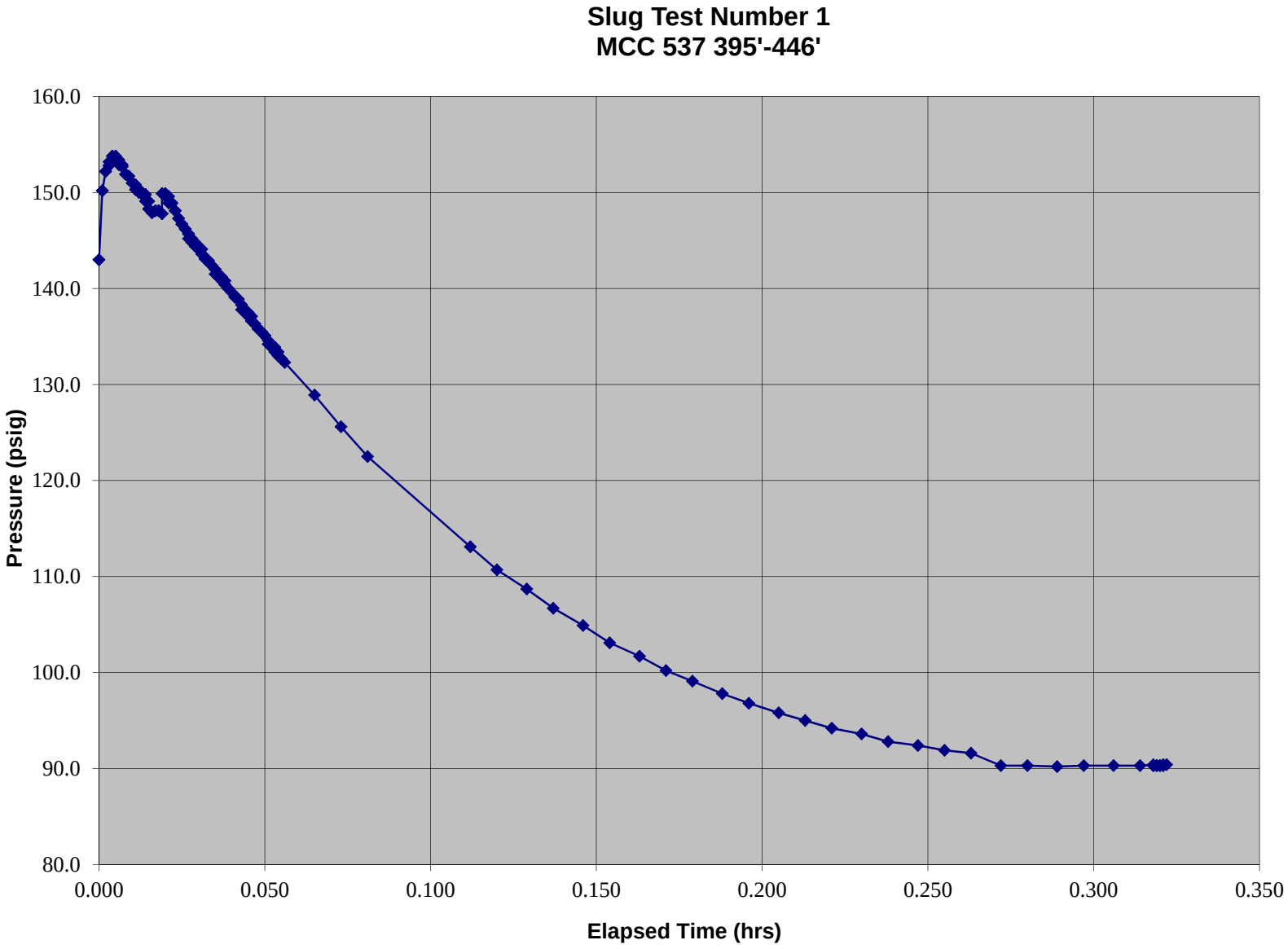
UBFU - Upper Basin-Fill Unit; LBFU - Lower Basin-Fill Unit; O - Oxide Bedrock Zone; S - Sulfide Bedrock Zone

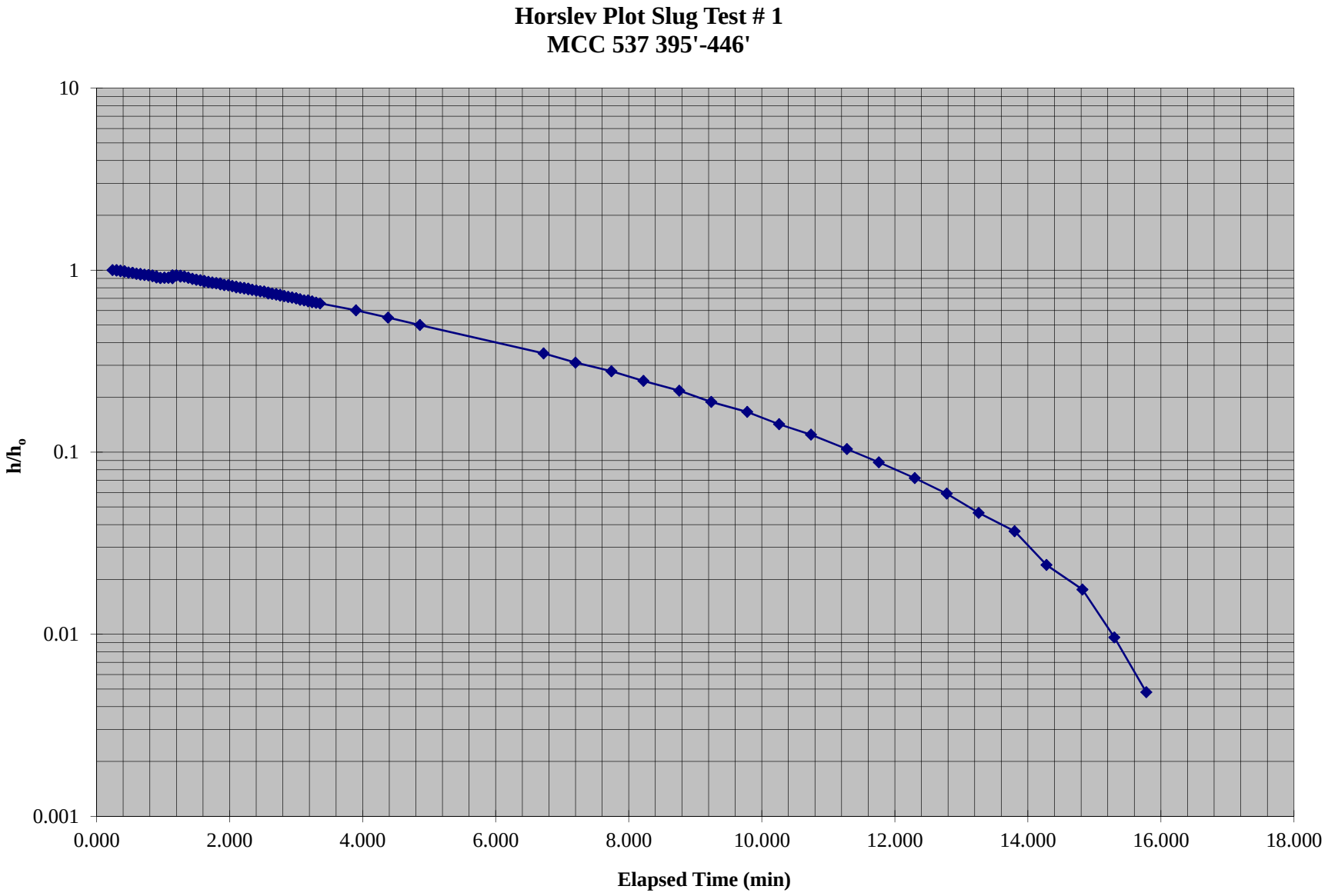
[d]Test evaluates degree of connection across the following hydrogeologic units (see note C, for unit definitions): UBFU/LBFU, LBFU/O, O/S

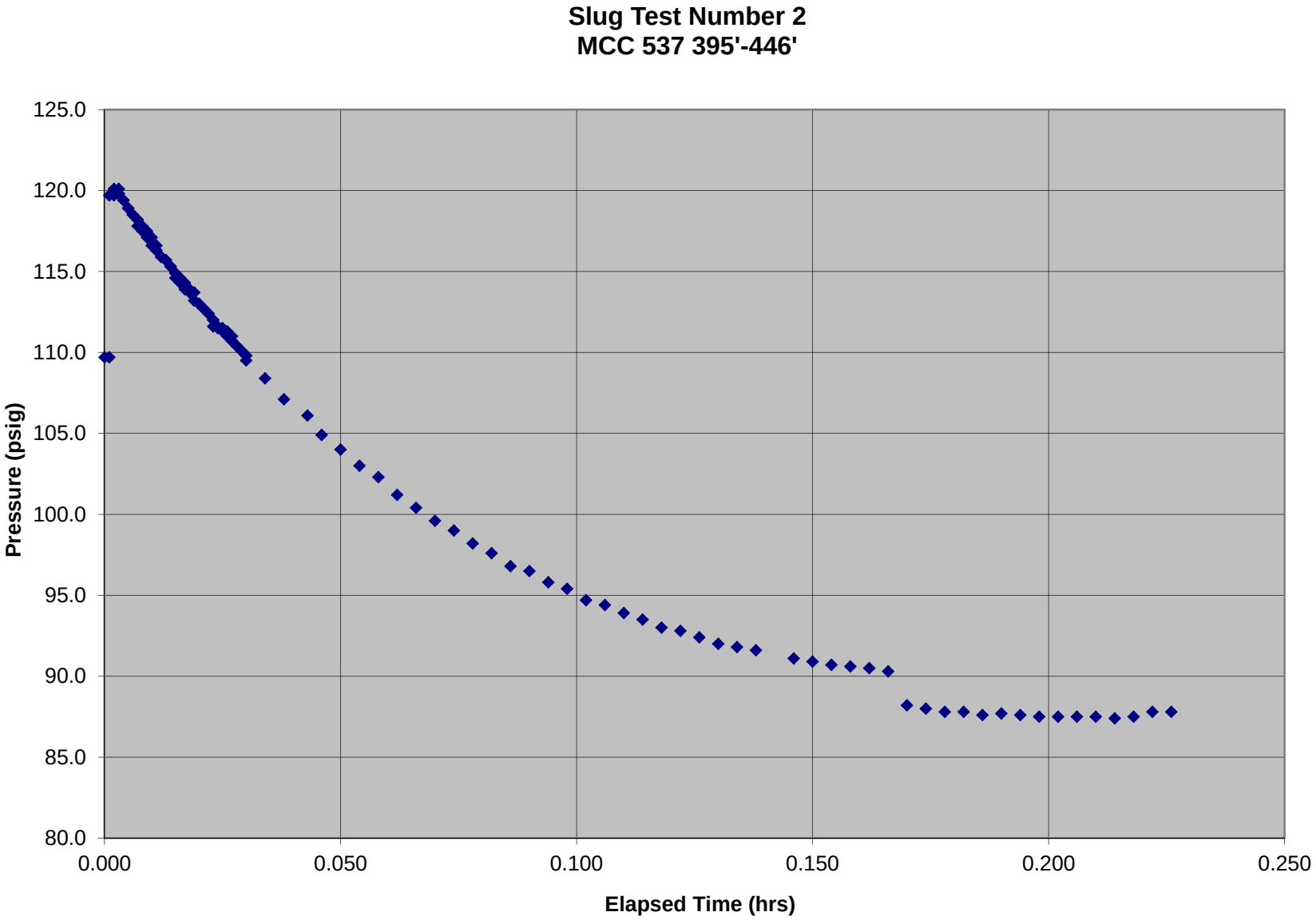
[e]Test 3 design incorporates existing wells PW7-1, OB7-1, and OB-1.

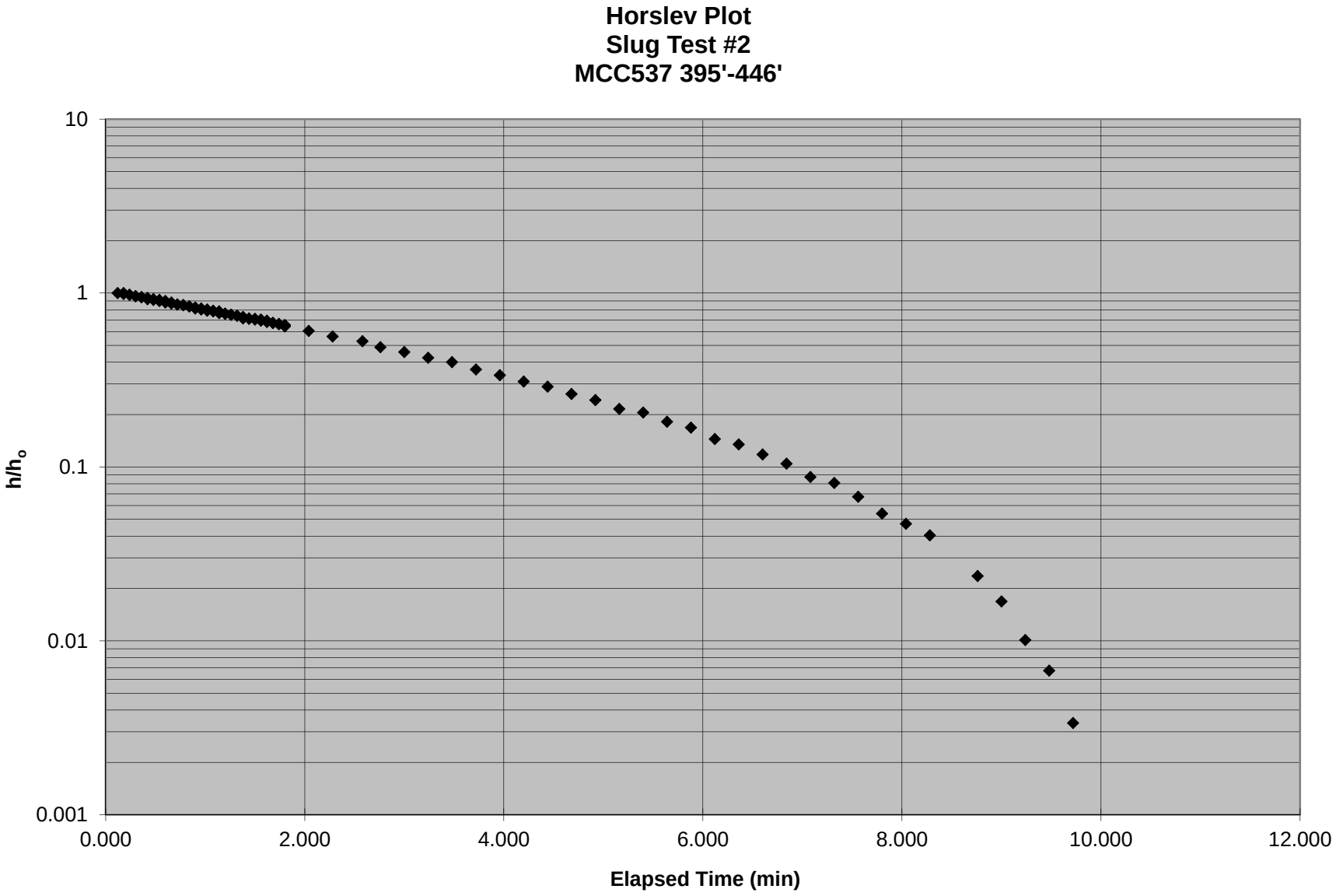
[f]Large scale aquifer tests (BIA-9, WW-3, and BIA-10B) incorporate approximately 20 observation wells.

ID = Identification NA = Not Applicable Yes = Information is planned to be acquired for listed test


Slug Test Number 1
MCC 537 395'-446'
Pressure (psig)
160.0
150.0
140.0
130.0
120.0
110.0
100.0
90.0
80.0
0.000
0.050
0.100
0.150
0.200
0.250
0.300
0.350
Elapsed Time (hrs)


Horslev Plot Slug Test # 1
MCC 537 395'-446'
10
1
0.1
0.01
0.001
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
16.000
18.000
Elapsed Time (min)


Slug Test Number 2
MCC 537 395'-446'
125.0
120.0
115.0
110.0
105.0
100.0
95.0
90.0
85.0
80.0
Pressure (psig)
0.000
0.050
0.100
0.150
0.200
0.250
Elapsed Time (hrs)


Horslev Plot
Slug Test #2
MCC537 395'-446'
10
1
0.1
0.01
0.001
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Elapsed Time (min)

Slug Test 2 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
Static Pressure					
18.882	-	-	-	90.4	-
18.882	0.000	0.000	0.00E+00	109.7	0.649832
18.883	0.001	0.060	4.17E-05	109.7	0.649832
18.883	0.001	0.060	4.17E-05	119.7	0.986532
18.884	0.002	0.120	8.33E-05	119.7	0.986532
18.884	0.002	0.120	8.33E-05	120.1	1
18.885	0.003	0.180	1.25E-04	120.1	1
18.885	0.003	0.180	1.25E-04	119.8	0.989899
18.885	0.003	0.180	1.25E-04	119.8	0.989899
18.886	0.004	0.240	1.67E-04	119.4	0.976431
18.886	0.004	0.240	1.67E-04	119.4	0.976431
18.887	0.005	0.300	2.08E-04	118.9	0.959596
18.887	0.005	0.300	2.08E-04	118.9	0.959596
18.888	0.006	0.360	2.50E-04	118.5	0.946128
18.888	0.006	0.360	2.50E-04	118.5	0.946128
18.889	0.007	0.420	2.92E-04	118.2	0.936027
18.889	0.007	0.420	2.92E-04	118.2	0.936027
18.889	0.007	0.420	2.92E-04	117.8	0.922559
18.890	0.008	0.480	3.33E-04	117.8	0.922559
18.890	0.008	0.480	3.33E-04	117.5	0.912458
18.891	0.009	0.540	3.75E-04	117.5	0.912458
18.891	0.009	0.540	3.75E-04	117.1	0.89899
18.892	0.010	0.600	4.17E-04	117.1	0.89899
18.892	0.010	0.600	4.17E-04	116.6	0.882155
18.893	0.011	0.660	4.58E-04	116.6	0.882155
18.893	0.011	0.660	4.58E-04	116.3	0.872054
18.893	0.011	0.660	4.58E-04	116.3	0.872054
18.894	0.012	0.720	5.00E-04	115.9	0.858586
18.894	0.012	0.720	5.00E-04	115.9	0.858586
18.895	0.013	0.780	5.42E-04	115.7	0.851852
18.895	0.013	0.780	5.42E-04	115.7	0.851852
18.896	0.014	0.840	5.83E-04	115.3	0.838384
18.896	0.014	0.840	5.83E-04	115.3	0.838384
18.897	0.015	0.900	6.25E-04	114.9	0.824916
18.897	0.015	0.900	6.25E-04	114.9	0.824916
18.897	0.015	0.900	6.25E-04	114.6	0.814815
18.898	0.016	0.960	6.67E-04	114.6	0.814815
18.898	0.016	0.960	6.67E-04	114.3	0.804714
18.899	0.017	1.020	7.08E-04	114.3	0.804714
18.899	0.017	1.020	7.08E-04	113.9	0.791246
18.900	0.018	1.080	7.50E-04	113.9	0.791246
18.900	0.018	1.080	7.50E-04	113.7	0.784512
18.901	0.019	1.140	7.92E-04	113.7	0.784512
18.901	0.019	1.140	7.92E-04	113.2	0.767677
18.901	0.019	1.140	7.92E-04	113.2	0.767677
18.902	0.020	1.200	8.33E-04	113.0	0.760943

Slug Test 2 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.902	0.020	1.200	8.33E-04	113.0	0.760943
18.903	0.021	1.260	8.75E-04	112.7	0.750842
18.903	0.021	1.260	8.75E-04	112.7	0.750842
18.904	0.022	1.320	9.17E-04	112.4	0.740741
18.904	0.022	1.320	9.17E-04	112.4	0.740741
18.905	0.023	1.380	9.58E-04	112.0	0.727273
18.905	0.023	1.380	9.58E-04	112.0	0.727273
18.905	0.023	1.380	9.58E-04	111.6	0.713805
18.906	0.024	1.440	1.00E-03	111.6	0.713805
18.906	0.024	1.440	1.00E-03	111.5	0.710438
18.907	0.025	1.500	1.04E-03	111.5	0.710438
18.907	0.025	1.500	1.04E-03	111.3	0.703704
18.908	0.026	1.560	1.08E-03	111.3	0.703704
18.908	0.026	1.560	1.08E-03	111.0	0.693603
18.909	0.027	1.620	1.12E-03	111.0	0.693603
18.909	0.027	1.620	1.12E-03	110.7	0.683502
18.909	0.027	1.620	1.12E-03	110.7	0.683502
18.910	0.028	1.680	1.17E-03	110.4	0.673401
18.910	0.028	1.680	1.17E-03	110.4	0.673401
18.911	0.029	1.740	1.21E-03	110.1	0.6633
18.911	0.029	1.740	1.21E-03	110.1	0.6633
18.912	0.030	1.800	1.25E-03	109.8	0.653199
18.912	0.030	1.800	1.25E-03	109.8	0.653199
18.912	0.030	1.800	1.25E-03	109.5	0.643098
18.916	0.034	2.040	1.42E-03	108.4	0.606061
18.920	0.038	2.280	1.58E-03	107.1	0.56229
18.925	0.043	2.580	1.79E-03	106.1	0.52862
18.928	0.046	2.760	1.92E-03	104.9	0.488215
18.932	0.050	3.000	2.08E-03	104.0	0.457912
18.936	0.054	3.240	2.25E-03	103.0	0.424242
18.940	0.058	3.480	2.42E-03	102.3	0.400673
18.944	0.062	3.720	2.58E-03	101.2	0.363636
18.948	0.066	3.960	2.75E-03	100.4	0.3367
18.952	0.070	4.200	2.92E-03	99.6	0.309764
18.956	0.074	4.440	3.08E-03	99.0	0.289562
18.960	0.078	4.680	3.25E-03	98.2	0.262626
18.964	0.082	4.920	3.42E-03	97.6	0.242424
18.968	0.086	5.160	3.58E-03	96.8	0.215488
18.972	0.090	5.400	3.75E-03	96.5	0.205387
18.976	0.094	5.640	3.92E-03	95.8	0.181818
18.980	0.098	5.880	4.08E-03	95.4	0.16835
18.984	0.102	6.120	4.25E-03	94.7	0.144781
18.988	0.106	6.360	4.42E-03	94.4	0.13468
18.992	0.110	6.600	4.58E-03	93.9	0.117845
18.996	0.114	6.840	4.75E-03	93.5	0.104377
19.000	0.118	7.080	4.92E-03	93.0	0.087542
19.004	0.122	7.320	5.08E-03	92.8	0.080808
19.008	0.126	7.560	5.25E-03	92.4	0.06734

Slug Test 2 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
19.012	0.130	7.800	5.42E-03	92.0	0.053872
19.016	0.134	8.040	5.58E-03	91.8	0.047138
19.020	0.138	8.280	5.75E-03	91.6	0.040404
19.028	0.146	8.760	6.08E-03	91.1	0.023569
19.032	0.150	9.000	6.25E-03	90.9	0.016835
19.036	0.154	9.240	6.42E-03	90.7	0.010101
19.040	0.158	9.480	6.58E-03	90.6	0.006734
19.044	0.162	9.720	6.75E-03	90.5	0.003367
19.048	0.166	9.960	6.92E-03	90.3	-0.003367
19.052	0.170	10.200	7.08E-03	88.2	-0.074074
19.056	0.174	10.440	7.25E-03	88.0	-0.080808
19.060	0.178	10.680	7.42E-03	87.8	-0.087542
19.064	0.182	10.920	7.58E-03	87.8	-0.087542
19.068	0.186	11.160	7.75E-03	87.6	-0.094276
19.072	0.190	11.400	7.92E-03	87.7	-0.090909
19.076	0.194	11.640	8.08E-03	87.6	-0.094276
19.080	0.198	11.880	8.25E-03	87.5	-0.097643
19.084	0.202	12.120	8.42E-03	87.5	-0.097643
19.088	0.206	12.360	8.58E-03	87.5	-0.097643
19.092	0.210	12.600	8.75E-03	87.5	-0.097643
19.096	0.214	12.840	8.92E-03	87.4	-0.10101
19.100	0.218	13.080	9.08E-03	87.5	-0.097643
19.104	0.222	13.320	9.25E-03	87.8	-0.087542
19.108	0.226	13.560	9.42E-03	87.8	-0.087542

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
Static Pressure					
18.560				91.3	
18.560	0.000	0.000	0.00E+00	143.0	0.8272
18.560	0.000	0.000	0.00E+00	143.0	0.8272
18.561	0.001	0.060	4.17E-05	150.2	0.9424
18.561	0.001	0.060	4.17E-05	150.2	0.9424
18.562	0.002	0.120	8.33E-05	152.2	0.9744
18.562	0.002	0.120	8.33E-05	152.2	0.9744
18.563	0.003	0.180	1.25E-04	152.8	0.984
18.563	0.003	0.180	1.25E-04	152.8	0.984
18.563	0.003	0.180	1.25E-04	153.2	0.9904
18.564	0.004	0.240	1.67E-04	153.2	0.9904
18.564	0.004	0.240	1.67E-04	153.8	1
18.565	0.005	0.300	2.08E-04	153.8	1
18.565	0.005	0.300	2.08E-04	153.4	0.9936
18.566	0.006	0.360	2.50E-04	153.4	0.9936
18.566	0.006	0.360	2.50E-04	152.9	0.9856
18.567	0.007	0.420	2.92E-04	152.9	0.9856
18.567	0.007	0.420	2.92E-04	152.7	0.9824
18.567	0.007	0.420	2.92E-04	152.7	0.9824
18.568	0.008	0.480	3.33E-04	151.9	0.9696
18.568	0.008	0.480	3.33E-04	151.9	0.9696
18.569	0.009	0.540	3.75E-04	151.7	0.9664
18.569	0.009	0.540	3.75E-04	151.7	0.9664
18.570	0.010	0.600	4.17E-04	151.0	0.9552
18.570	0.010	0.600	4.17E-04	151.0	0.9552
18.571	0.011	0.660	4.58E-04	150.8	0.952
18.571	0.011	0.660	4.58E-04	150.8	0.952
18.571	0.011	0.660	4.58E-04	150.3	0.944
18.572	0.012	0.720	5.00E-04	150.3	0.944
18.572	0.012	0.720	5.00E-04	150.0	0.9392
18.573	0.013	0.780	5.42E-04	150.0	0.9392
18.573	0.013	0.780	5.42E-04	149.8	0.936
18.574	0.014	0.840	5.83E-04	149.8	0.936
18.574	0.014	0.840	5.83E-04	149.1	0.9248
18.575	0.015	0.900	6.25E-04	149.1	0.9248
18.575	0.015	0.900	6.25E-04	148.3	0.912
18.575	0.015	0.900	6.25E-04	148.3	0.912
18.576	0.016	0.960	6.67E-04	147.9	0.9056
18.576	0.016	0.960	6.67E-04	147.9	0.9056
18.577	0.017	1.020	7.08E-04	148.1	0.9088
18.577	0.017	1.020	7.08E-04	148.1	0.9088
18.578	0.018	1.080	7.50E-04	148.1	0.9088
18.578	0.018	1.080	7.50E-04	148.1	0.9088
18.579	0.019	1.140	7.92E-04	147.8	0.904
18.579	0.019	1.140	7.92E-04	147.8	0.904

Slug Test 1 Data

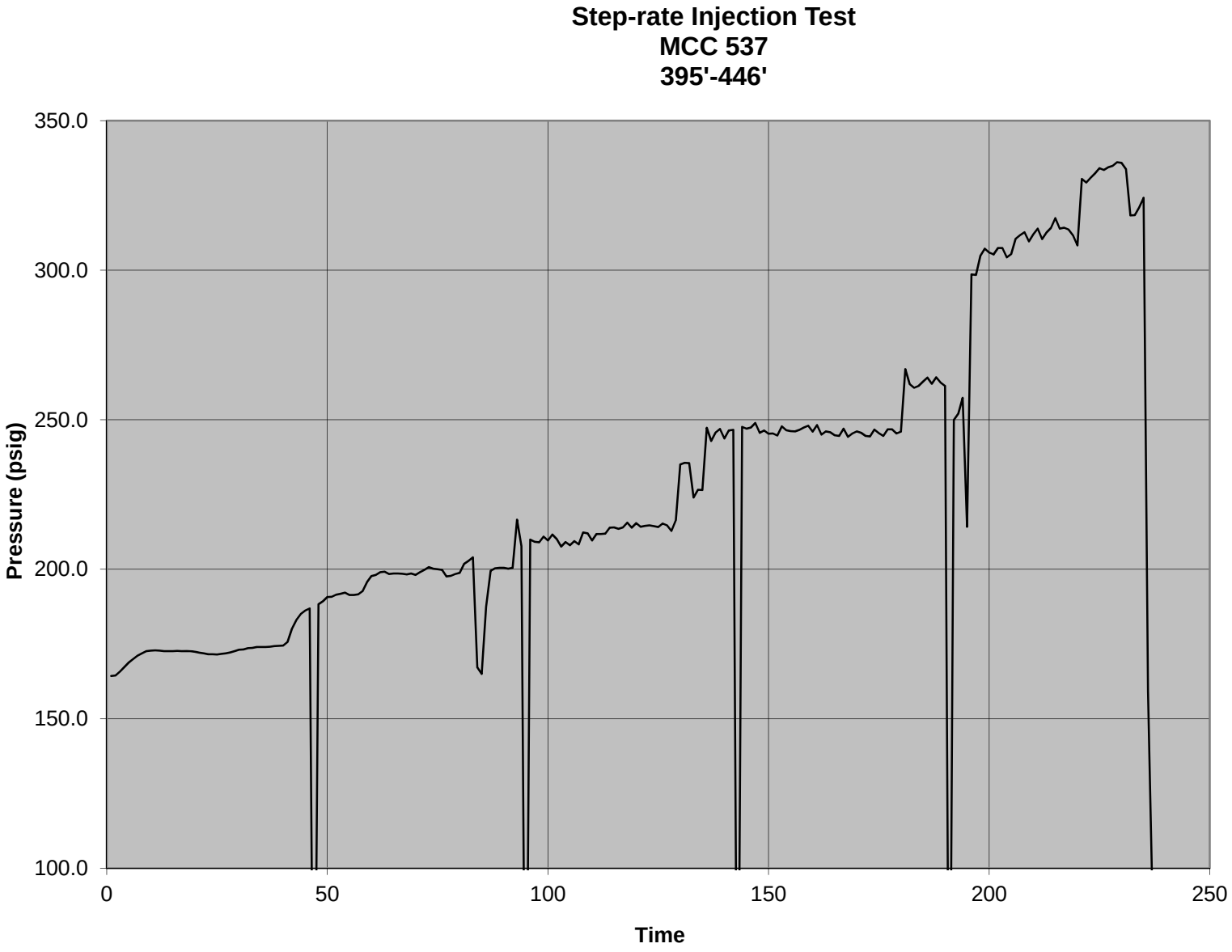
Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.579	0.019	1.140	7.92E-04	149.9	0.9376
18.580	0.020	1.200	8.33E-04	149.9	0.9376
18.580	0.020	1.200	8.33E-04	149.6	0.9328
18.581	0.021	1.260	8.75E-04	149.6	0.9328
18.581	0.021	1.260	8.75E-04	148.9	0.9216
18.582	0.022	1.320	9.17E-04	148.9	0.9216
18.582	0.022	1.320	9.17E-04	148.9	0.9216
18.583	0.023	1.380	9.58E-04	148.1	0.9088
18.583	0.023	1.380	9.58E-04	148.1	0.9088
18.584	0.024	1.440	1.00E-03	147.3	0.896
18.584	0.024	1.440	1.00E-03	147.3	0.896
18.585	0.025	1.500	1.04E-03	146.7	0.8864
18.585	0.025	1.500	1.04E-03	146.7	0.8864
18.586	0.026	1.560	1.08E-03	146.2	0.8784
18.586	0.026	1.560	1.08E-03	146.2	0.8784
18.587	0.027	1.620	1.13E-03	145.7	0.8704
18.587	0.027	1.620	1.13E-03	145.7	0.8704
18.587	0.027	1.620	1.13E-03	145.2	0.8624
18.588	0.028	1.680	1.17E-03	145.2	0.8624
18.588	0.028	1.680	1.17E-03	144.8	0.856
18.589	0.029	1.740	1.21E-03	144.8	0.856
18.589	0.029	1.740	1.21E-03	144.4	0.8496
18.590	0.030	1.800	1.25E-03	144.4	0.8496
18.590	0.030	1.800	1.25E-03	144.1	0.8448
18.591	0.031	1.860	1.29E-03	144.1	0.8448
18.591	0.031	1.860	1.29E-03	143.6	0.8368
18.591	0.031	1.860	1.29E-03	143.6	0.8368
18.592	0.032	1.920	1.33E-03	143.1	0.8288
18.592	0.032	1.920	1.33E-03	143.1	0.8288
18.593	0.033	1.980	1.38E-03	142.9	0.8256
18.593	0.033	1.980	1.38E-03	142.9	0.8256
18.594	0.034	2.040	1.42E-03	142.4	0.8176
18.594	0.034	2.040	1.42E-03	142.4	0.8176
18.595	0.035	2.100	1.46E-03	142.0	0.8112
18.595	0.035	2.100	1.46E-03	142.0	0.8112
18.595	0.035	2.100	1.46E-03	141.5	0.8032
18.596	0.036	2.160	1.50E-03	141.5	0.8032
18.596	0.036	2.160	1.50E-03	141.2	0.7984
18.597	0.037	2.220	1.54E-03	141.2	0.7984
18.597	0.037	2.220	1.54E-03	140.8	0.792
18.598	0.038	2.280	1.58E-03	140.8	0.792
18.598	0.038	2.280	1.58E-03	140.4	0.7856
18.598	0.038	2.280	1.58E-03	140.4	0.7856
18.599	0.039	2.340	1.63E-03	140.0	0.7792
18.599	0.039	2.340	1.63E-03	140.0	0.7792
18.600	0.040	2.400	1.67E-03	139.6	0.7728
18.600	0.040	2.400	1.67E-03	139.6	0.7728
18.601	0.041	2.460	1.71E-03	139.1	0.7648

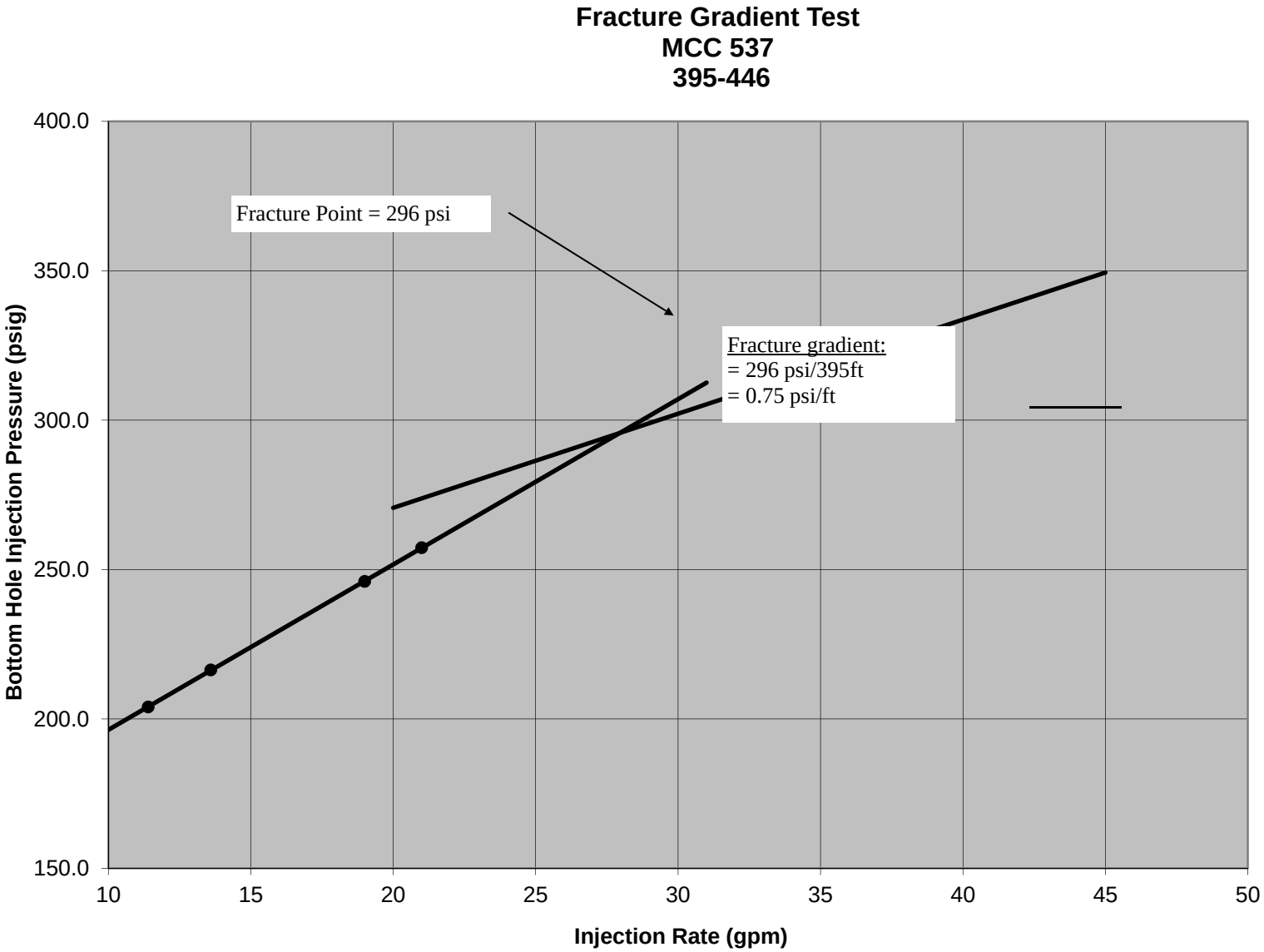
Slug Test 1 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.601	0.041	2.460	1.71E-03	139.1	0.7648
18.602	0.042	2.520	1.75E-03	138.9	0.7616
18.602	0.042	2.520	1.75E-03	138.9	0.7616
18.603	0.043	2.580	1.79E-03	138.3	0.752
18.603	0.043	2.580	1.79E-03	138.3	0.752
18.603	0.043	2.580	1.79E-03	137.8	0.744
18.604	0.044	2.640	1.83E-03	137.8	0.744
18.604	0.044	2.640	1.83E-03	137.5	0.7392
18.605	0.045	2.700	1.88E-03	137.5	0.7392
18.605	0.045	2.700	1.88E-03	137.1	0.7328
18.606	0.046	2.760	1.92E-03	137.1	0.7328
18.606	0.046	2.760	1.92E-03	136.6	0.7248
18.606	0.046	2.760	1.92E-03	136.6	0.7248
18.607	0.047	2.820	1.96E-03	136.3	0.72
18.607	0.047	2.820	1.96E-03	136.3	0.72
18.608	0.048	2.880	2.00E-03	135.8	0.712
18.608	0.048	2.880	2.00E-03	135.8	0.712
18.609	0.049	2.940	2.04E-03	135.5	0.7072
18.609	0.049	2.940	2.04E-03	135.5	0.7072
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.610	0.050	3.000	2.08E-03	135.1	0.7008
18.611	0.051	3.060	2.13E-03	134.6	0.6928
18.611	0.051	3.060	2.13E-03	134.2	0.6864
18.612	0.052	3.120	2.17E-03	133.9	0.6816
18.613	0.053	3.180	2.21E-03	133.9	0.6816
18.613	0.053	3.180	2.21E-03	133.4	0.6736
18.614	0.054	3.240	2.25E-03	133.4	0.6736
18.614	0.054	3.240	2.25E-03	133.0	0.6672
18.614	0.054	3.240	2.25E-03	133.0	0.6672
18.615	0.055	3.300	2.29E-03	132.7	0.6624
18.615	0.055	3.300	2.29E-03	132.7	0.6624
18.616	0.056	3.360	2.33E-03	132.3	0.656
18.625	0.065	3.900	2.71E-03	128.9	0.6016
18.633	0.073	4.380	3.04E-03	125.6	0.5488
18.641	0.081	4.860	3.37E-03	122.5	0.4992
18.672	0.112	6.720	4.67E-03	113.1	0.3488
18.680	0.120	7.200	5.00E-03	110.7	0.3104
18.689	0.129	7.740	5.38E-03	108.7	0.2784
18.697	0.137	8.220	5.71E-03	106.7	0.2464
18.706	0.146	8.760	6.08E-03	104.9	0.2176
18.714	0.154	9.240	6.42E-03	103.1	0.1888
18.723	0.163	9.780	6.79E-03	101.7	0.1664
18.731	0.171	10.260	7.13E-03	100.2	0.1424
18.739	0.179	10.740	7.46E-03	99.1	0.1248
18.748	0.188	11.280	7.83E-03	97.8	0.104
18.756	0.196	11.760	8.17E-03	96.8	0.088
18.765	0.205	12.300	8.54E-03	95.8	0.072

Slug Test 1 Data

Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (Days)	Pressure (psig)	h/h_o
18.773	0.213	12.780	8.88E-03	95.0	0.0592
18.781	0.221	13.260	9.21E-03	94.2	0.0464
18.790	0.230	13.800	9.58E-03	93.6	0.0368
18.798	0.238	14.280	9.92E-03	92.8	0.024
18.807	0.247	14.820	1.03E-02	92.4	0.0176
18.815	0.255	15.300	1.06E-02	91.9	0.0096
18.823	0.263	15.780	1.10E-02	91.6	0.0048
18.832	0.272	16.320	1.13E-02	90.3	-0.016
18.840	0.280	16.800	1.17E-02	90.3	-0.016
18.849	0.289	17.340	1.20E-02	90.2	-0.0176
18.857	0.297	17.820	1.24E-02	90.3	-0.016
18.866	0.306	18.360	1.28E-02	90.3	-0.016
18.874	0.314	18.840	1.31E-02	90.3	-0.016
18.878	0.318	19.080	1.33E-02	90.4	-0.0144
18.878	0.318	19.080	1.33E-02	90.3	-0.016
18.878	0.318	19.080	1.33E-02	90.3	-0.016
18.879	0.319	19.140	1.33E-02	90.3	-0.016
18.879	0.319	19.140	1.33E-02	90.3	-0.016
18.880	0.320	19.200	1.33E-02	90.3	-0.016
18.880	0.320	19.200	1.33E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.3	-0.016
18.881	0.321	19.260	1.34E-02	90.4	-0.0144
18.882	0.322	19.320	1.34E-02	90.4	-0.0144


Step-rate Injection Test
MCC 537
395'-446'
350.0
300.0
250.0
200.0
150.0
100.0
Pressure (psig)
0
50
100
150
200
250
Time


Fracture Gradient Test
MCC 537
395-446
Fracture Point = 296 psi
Fracture gradient:
= 296 psi/395ft
= 0.75 psi/ft
Bottom Hole Injection Pressure (psig)
400.0
350.0
300.0
250.0
200.0
150.0
10
15
20
25
30
35
40
45
50
Injection Rate (gpm)

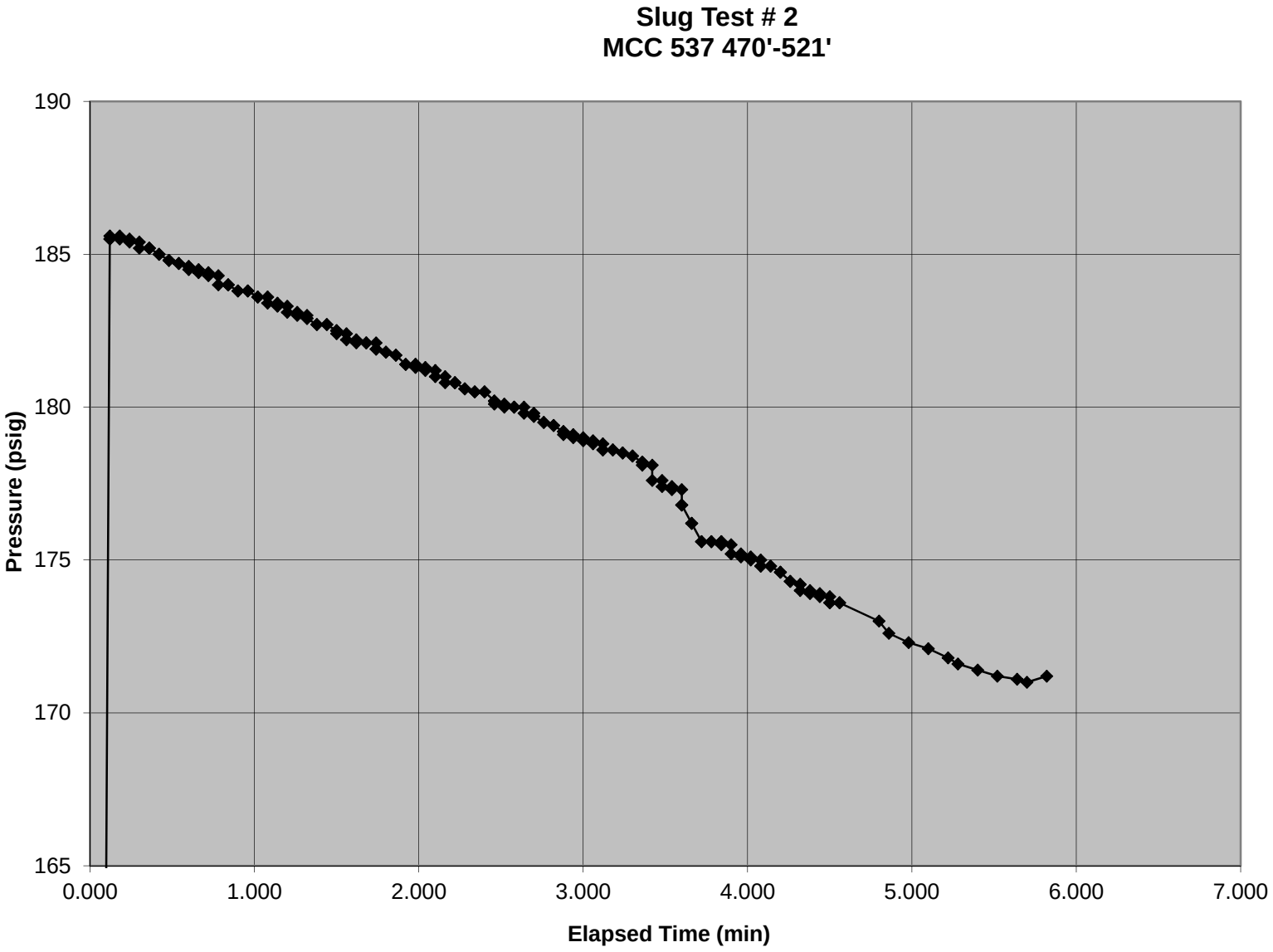
Step-rate Injection Test			
Time	Injection Rate (gpm)	Pressure (psig)	
19.502	11.4	164.3	
19.506	11.4	164.5	
19.510	11.4	165.8	
19.514	11.4	167.3	
19.518	11.4	168.8	
19.522	11.4	170.0	
19.526	11.4	171.1	
19.530	11.4	171.9	
19.534	11.4	172.6	
19.538	11.4	172.8	
19.542	11.4	172.9	
19.546	11.4	172.8	
19.554	11.4	172.6	
19.558	11.4	172.6	
19.563	11.4	172.6	
19.567	11.4	172.7	
19.571	11.4	172.6	
19.576	11.4	172.6	
19.580	11.4	172.6	
19.585	11.4	172.4	
19.589	11.4	172.1	
19.594	11.4	171.9	
19.598	11.4	171.6	
19.602	11.4	171.6	
19.607	11.4	171.5	
19.611	11.4	171.7	
19.616	11.4	171.9	
19.620	11.4	172.2	
19.625	11.4	172.6	
19.629	11.4	173.1	
19.633	11.4	173.2	
19.638	11.4	173.6	
19.642	11.4	173.7	
19.647	11.4	174.0	
19.651	11.4	174.0	
19.656	11.4	174.0	
19.660	11.4	174.1	
19.664	11.4	174.3	
19.669	11.4	174.4	
19.673	11.4	174.5	
19.678	11.4	175.7	
19.682	11.4	180.1	
19.687	11.4	183.1	
19.691	11.4	185.1	
19.695	11.4	186.2	
19.700	11.4	186.9	

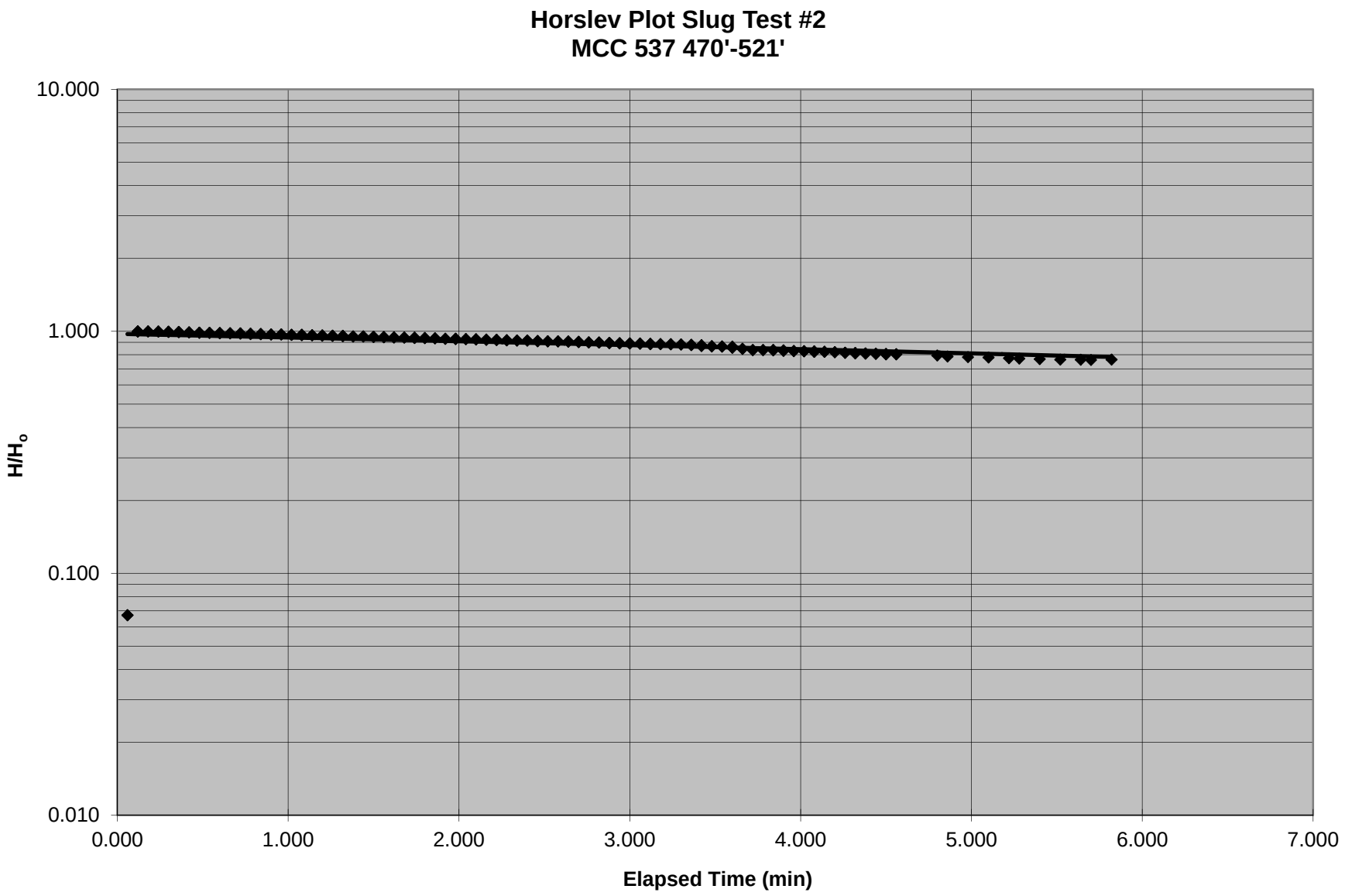
Time	Injection Rate (gpm)	Pressure (psig)	
19.704	11.4	188.3	
19.709	11.4	189.3	
19.713	11.4	190.7	
19.718	11.4	190.8	
19.722	11.4	191.5	
19.726	11.4	191.8	
19.731	11.4	192.2	
19.735	11.4	191.4	
19.740	11.4	191.4	
19.744	11.4	191.6	
19.749	11.4	192.7	
19.753	11.4	195.7	
19.757	11.4	197.7	
19.762	11.4	198.1	
19.766	11.4	199.0	
19.771	11.4	199.2	
19.775	11.4	198.4	
19.780	11.4	198.6	
19.784	11.4	198.6	
19.788	11.4	198.5	
19.793	11.4	198.3	
19.797	11.4	198.6	
19.802	11.4	198.1	
19.806	11.4	199.0	
19.811	11.4	199.8	
19.815	11.4	200.7	
19.819	11.4	200.2	
19.824	11.4	200.0	
19.828	11.4	199.8	
19.833	11.4	197.6	
19.837	11.4	197.8	
19.842	11.4	198.4	
19.846	11.4	198.8	
19.850	11.4	201.8	
19.855	11.4	202.8	
19.859	11.4	204.0	
19.864	13.6	167.2	
19.868	13.6	165.0	
19.873	13.6	187.4	
19.877	13.6	199.5	
19.881	13.6	200.3	
19.886	13.6	200.5	
19.890	13.6	200.5	
19.895	13.6	200.2	
19.899	13.6	200.5	
19.904	13.6	216.6	
19.908	13.6	207.7	

Time	Injection Rate (gpm)	Pressure (psig)	
19.912	13.6	209.9	
19.917	13.6	209.2	
19.921	13.6	209.0	
19.926	13.6	210.9	
19.930	13.6	209.6	
19.935	13.6	211.6	
19.939	13.6	210.1	
19.943	13.6	207.6	
19.948	13.6	209.1	
19.952	13.6	208.0	
19.957	13.6	209.4	
19.961	13.6	208.3	
19.966	13.6	212.3	
19.970	13.6	212.0	
19.974	13.6	209.6	
19.979	13.6	211.8	
19.983	13.6	211.8	
19.988	13.6	211.9	
19.992	13.6	213.9	
19.997	13.6	214.0	
20.001	13.6	213.5	
20.005	13.6	214.0	
20.010	13.6	215.6	
20.014	13.6	213.9	
20.019	13.6	215.4	
20.023	13.6	214.2	
20.028	13.6	214.5	
20.032	13.6	214.7	
20.036	13.6	214.4	
20.041	13.6	214.1	
20.045	13.6	215.3	
20.050	13.6	214.7	
20.054	13.6	212.8	
20.059	13.6	216.4	
20.063	19	235.0	
20.067	19	235.6	
20.072	19	235.5	
20.076	19	224.0	
20.081	19	226.6	
20.085	19	226.5	
20.090	19	247.3	
20.094	19	242.9	
20.098	19	245.7	
20.103	19	246.9	
20.107	19	243.7	
20.112	19	246.4	
20.116	19	246.6	

Time	Injection Rate (gpm)	Pressure (psig)	
20.121	19	247.6	
20.125	19	247.0	
20.129	19	247.4	
20.134	19	248.9	
20.138	19	245.6	
20.143	19	246.4	
20.147	19	245.3	
20.152	19	245.4	
20.156	19	244.7	
20.160	19	247.8	
20.165	19	246.5	
20.169	19	246.2	
20.174	19	246.1	
20.178	19	246.6	
20.183	19	247.4	
20.187	19	248.0	
20.191	19	246.0	
20.196	19	248.2	
20.200	19	245.0	
20.205	19	246.1	
20.209	19	245.8	
20.214	19	244.8	
20.218	19	244.6	
20.222	19	247.0	
20.227	19	244.3	
20.231	19	245.4	
20.236	19	246.1	
20.240	19	245.6	
20.245	19	244.6	
20.249	19	244.4	
20.253	19	246.7	
20.258	19	245.5	
20.262	19	244.6	
20.267	19	246.8	
20.271	19	246.8	
20.276	19	245.4	
20.280	19	246.0	
20.284	21	266.9	
20.289	21	261.9	
20.293	21	260.7	
20.298	21	261.3	
20.302	21	262.7	
20.307	21	264.1	
20.311	21	262.0	
20.315	21	264.2	
20.320	21	262.4	
20.324	21	261.3	

Time	Injection Rate (gpm)	Pressure (psig)	
20.329	21	249.9	
20.333	21	252.0	
20.338	21	257.3	
20.342	33	214.2	
20.346	33	298.6	
20.351	33	298.4	
20.355	33	304.8	
20.360	33	307.2	
20.364	33	305.9	
20.369	33	305.3	
20.373	33	307.4	
20.377	33	307.4	
20.382	33	304.3	
20.386	33	305.4	
20.391	33	310.5	
20.395	33	311.7	
20.400	33	312.7	
20.404	33	309.6	
20.408	33	312.0	
20.413	33	313.9	
20.417	33	310.4	
20.422	33	312.6	
20.426	33	314.1	
20.431	33	317.4	
20.435	33	313.9	
20.439	33	314.2	
20.444	33	313.6	
20.448	33	311.6	
20.453	37	308.3	
20.457	37	330.5	
20.462	37	329.3	
20.466	37	330.9	
20.470	37	332.4	
20.475	37	334.1	
20.479	37	333.5	
20.484	37	334.4	
20.488	37	334.9	
20.493	37	336.1	
20.497	37	335.9	
20.501	37	333.8	
20.506	37	318.3	
20.510	37	318.4	
20.515	37	321.0	
20.519	37	324.2	End Test
20.524	-	159.4	
20.528	-	90.3	
20.532	-	90.3	


Slug Test # 2
MCC 537 470'-521'
190
185
180
175
170
165
Pressure (psig)
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
Elapsed Time (min)

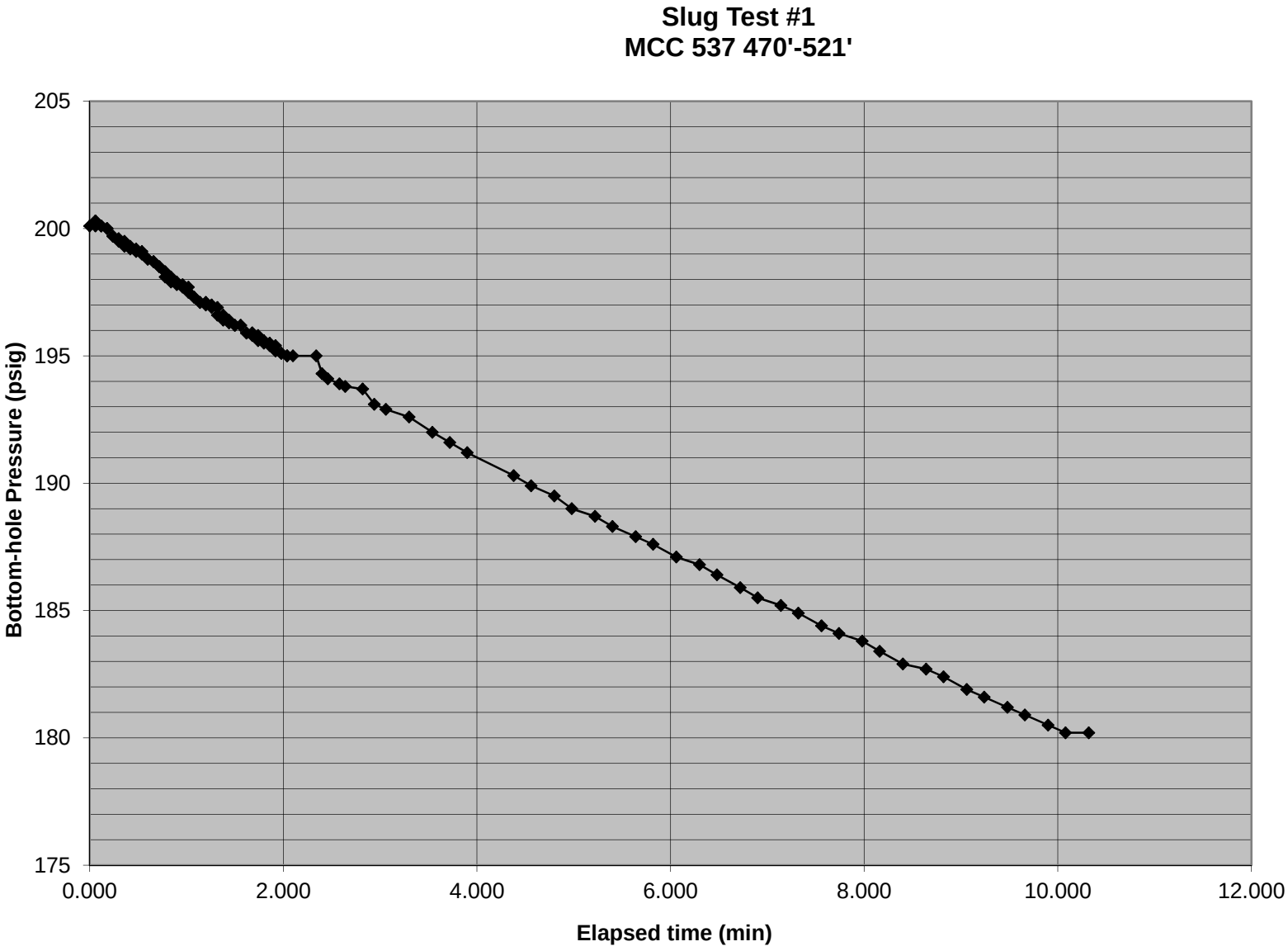

Horslev Plot Slug Test #2
MCC 537 470'-521'
10.000
1.000
0.100
0.010
H/H$_o$
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
Elapsed Time (min)

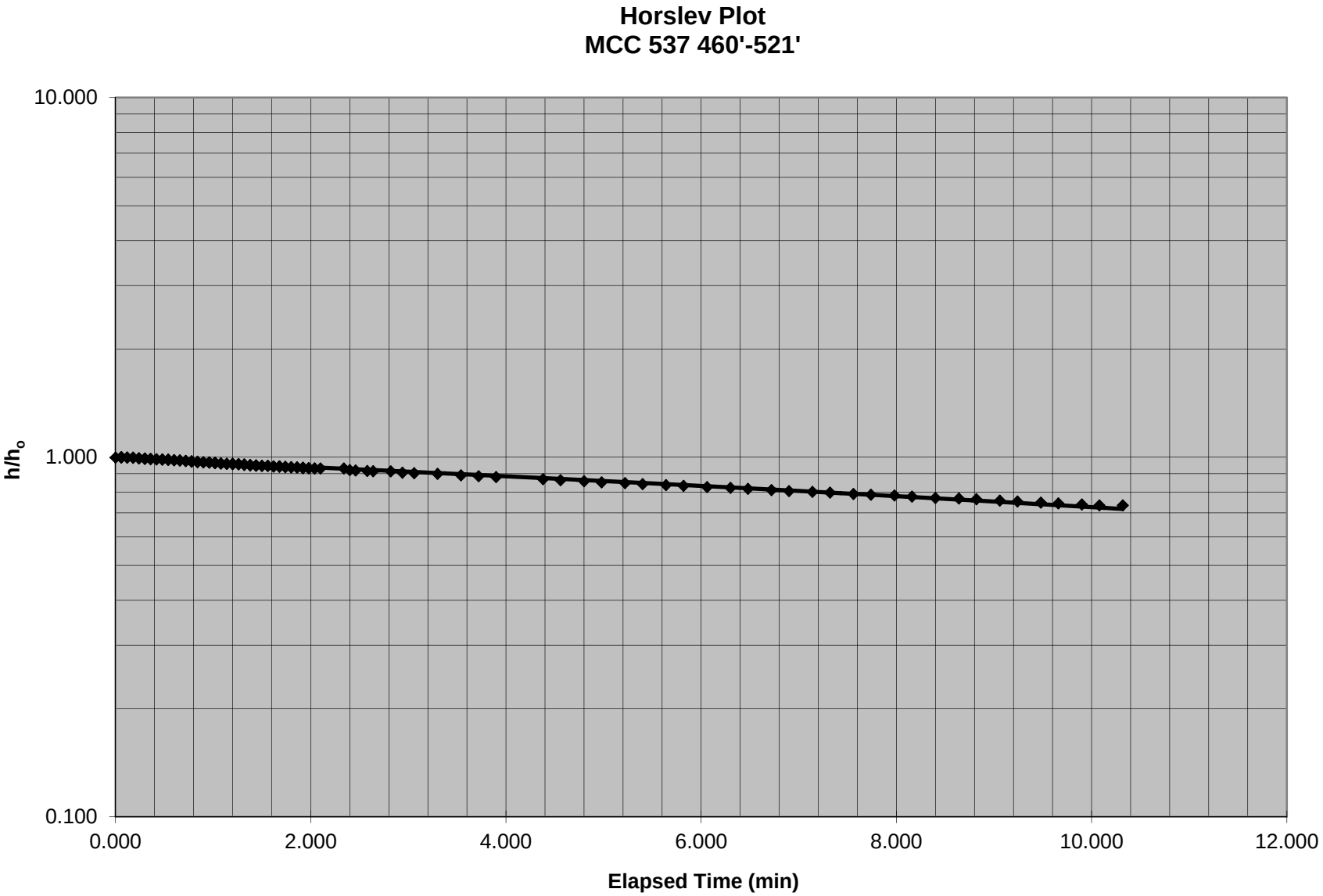
Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
Static Pressure						
16:17:36	16.293				124.5	
16:17:37	16.294	4.17E-05	0.060	0.001	128.6	0.067
16:17:39	16.294	4.17E-05	0.060	0.001	128.6	0.067
16:17:40	16.295	8.33E-05	0.120	0.002	185.5	0.998
16:17:42	16.295	8.33E-05	0.120	0.002	185.5	0.998
16:17:44	16.295	8.33E-05	0.120	0.002	185.6	1.000
16:17:45	16.296	0.000125	0.180	0.003	185.6	1.000
16:17:47	16.296	0.000125	0.180	0.003	185.5	0.998
16:17:48	16.297	0.000167	0.240	0.004	185.5	0.998
16:17:50	16.297	0.000167	0.240	0.004	185.4	0.997
16:17:52	16.298	0.000208	0.300	0.005	185.4	0.997
16:17:53	16.298	0.000208	0.300	0.005	185.2	0.993
16:17:55	16.299	0.00025	0.360	0.006	185.2	0.993
16:17:56	16.299	0.00025	0.360	0.006	185.2	0.993
16:17:58	16.299	0.00025	0.360	0.006	185.2	0.993
16:18:00	16.3	0.000292	0.420	0.007	185	0.990
16:18:01	16.3	0.000292	0.420	0.007	185	0.990
16:18:03	16.301	0.000333	0.480	0.008	184.8	0.987
16:18:05	16.301	0.000333	0.480	0.008	184.8	0.987
16:18:06	16.302	0.000375	0.540	0.009	184.7	0.985
16:18:08	16.302	0.000375	0.540	0.009	184.7	0.985
16:18:09	16.303	0.000417	0.600	0.01	184.6	0.984
16:18:11	16.303	0.000417	0.600	0.01	184.6	0.984
16:18:12	16.303	0.000417	0.600	0.01	184.5	0.982
16:18:14	16.304	0.000458	0.660	0.011	184.5	0.982
16:18:16	16.304	0.000458	0.660	0.011	184.4	0.980
16:18:17	16.305	0.0005	0.720	0.012	184.4	0.980
16:18:19	16.305	0.0005	0.720	0.012	184.3	0.979
16:18:20	16.306	0.000542	0.780	0.013	184.3	0.979
16:18:22	16.306	0.000542	0.780	0.013	184	0.974
16:18:24	16.307	0.000583	0.840	0.014	184	0.974
16:18:25	16.307	0.000583	0.840	0.014	184	0.974
16:18:27	16.307	0.000583	0.840	0.014	184	0.974
16:18:28	16.308	0.000625	0.900	0.015	183.8	0.971
16:18:30	16.308	0.000625	0.900	0.015	183.8	0.971
16:18:31	16.309	0.000667	0.960	0.016	183.8	0.971
16:18:33	16.309	0.000667	0.960	0.016	183.8	0.971
16:18:35	16.31	0.000708	1.020	0.017	183.6	0.967
16:18:36	16.31	0.000708	1.020	0.017	183.6	0.967
16:18:38	16.311	0.00075	1.080	0.018	183.6	0.967
16:18:40	16.311	0.00075	1.080	0.018	183.6	0.967
16:18:41	16.311	0.00075	1.080	0.018	183.4	0.964
16:18:43	16.312	0.000792	1.140	0.019	183.4	0.964
16:18:44	16.312	0.000792	1.140	0.019	183.3	0.962

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:18:46	16.313	0.000833	1.200	0.02	183.3	0.962
16:18:48	16.313	0.000833	1.200	0.02	183.1	0.959
16:18:49	16.314	0.000875	1.260	0.021	183.1	0.959
16:18:51	16.314	0.000875	1.260	0.021	183	0.957
16:18:52	16.315	0.000917	1.320	0.022	183	0.957
16:18:54	16.315	0.000917	1.320	0.022	182.9	0.956
16:18:55	16.315	0.000917	1.320	0.022	182.9	0.956
16:18:57	16.316	0.000958	1.380	0.023	182.7	0.953
16:18:59	16.316	0.000958	1.380	0.023	182.7	0.953
16:19:00	16.317	0.001	1.440	0.024	182.7	0.953
16:19:02	16.317	0.001	1.440	0.024	182.7	0.953
16:19:04	16.318	0.001042	1.500	0.025	182.5	0.949
16:19:05	16.318	0.001042	1.500	0.025	182.5	0.949
16:19:06	16.318	0.001042	1.500	0.025	182.4	0.948
16:19:08	16.319	0.001083	1.560	0.026	182.4	0.948
16:19:10	16.319	0.001083	1.560	0.026	182.2	0.944
16:19:11	16.32	0.001125	1.620	0.027	182.2	0.944
16:19:13	16.32	0.001125	1.620	0.027	182.1	0.943
16:19:15	16.321	0.001167	1.680	0.028	182.1	0.943
16:19:16	16.321	0.001167	1.680	0.028	182.1	0.943
16:19:18	16.322	0.001208	1.740	0.029	182.1	0.943
16:19:19	16.322	0.001208	1.740	0.029	181.9	0.939
16:19:21	16.322	0.001208	1.740	0.029	181.9	0.939
16:19:23	16.323	0.00125	1.800	0.03	181.8	0.938
16:19:24	16.323	0.00125	1.800	0.03	181.8	0.938
16:19:26	16.324	0.001292	1.860	0.031	181.7	0.936
16:19:27	16.324	0.001292	1.860	0.031	181.7	0.936
16:19:29	16.325	0.001333	1.920	0.032	181.4	0.931
16:19:30	16.325	0.001333	1.920	0.032	181.4	0.931
16:19:32	16.326	0.001375	1.980	0.033	181.4	0.931
16:19:34	16.326	0.001375	1.980	0.033	181.4	0.931
16:19:35	16.326	0.001375	1.980	0.033	181.3	0.930
16:19:37	16.327	0.001417	2.040	0.034	181.3	0.930
16:19:39	16.327	0.001417	2.040	0.034	181.2	0.928
16:19:40	16.328	0.001458	2.100	0.035	181.2	0.928
16:19:42	16.328	0.001458	2.100	0.035	181	0.925
16:19:43	16.329	0.0015	2.160	0.036	181	0.925
16:19:45	16.329	0.0015	2.160	0.036	180.8	0.921
16:19:46	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:48	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:50	16.33	0.001542	2.220	0.037	180.8	0.921
16:19:51	16.331	0.001583	2.280	0.038	180.6	0.918
16:19:53	16.331	0.001583	2.280	0.038	180.6	0.918
16:19:54	16.332	0.001625	2.340	0.039	180.5	0.917
16:19:56	16.332	0.001625	2.340	0.039	180.5	0.917
16:19:58	16.333	0.001667	2.400	0.04	180.5	0.917
16:19:59	16.333	0.001667	2.400	0.04	180.5	0.917

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:20:01	16.334	0.001708	2.460	0.041	180.2	0.912
16:20:02	16.334	0.001708	2.460	0.041	180.2	0.912
16:20:04	16.334	0.001708	2.460	0.041	180.1	0.910
16:20:06	16.335	0.00175	2.520	0.042	180.1	0.910
16:20:07	16.335	0.00175	2.520	0.042	180	0.908
16:20:09	16.336	0.001792	2.580	0.043	180	0.908
16:20:10	16.336	0.001792	2.580	0.043	180	0.908
16:20:12	16.337	0.001833	2.640	0.044	180	0.908
16:20:14	16.337	0.001833	2.640	0.044	179.8	0.905
16:20:15	16.338	0.001875	2.700	0.045	179.8	0.905
16:20:17	16.338	0.001875	2.700	0.045	179.7	0.903
16:20:18	16.338	0.001875	2.700	0.045	179.7	0.903
16:20:20	16.339	0.001917	2.760	0.046	179.5	0.900
16:20:22	16.339	0.001917	2.760	0.046	179.5	0.900
16:20:23	16.34	0.001958	2.820	0.047	179.4	0.899
16:20:25	16.34	0.001958	2.820	0.047	179.4	0.899
16:20:26	16.341	0.002	2.880	0.048	179.2	0.895
16:20:28	16.341	0.002	2.880	0.048	179.2	0.895
16:20:29	16.341	0.002	2.880	0.048	179.1	0.894
16:20:31	16.342	0.002042	2.940	0.049	179.1	0.894
16:20:33	16.342	0.002042	2.940	0.049	179	0.892
16:20:34	16.343	0.002083	3.000	0.05	179	0.892
16:20:36	16.343	0.002083	3.000	0.05	178.9	0.890
16:20:37	16.344	0.002125	3.060	0.051	178.9	0.890
16:20:39	16.344	0.002125	3.060	0.051	178.8	0.889
16:20:41	16.345	0.002167	3.120	0.052	178.8	0.889
16:20:42	16.345	0.002167	3.120	0.052	178.6	0.885
16:20:44	16.345	0.002167	3.120	0.052	178.6	0.885
16:20:45	16.346	0.002208	3.180	0.053	178.6	0.885
16:20:47	16.346	0.002208	3.180	0.053	178.6	0.885
16:20:49	16.347	0.00225	3.240	0.054	178.5	0.884
16:20:50	16.347	0.00225	3.240	0.054	178.5	0.884
16:20:52	16.348	0.002292	3.300	0.055	178.4	0.882
16:20:53	16.348	0.002292	3.300	0.055	178.4	0.882
16:20:55	16.349	0.002333	3.360	0.056	178.2	0.879
16:20:57	16.349	0.002333	3.360	0.056	178.2	0.879
16:20:58	16.349	0.002333	3.360	0.056	178.1	0.877
16:21:00	16.35	0.002375	3.420	0.057	178.1	0.877
16:21:01	16.35	0.002375	3.420	0.057	177.6	0.869
16:21:03	16.351	0.002417	3.480	0.058	177.6	0.869
16:21:04	16.351	0.002417	3.480	0.058	177.4	0.866
16:21:06	16.352	0.002458	3.540	0.059	177.4	0.866
16:21:08	16.352	0.002458	3.540	0.059	177.3	0.864
16:21:09	16.353	0.0025	3.600	0.06	177.3	0.864
16:21:11	16.353	0.0025	3.600	0.06	176.8	0.856
16:21:13	16.353	0.0025	3.600	0.06	176.8	0.856
16:21:14	16.354	0.002542	3.660	0.061	176.2	0.846

Slug Test #2 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
16:21:16	16.354	0.002542	3.660	0.061	176.2	0.846
16:21:17	16.355	0.002583	3.720	0.062	175.6	0.836
16:21:19	16.355	0.002583	3.720	0.062	175.6	0.836
16:21:20	16.356	0.002625	3.780	0.063	175.6	0.836
16:21:22	16.356	0.002625	3.780	0.063	175.6	0.836
16:21:24	16.357	0.002667	3.840	0.064	175.6	0.836
16:21:25	16.357	0.002667	3.840	0.064	175.6	0.836
16:21:27	16.357	0.002667	3.840	0.064	175.5	0.835
16:21:28	16.358	0.002708	3.900	0.065	175.5	0.835
16:21:30	16.358	0.002708	3.900	0.065	175.2	0.830
16:21:31	16.359	0.00275	3.960	0.066	175.2	0.830
16:21:33	16.359	0.00275	3.960	0.066	175.1	0.828
16:21:35	16.36	0.002792	4.020	0.067	175.1	0.828
16:21:36	16.36	0.002792	4.020	0.067	175	0.827
16:21:38	16.361	0.002833	4.080	0.068	175	0.827
16:21:40	16.361	0.002833	4.080	0.068	174.8	0.823
16:21:41	16.361	0.002833	4.080	0.068	174.8	0.823
16:21:43	16.362	0.002875	4.140	0.069	174.8	0.823
16:21:44	16.362	0.002875	4.140	0.069	174.8	0.823
16:21:46	16.363	0.002917	4.200	0.07	174.6	0.820
16:21:47	16.363	0.002917	4.200	0.07	174.6	0.820
16:21:49	16.364	0.002958	4.260	0.071	174.3	0.815
16:21:51	16.364	0.002958	4.260	0.071	174.3	0.815
16:21:52	16.365	0.003	4.320	0.072	174.2	0.813
16:21:54	16.365	0.003	4.320	0.072	174.2	0.813
16:21:55	16.365	0.003	4.320	0.072	174	0.810
16:21:57	16.366	0.003042	4.380	0.073	174	0.810
16:21:59	16.366	0.003042	4.380	0.073	173.9	0.809
16:22:00	16.367	0.003083	4.440	0.074	173.9	0.809
16:22:02	16.367	0.003083	4.440	0.074	173.8	0.807
16:22:03	16.368	0.003125	4.500	0.075	173.8	0.807
16:22:05	16.368	0.003125	4.500	0.075	173.6	0.804
16:22:07	16.368	0.003125	4.500	0.075	173.6	0.804
16:22:08	16.369	0.003167	4.560	0.076	173.6	0.804
16:22:10	16.369	0.003167	4.560	0.076	173.6	0.804
16:22:22	16.373	0.003333	4.800	0.08	173	0.794
16:22:27	16.374	0.003375	4.860	0.081	172.6	0.787
16:22:34	16.376	0.003458	4.980	0.083	172.3	0.782
16:22:40	16.378	0.003542	5.100	0.085	172.1	0.779
16:22:46	16.38	0.003625	5.220	0.087	171.8	0.774
16:22:53	16.381	0.003667	5.280	0.088	171.6	0.771
16:22:59	16.383	0.00375	5.400	0.09	171.4	0.768
16:23:05	16.385	0.003833	5.520	0.092	171.2	0.764
16:23:12	16.387	0.003917	5.640	0.094	171.1	0.763
16:23:18	16.388	0.003958	5.700	0.095	171	0.761
16:23:25	16.39	0.004042	5.820	0.097	171.2	0.764

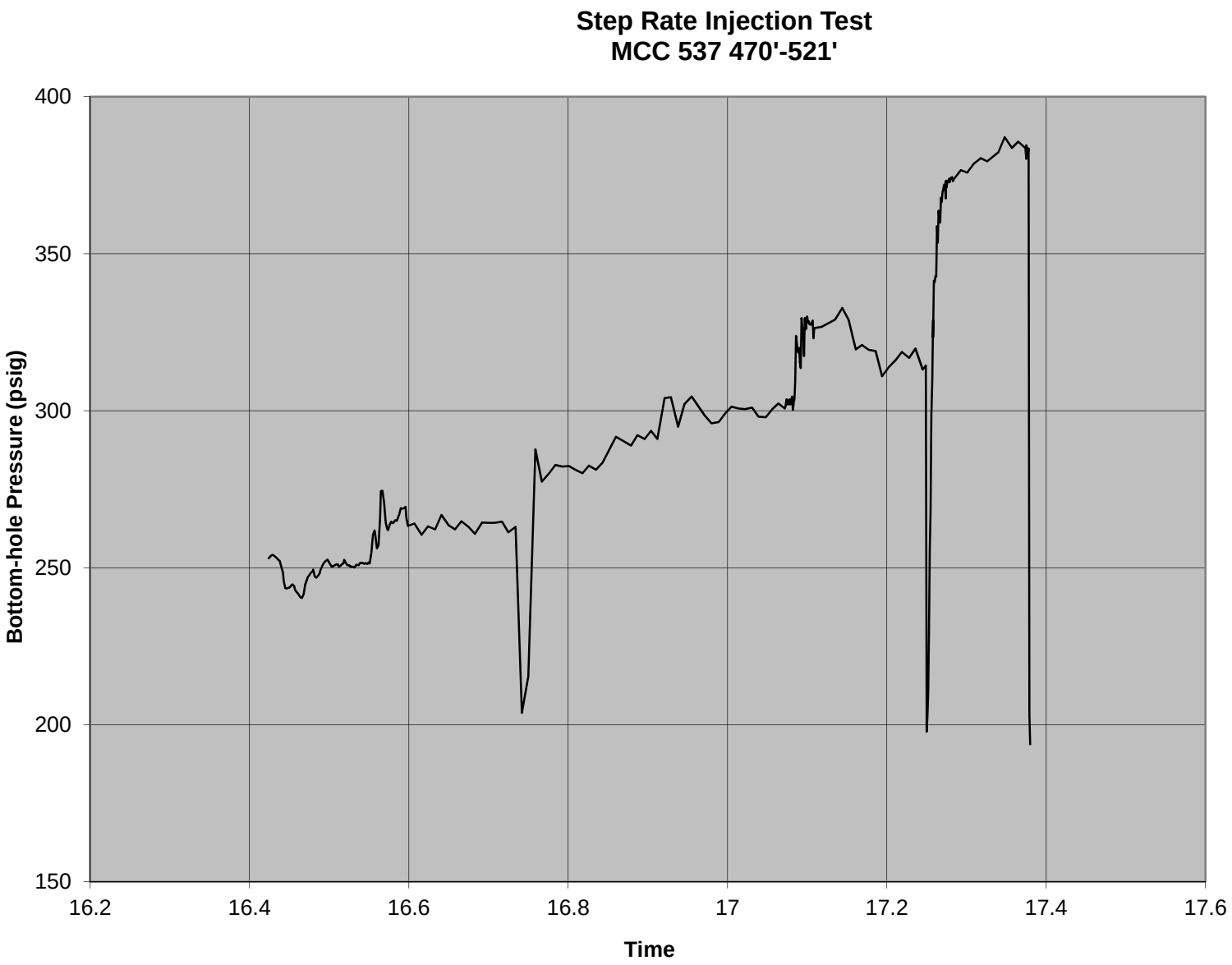

Slug Test #1
MCC 537 470'-521'
205
200
195
190
185
180
175
Bottom-hole Pressure (psig)
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Elapsed time (min)

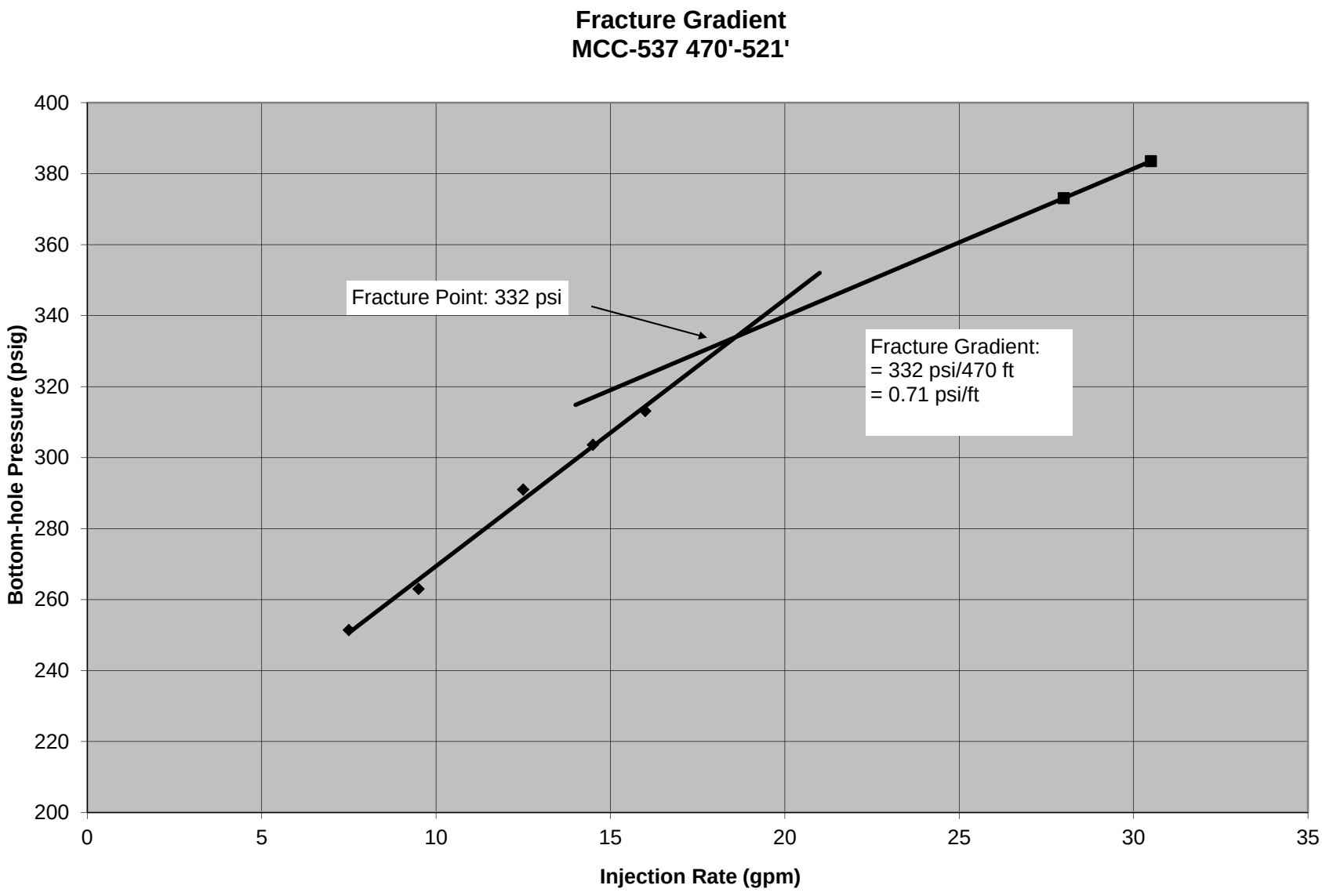

Horslev Plot
MCC 537 460'-521'
10.000
1.000
0.100
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
Elapsed Time (min)

Slug Test #1 Data MCC 537 470'-521'						
Time	Time	Elapsed Time (days)	Elapsed Time (min)	Elapsed Time (hrs)	Pressure (psig)	h/h_o
Static Pressure						
16:03:31	16.059				124.6	
16:03:33	16.059	0.00E+00	0.000	0.000	200.1	0.997
16:03:34	16.060	4.17E-05	0.060	0.001	200.1	0.997
16:03:36	16.060	4.17E-05	0.060	0.001	200.3	1.000
16:03:38	16.060	4.17E-05	0.060	0.001	200.3	1.000
16:03:39	16.061	8.33E-05	0.120	0.002	200.1	0.997
16:03:41	16.061	8.33E-05	0.120	0.002	200.1	0.997
16:03:42	16.062	1.25E-04	0.180	0.003	200	0.996
16:03:44	16.062	1.25E-04	0.180	0.003	200	0.996
16:03:46	16.063	1.67E-04	0.240	0.004	199.7	0.992
16:03:47	16.063	1.67E-04	0.240	0.004	199.7	0.992
16:03:49	16.064	2.08E-04	0.300	0.005	199.6	0.991
16:03:50	16.064	2.08E-04	0.300	0.005	199.6	0.991
16:03:52	16.064	2.08E-04	0.300	0.005	199.5	0.989
16:03:54	16.065	2.50E-04	0.360	0.006	199.5	0.989
16:03:55	16.065	2.50E-04	0.360	0.006	199.3	0.987
16:03:57	16.066	2.92E-04	0.420	0.007	199.3	0.987
16:03:58	16.066	2.92E-04	0.420	0.007	199.2	0.985
16:04:00	16.067	3.33E-04	0.480	0.008	199.2	0.985
16:04:01	16.067	3.33E-04	0.480	0.008	199.1	0.984
16:04:03	16.068	3.75E-04	0.540	0.009	199.1	0.984
16:04:05	16.068	3.75E-04	0.540	0.009	199	0.983
16:04:06	16.068	3.75E-04	0.540	0.009	199	0.983
16:04:08	16.069	4.17E-04	0.600	0.010	198.8	0.980
16:04:10	16.069	4.17E-04	0.600	0.010	198.8	0.980
16:04:11	16.070	4.58E-04	0.660	0.011	198.7	0.979
16:04:13	16.070	4.58E-04	0.660	0.011	198.7	0.979
16:04:14	16.071	5.00E-04	0.720	0.012	198.5	0.976
16:04:16	16.071	5.00E-04	0.720	0.012	198.5	0.976
16:04:18	16.072	5.42E-04	0.780	0.013	198.3	0.974
16:04:19	16.072	5.42E-04	0.780	0.013	198.3	0.974
16:04:21	16.072	5.42E-04	0.780	0.013	198.1	0.971
16:04:22	16.073	5.83E-04	0.840	0.014	198.1	0.971
16:04:24	16.073	5.83E-04	0.840	0.014	197.9	0.968
16:04:26	16.074	6.25E-04	0.900	0.015	197.9	0.968
16:04:27	16.074	6.25E-04	0.900	0.015	197.8	0.967
16:04:29	16.075	6.67E-04	0.960	0.016	197.8	0.967
16:04:30	16.075	6.67E-04	0.960	0.016	197.7	0.966
16:04:32	16.076	7.08E-04	1.020	0.017	197.7	0.966
16:04:33	16.076	7.08E-04	1.020	0.017	197.5	0.963
16:04:35	16.076	7.08E-04	1.020	0.017	197.5	0.963
16:04:37	16.077	7.50E-04	1.080	0.018	197.3	0.960
16:04:38	16.077	7.50E-04	1.080	0.018	197.3	0.960
16:04:40	16.078	7.92E-04	1.140	0.019	197.1	0.958

16:04:41	16.078	7.92E-04	1.140	0.019	197.1	0.958
16:04:43	16.079	8.33E-04	1.200	0.020	197.1	0.958
16:04:45	16.079	8.33E-04	1.200	0.020	197.1	0.958
16:04:46	16.079	8.33E-04	1.200	0.020	197	0.956
16:04:48	16.080	8.75E-04	1.260	0.021	197	0.956
16:04:49	16.080	8.75E-04	1.260	0.021	196.9	0.955
16:04:51	16.081	9.17E-04	1.320	0.022	196.9	0.955
16:04:52	16.081	9.17E-04	1.320	0.022	196.6	0.951
16:04:54	16.082	9.58E-04	1.380	0.023	196.6	0.951
16:04:56	16.082	9.58E-04	1.380	0.023	196.4	0.948
16:04:57	16.083	1.00E-03	1.440	0.024	196.4	0.948
16:04:59	16.083	1.00E-03	1.440	0.024	196.3	0.947
16:05:00	16.083	1.00E-03	1.440	0.024	196.3	0.947
16:05:02	16.084	1.04E-03	1.500	0.025	196.2	0.946
16:05:04	16.084	1.04E-03	1.500	0.025	196.2	0.946
16:05:05	16.085	1.08E-03	1.560	0.026	196.2	0.946
16:05:07	16.085	1.08E-03	1.560	0.026	196.2	0.946
16:05:08	16.086	1.12E-03	1.620	0.027	195.9	0.942
16:05:10	16.086	1.12E-03	1.620	0.027	195.9	0.942
16:05:12	16.087	1.17E-03	1.680	0.028	195.9	0.942
16:05:13	16.087	1.17E-03	1.680	0.028	195.9	0.942
16:05:15	16.087	1.17E-03	1.680	0.028	195.8	0.941
16:05:16	16.088	1.21E-03	1.740	0.029	195.8	0.941
16:05:18	16.088	1.21E-03	1.740	0.029	195.6	0.938
16:05:20	16.089	1.25E-03	1.800	0.030	195.6	0.938
16:05:21	16.089	1.25E-03	1.800	0.030	195.5	0.937
16:05:23	16.090	1.29E-03	1.860	0.031	195.5	0.937
16:05:24	16.090	1.29E-03	1.860	0.031	195.4	0.935
16:05:26	16.091	1.33E-03	1.920	0.032	195.4	0.935
16:05:28	16.091	1.33E-03	1.920	0.032	195.2	0.933
16:05:29	16.091	1.33E-03	1.920	0.032	195.2	0.933
16:05:31	16.092	1.37E-03	1.980	0.033	195.1	0.931
16:05:32	16.092	1.37E-03	1.980	0.033	195.1	0.931
16:05:34	16.093	1.42E-03	2.040	0.034	195	0.930
16:05:36	16.093	1.42E-03	2.040	0.034	195	0.930
16:05:37	16.094	1.46E-03	2.100	0.035	195	0.930
16:05:52	16.098	1.62E-03	2.340	0.039	195	0.930
16:05:56	16.099	1.67E-03	2.400	0.040	194.3	0.921
16:06:01	16.100	1.71E-03	2.460	0.041	194.1	0.918
16:06:06	16.102	1.79E-03	2.580	0.043	193.9	0.915
16:06:11	16.103	1.83E-03	2.640	0.044	193.8	0.914
16:06:22	16.106	1.96E-03	2.820	0.047	193.7	0.913
16:06:28	16.108	2.04E-03	2.940	0.049	193.1	0.905
16:06:35	16.110	2.12E-03	3.060	0.051	192.9	0.902
16:06:52	16.114	2.29E-03	3.300	0.055	192.6	0.898
16:07:03	16.118	2.46E-03	3.540	0.059	192	0.890
16:07:16	16.121	2.58E-03	3.720	0.062	191.6	0.885
16:07:27	16.124	2.71E-03	3.900	0.065	191.2	0.880
16:07:54	16.132	3.04E-03	4.380	0.073	190.3	0.868
16:08:07	16.135	3.17E-03	4.560	0.076	189.9	0.863
16:08:20	16.139	3.33E-03	4.800	0.080	189.5	0.857

16:08:33	16.142	3.46E-03	4.980	0.083	189	0.851
16:08:45	16.146	3.62E-03	5.220	0.087	188.7	0.847
16:08:58	16.149	3.75E-03	5.400	0.090	188.3	0.841
16:09:11	16.153	3.92E-03	5.640	0.094	187.9	0.836
16:09:23	16.156	4.04E-03	5.820	0.097	187.6	0.832
16:09:36	16.160	4.21E-03	6.060	0.101	187.1	0.826
16:09:49	16.164	4.38E-03	6.300	0.105	186.8	0.822
16:10:02	16.167	4.50E-03	6.480	0.108	186.4	0.816
16:10:14	16.171	4.67E-03	6.720	0.112	185.9	0.810
16:10:27	16.174	4.79E-03	6.900	0.115	185.5	0.804
16:10:40	16.178	4.96E-03	7.140	0.119	185.2	0.801
16:10:53	16.181	5.08E-03	7.320	0.122	184.9	0.797
16:11:05	16.185	5.25E-03	7.560	0.126	184.4	0.790
16:11:18	16.188	5.37E-03	7.740	0.129	184.1	0.786
16:11:31	16.192	5.54E-03	7.980	0.133	183.8	0.782
16:11:44	16.195	5.67E-03	8.160	0.136	183.4	0.777
16:11:56	16.199	5.83E-03	8.400	0.140	182.9	0.770
16:12:09	16.203	6.00E-03	8.640	0.144	182.7	0.768
16:12:22	16.206	6.12E-03	8.820	0.147	182.4	0.764
16:12:35	16.210	6.29E-03	9.060	0.151	181.9	0.757
16:12:47	16.213	6.42E-03	9.240	0.154	181.6	0.753
16:13:00	16.217	6.58E-03	9.480	0.158	181.2	0.748
16:13:13	16.220	6.71E-03	9.660	0.161	180.9	0.744
16:13:26	16.224	6.87E-03	9.900	0.165	180.5	0.738
16:13:38	16.227	7.00E-03	10.080	0.168	180.2	0.734
16:13:51	16.231	7.17E-03	10.320	0.172	180.2	0.734


Step Rate Injection Test
MCC 537 470'-521'
Bottom-hole Pressure (psig)
400
350
300
250
200
150
16.2
16.4
16.6
16.8
17
17.2
17.4
17.6
Time


Fracture Gradient
MCC-537 470'-521'
Fracture Point: 332 psi
Fracture Gradient:
= 332 psi/470 ft
= 0.71 psi/ft
Bottom-hole Pressure (psig)
Injection Rate (gpm)
400
380
360
340
320
300
280
260
240
220
200
0
5
10
15
20
25
30
35

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:25:26	16.424	7.5	253	
16:25:32	16.426	7.5	253.5	
16:25:38	16.427	7.5	253.9	
16:25:45	16.429	7.5	254.1	
16:25:51	16.431	7.5	253.8	
16:25:58	16.433	7.5	253.4	
16:26:04	16.434	7.5	253.2	
16:26:10	16.436	7.5	252.6	
16:26:17	16.438	7.5	252.2	
16:26:23	16.44	7.5	250.2	
16:26:30	16.442	7.5	248.5	
16:26:36	16.443	7.5	245.7	
16:26:42	16.445	7.5	243.5	
16:26:49	16.447	7.5	243.4	
16:26:55	16.449	7.5	243.6	
16:27:01	16.45	7.5	243.7	
16:27:08	16.452	7.5	244.2	
16:27:14	16.454	7.5	244.7	
16:27:21	16.456	7.5	244.2	
16:27:27	16.457	7.5	243.1	
16:27:33	16.459	7.5	242.3	
16:27:40	16.461	7.5	241.8	
16:27:46	16.463	7.5	240.9	
16:27:52	16.465	7.5	240.4	
16:27:59	16.466	7.5	240.4	
16:28:05	16.468	7.5	241.5	
16:28:11	16.47	7.5	244.6	
16:28:18	16.472	7.5	246.2	
16:28:24	16.473	7.5	247	
16:28:31	16.475	7.5	247.6	
16:28:37	16.477	7.5	248.4	
16:28:43	16.479	7.5	248.8	
16:28:50	16.48	7.5	249.4	
16:28:56	16.482	7.5	247.2	
16:29:02	16.484	7.5	246.8	
16:29:09	16.486	7.5	247.4	
16:29:15	16.488	7.5	248.2	
16:29:21	16.489	7.5	249.2	
16:29:28	16.491	7.5	250.4	
16:29:34	16.493	7.5	251.4	
16:29:41	16.495	7.5	252	
16:29:47	16.496	7.5	252.2	
16:29:53	16.498	7.5	252.6	
16:30:00	16.5	7.5	251.7	
16:30:13	16.503	7.5	250.4	

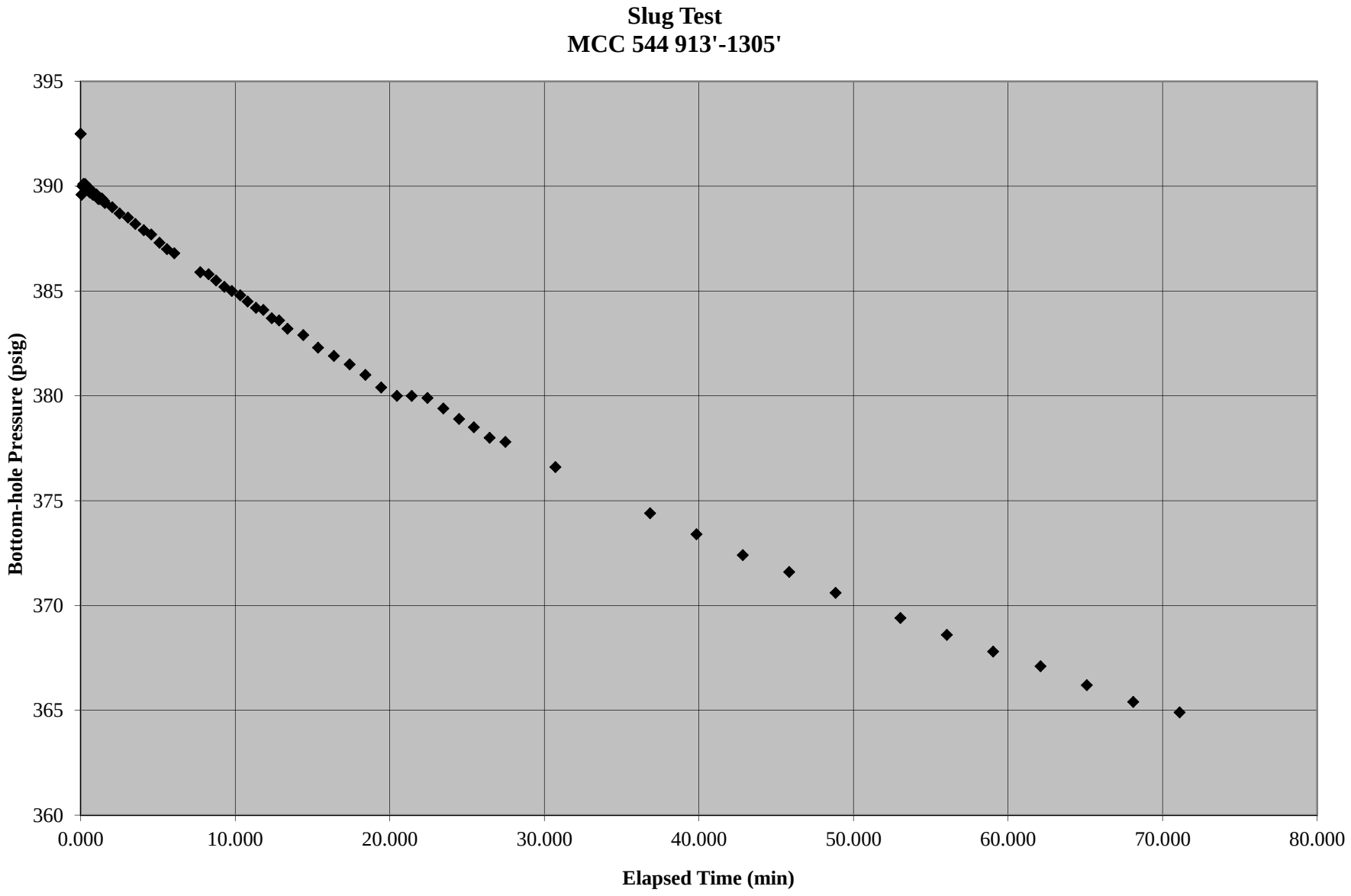
Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:30:19	16.505	7.5	250.5	
16:30:25	16.507	7.5	250.8	
16:30:32	16.509	7.5	251.1	
16:30:38	16.511	7.5	251.1	
16:30:44	16.512	7.5	250.4	
16:30:51	16.514	7.5	250.6	
16:30:57	16.516	7.5	251.1	
16:31:04	16.518	7.5	251.4	
16:31:10	16.519	7.5	252.5	
16:31:16	16.521	7.5	251.5	
16:31:23	16.523	7.5	250.8	
16:31:29	16.525	7.5	250.8	
16:31:36	16.527	7.5	250.3	
16:31:42	16.528	7.5	250.4	
16:31:48	16.53	7.5	250.2	
16:31:54	16.532	7.5	250.1	
16:32:01	16.534	7.5	250.9	
16:32:07	16.535	7.5	250.9	
16:32:14	16.537	7.5	250.8	
16:32:20	16.539	7.5	251.6	
16:32:26	16.541	7.5	251.5	
16:32:33	16.542	7.5	251.6	
16:32:39	16.544	7.5	251.2	
16:32:46	16.546	7.5	251.5	
16:32:52	16.548	7.5	251.2	
16:32:58	16.55	7.5	251.7	
16:33:05	16.551	7.5	251.4	
16:33:11	16.553	9.5	254.9	
16:33:17	16.555	9.5	260.6	
16:33:24	16.557	9.5	261.9	
16:33:30	16.558	9.5	260.3	
16:33:37	16.56	9.5	256.2	
16:33:43	16.562	9.5	257.1	
16:33:49	16.564	9.5	265.7	
16:33:56	16.565	9.5	274.4	
16:34:02	16.567	9.5	274.5	
16:34:08	16.569	9.5	270.6	
16:34:15	16.571	9.5	264.4	
16:34:21	16.573	9.5	262.2	
16:34:27	16.574	9.5	262	
16:34:34	16.576	9.5	263.7	
16:34:40	16.578	9.5	264.7	
16:34:47	16.58	9.5	264.2	
16:34:53	16.581	9.5	264.4	
16:34:59	16.583	9.5	265.1	
16:35:06	16.585	9.5	265	
16:35:19	16.588	9.5	267	

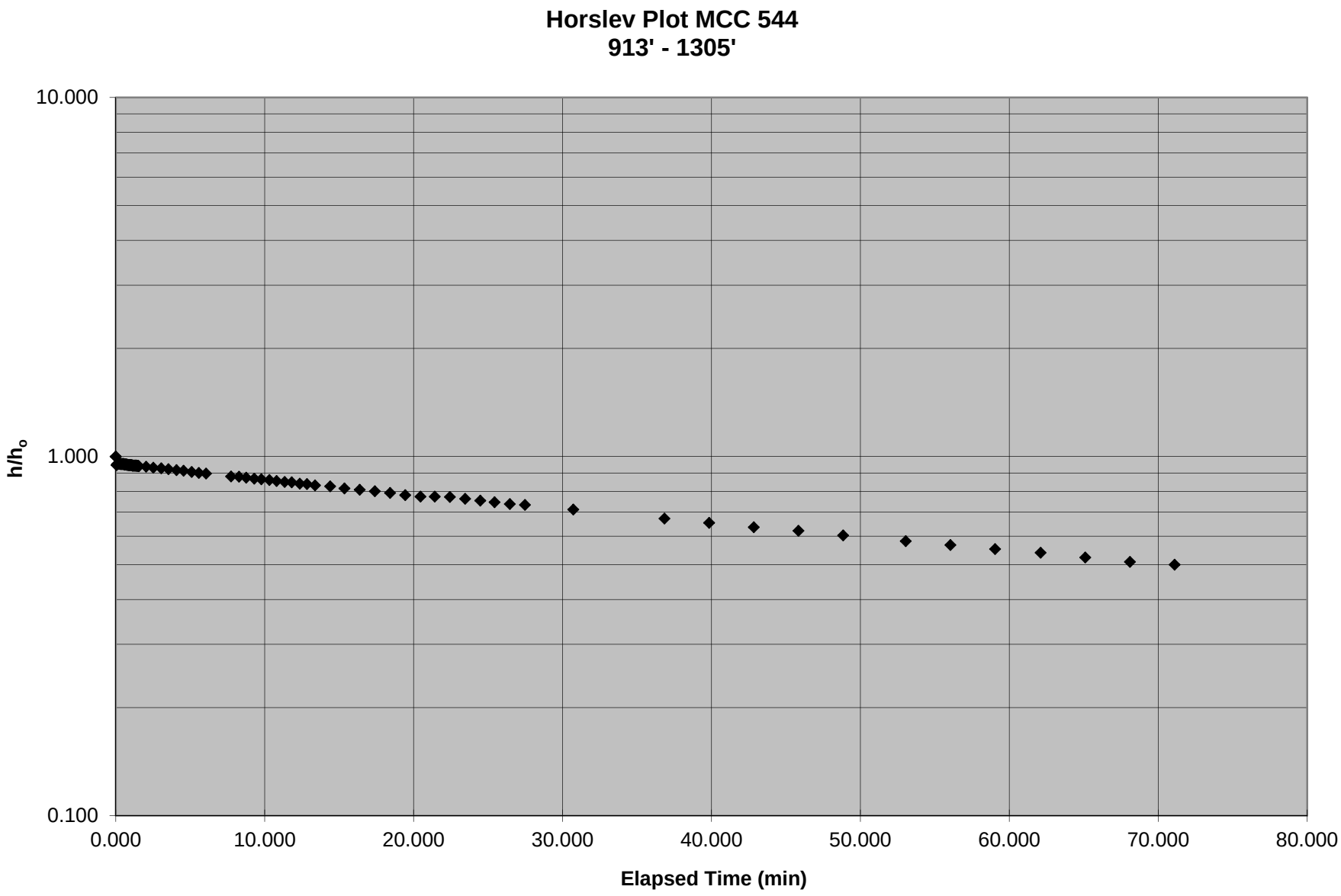
Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:35:25	16.59	9.5	269	
16:35:31	16.592	9.5	268.8	
16:35:38	16.594	9.5	269	
16:35:44	16.596	9.5	269.4	
16:35:50	16.597	9.5	266	
16:35:57	16.599	9.5	263.3	
16:36:27	16.607	9.5	264.1	
16:36:57	16.616	9.5	260.5	
16:37:28	16.624	9.5	263.2	
16:37:58	16.633	9.5	262.2	
16:38:28	16.641	9.5	266.8	
16:38:58	16.65	9.5	263.5	
16:39:29	16.658	9.5	262.2	
16:39:59	16.666	9.5	264.8	
16:40:29	16.675	9.5	263	
16:40:59	16.683	9.5	260.8	
16:41:30	16.692	9.5	264.4	
16:42:00	16.7	9.5	264.3	
16:42:30	16.708	9.5	264.3	
16:43:00	16.717	9.5	264.7	
16:43:31	16.725	9.5	261.3	
16:44:01	16.734	9.5	263	
16:44:31	16.742	12.5	203.8	
16:45:02	16.75	12.5	215.4	
16:45:32	16.759	12.5	287.7	
16:46:02	16.767	12.5	277.4	
16:46:32	16.776	12.5	280.1	
16:47:03	16.784	12.5	282.7	
16:47:33	16.793	12.5	282.2	
16:48:03	16.801	12.5	282.4	
16:48:34	16.809	12.5	281.2	
16:49:04	16.818	12.5	280.1	
16:49:34	16.826	12.5	282.5	
16:50:04	16.835	12.5	281.2	
16:50:35	16.843	12.5	283.4	
16:51:35	16.86	12.5	291.7	
16:52:44	16.879	12.5	288.9	
16:53:14	16.887	12.5	292.2	
16:53:44	16.896	12.5	291	
16:54:15	16.904	12.5	293.6	
16:54:45	16.912	12.5	291	
16:55:15	16.921	14.5	304	
16:55:46	16.929	14.5	304.3	
16:56:16	16.938	14.5	294.9	
16:56:46	16.946	14.5	302.1	
16:57:17	16.955	14.5	304.5	
16:58:17	16.971	14.5	298.6	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
16:58:47	16.98	14.5	296	
16:59:19	16.989	14.5	296.4	
16:59:49	16.997	14.5	299.1	
17:00:20	17.005	14.5	301.3	
17:00:50	17.014	14.5	300.7	
17:01:20	17.022	14.5	300.5	
17:01:51	17.031	14.5	301	
17:02:21	17.039	14.5	298.1	
17:02:51	17.048	14.5	297.9	
17:03:22	17.056	14.5	300.4	
17:03:52	17.064	14.5	302.3	
17:04:20	17.072	14.5	300.7	
17:04:22	17.073	14.5	301.6	
17:04:25	17.074	14.5	303.6	
17:04:29	17.075	14.5	303.5	
17:04:32	17.075	14.5	302	
17:04:35	17.076	14.5	302.2	
17:04:38	17.077	14.5	302	
17:04:41	17.078	14.5	303.6	
17:04:45	17.079	14.5	302	
17:04:51	17.081	14.5	304.5	
17:04:54	17.082	14.5	300.3	
17:04:57	17.083	14.5	302.2	
17:05:01	17.083	14.5	302.8	
17:05:04	17.084	14.5	303.6	
17:05:07	17.085	16	309.3	
17:05:10	17.086	16	323.8	
17:05:13	17.087	16	321.7	
17:05:16	17.088	16	319.3	
17:05:20	17.089	16	318.5	
17:05:23	17.09	16	320	
17:05:26	17.091	16	315.4	
17:05:29	17.091	16	315.5	
17:05:32	17.092	16	313.6	
17:05:36	17.093	16	329.5	
17:05:39	17.094	16	326.8	
17:05:42	17.095	16	324.5	
17:05:45	17.096	16	317.4	
17:05:48	17.097	16	329.5	
17:05:51	17.098	16	325.9	
17:05:55	17.099	16	326.2	
17:05:58	17.099	16	328.6	
17:06:01	17.1	16	330	
17:06:04	17.101	16	328.1	
17:06:07	17.102	16	328.5	
17:06:11	17.103	16	327.5	
17:06:17	17.105	16	327.4	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
17:06:20	17.106	16	328.1	
17:06:24	17.107	16	328.7	
17:06:27	17.107	16	328.4	
17:06:30	17.108	16	323.1	
17:06:33	17.109	16	326.3	
17:07:06	17.118	16	326.7	
17:07:37	17.127	16	327.9	
17:08:07	17.135	16	329	
17:08:37	17.144	16	332.7	
17:09:08	17.152	16	329	
17:09:38	17.161	16	319.5	
17:10:08	17.169	16	320.9	
17:10:39	17.177	16	319.4	
17:11:09	17.186	16	319	
17:11:39	17.194	16	311	
17:12:10	17.203	16	314	
17:12:40	17.211	16	316.1	
17:13:10	17.219	16	318.7	
17:13:40	17.228	16	316.8	
17:14:11	17.236	16	319.8	
17:14:41	17.245	16	313.1	
17:14:56	17.249	28	314.4	
17:14:59	17.25	28	207.2	
17:15:02	17.25	28	197.8	
17:15:05	17.251	28	202.5	
17:15:08	17.252	28	210.2	
17:15:11	17.253	28	229.8	
17:15:14	17.254	28	255.8	
17:15:18	17.255	28	267.9	
17:15:21	17.256	28	298.5	
17:15:24	17.257	28	309.8	
17:15:27	17.258	28	328.8	
17:15:31	17.258	28	323.4	
17:15:34	17.259	28	341.4	
17:15:37	17.26	28	340.9	
17:15:40	17.261	28	342.8	
17:15:43	17.262	28	342.7	
17:15:46	17.263	28	358.8	
17:15:50	17.264	28	353.5	
17:15:53	17.265	28	363.7	
17:15:56	17.266	28	360.5	
17:15:59	17.266	28	361.5	
17:16:02	17.267	28	359.9	
17:16:05	17.268	28	367.8	
17:16:09	17.269	28	366.5	
17:16:12	17.27	28	369.6	
17:16:18	17.272	28	372	

Step-Rate Injection Test Data MCC 537 470'-521'				
Time	Time	Pumping Rate (gpm)	Pressure (psig)	
17:16:22	17.273	28	371	
17:16:25	17.274	28	367.6	
17:16:28	17.274	28	373.2	
17:16:31	17.275	28	371.1	
17:16:34	17.276	28	373.2	
17:16:38	17.277	28	372.7	
17:16:41	17.278	28	373.8	
17:16:44	17.279	28	372.8	
17:16:47	17.28	28	374.1	
17:16:50	17.281	28	374	
17:16:54	17.282	28	374.4	
17:16:57	17.282	28	374.1	
17:17:00	17.283	28	373.1	
17:17:03	17.284	30.5	373.7	
17:17:33	17.293	30.5	376.6	
17:18:04	17.301	30.5	375.8	
17:18:34	17.309	30.5	378.6	
17:19:04	17.318	30.5	380.4	
17:19:35	17.326	30.5	379.4	
17:20:24	17.34	30.5	382.3	
17:20:54	17.348	30.5	387.1	
17:21:25	17.357	30.5	383.7	
17:21:55	17.365	30.5	385.7	
17:22:25	17.374	30.5	383.6	
17:22:28	17.375	30.5	380.2	
17:22:32	17.375	30.5	384.5	
17:22:35	17.376	30.5	383.7	
17:22:38	17.377	30.5	381.6	
17:22:41	17.378	30.5	383.5	End Test
17:22:44	17.379		203.1	
17:22:48	17.38		193.8	
Summary of Injection Data				
		7.5	251.4	
		9.5	263	
		12.5	291	
		14.5	303.6	
		16	313.1	
		28	373.1	
		30.5	383.5	

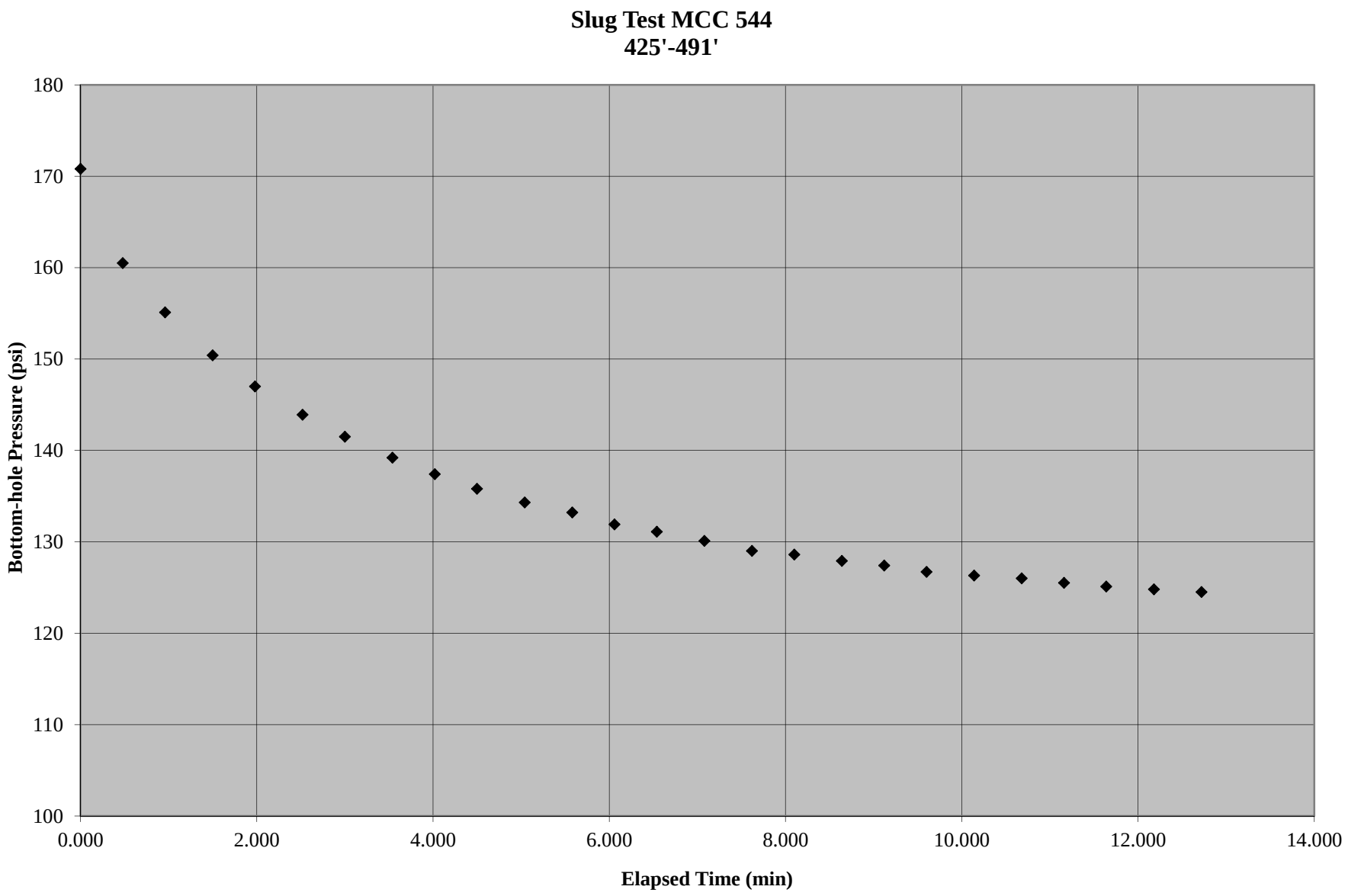

Slug Test
MCC 544 913'-1305'
395
390
385
380
375
370
365
360
Bottom-hole Pressure (psig)
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
Elapsed Time (min)

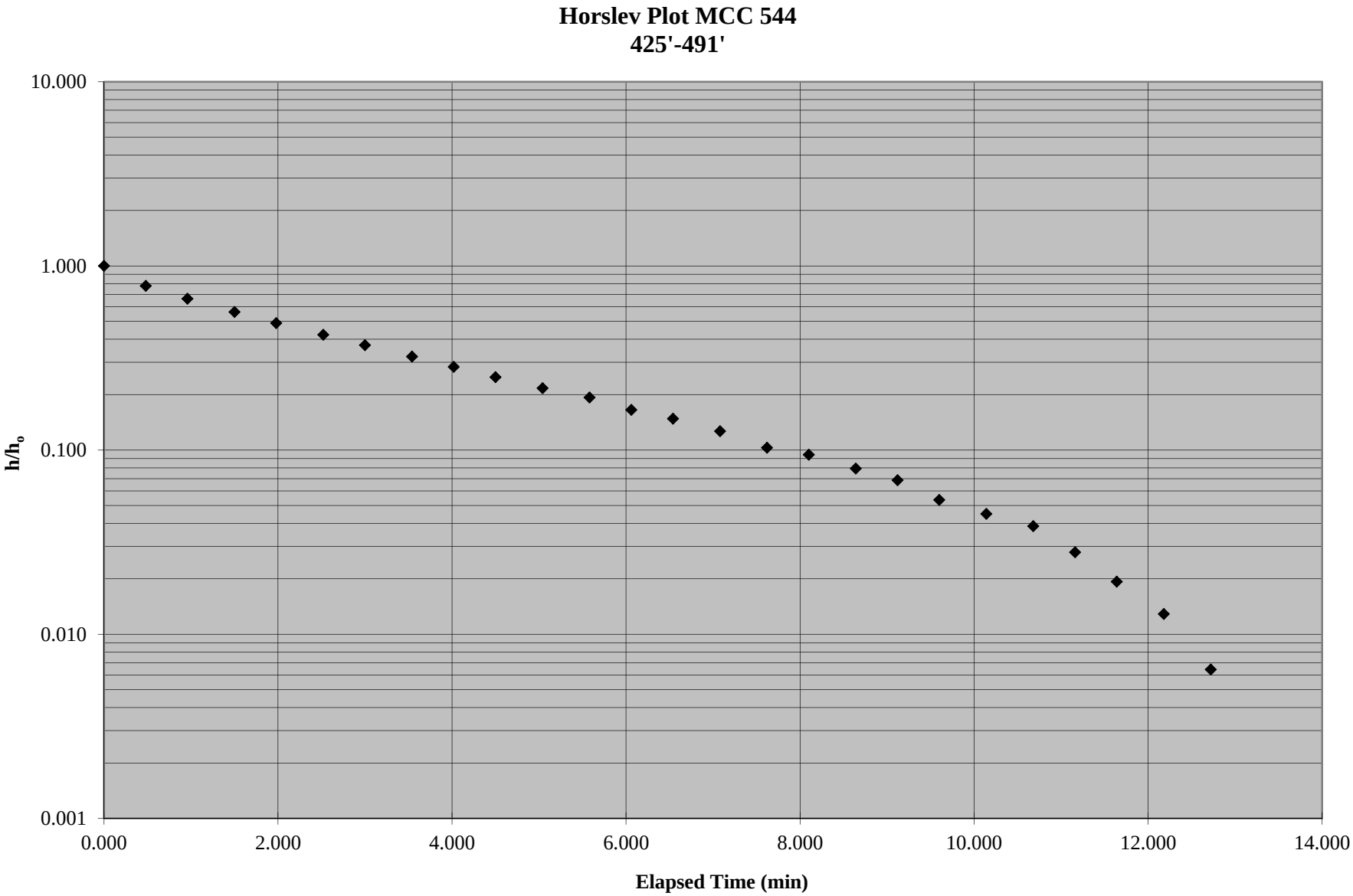

Horslev Plot MCC 544
913' - 1305'
10.000
1.000
0.100
h/h$_o$
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
Elapsed Time (min)

Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:56:33	13.943	0.000	0.000	0.000	337.3	-
13:56:35	13.943	0.000	0.000	0.000	392.5	1.000
13:56:36	13.943	0.000	0.000	0.000	392.5	1.000
13:56:38	13.944	0.001	0.060	0.000	389.6	0.947
13:56:40	13.944	0.001	0.060	0.000	389.6	0.947
13:56:41	13.945	0.002	0.120	0.000	390	0.955
13:56:43	13.945	0.002	0.120	0.000	390	0.955
13:56:44	13.946	0.003	0.180	0.000	390.1	0.957
13:56:46	13.946	0.003	0.180	0.000	390.1	0.957
13:56:48	13.947	0.004	0.240	0.000	390	0.955
13:56:49	13.947	0.004	0.240	0.000	390	0.955
13:56:51	13.947	0.004	0.240	0.000	390.1	0.957
13:56:52	13.948	0.005	0.300	0.000	390.1	0.957
13:56:54	13.948	0.005	0.300	0.000	389.9	0.953
13:56:56	13.949	0.006	0.360	0.000	389.9	0.953
13:56:57	13.949	0.006	0.360	0.000	389.9	0.953
13:56:59	13.95	0.007	0.420	0.000	389.9	0.953
13:57:00	13.95	0.007	0.420	0.000	389.9	0.953
13:57:02	13.951	0.008	0.480	0.000	389.9	0.953
13:57:04	13.951	0.008	0.480	0.000	389.9	0.953
13:57:05	13.951	0.008	0.480	0.000	389.9	0.953
13:57:07	13.952	0.009	0.540	0.000	389.9	0.953
13:57:08	13.952	0.009	0.540	0.000	389.9	0.953
13:57:10	13.953	0.010	0.600	0.000	389.7	0.949
13:57:11	13.953	0.010	0.600	0.000	389.7	0.949
13:57:13	13.954	0.011	0.660	0.000	389.8	0.951
13:57:15	13.954	0.011	0.660	0.000	389.8	0.951
13:57:16	13.955	0.012	0.720	0.001	389.7	0.949
13:57:18	13.955	0.012	0.720	0.001	389.7	0.949
13:57:20	13.955	0.012	0.720	0.001	389.7	0.949
13:57:21	13.956	0.013	0.780	0.001	389.7	0.949
13:57:23	13.956	0.013	0.780	0.001	389.6	0.947
13:57:24	13.957	0.014	0.840	0.001	389.6	0.947
13:57:26	13.957	0.014	0.840	0.001	389.6	0.947
13:57:28	13.958	0.015	0.900	0.001	389.6	0.947
13:57:29	13.958	0.015	0.900	0.001	389.6	0.947
13:57:31	13.958	0.015	0.900	0.001	389.6	0.947
13:57:32	13.959	0.016	0.960	0.001	389.6	0.947
13:57:34	13.959	0.016	0.960	0.001	389.6	0.947
13:57:35	13.96	0.017	1.020	0.001	389.6	0.947
13:57:37	13.96	0.017	1.020	0.001	389.6	0.947
13:57:39	13.961	0.018	1.080	0.001	389.5	0.946
13:57:40	13.961	0.018	1.080	0.001	389.5	0.946
13:57:42	13.962	0.019	1.140	0.001	389.4	0.944

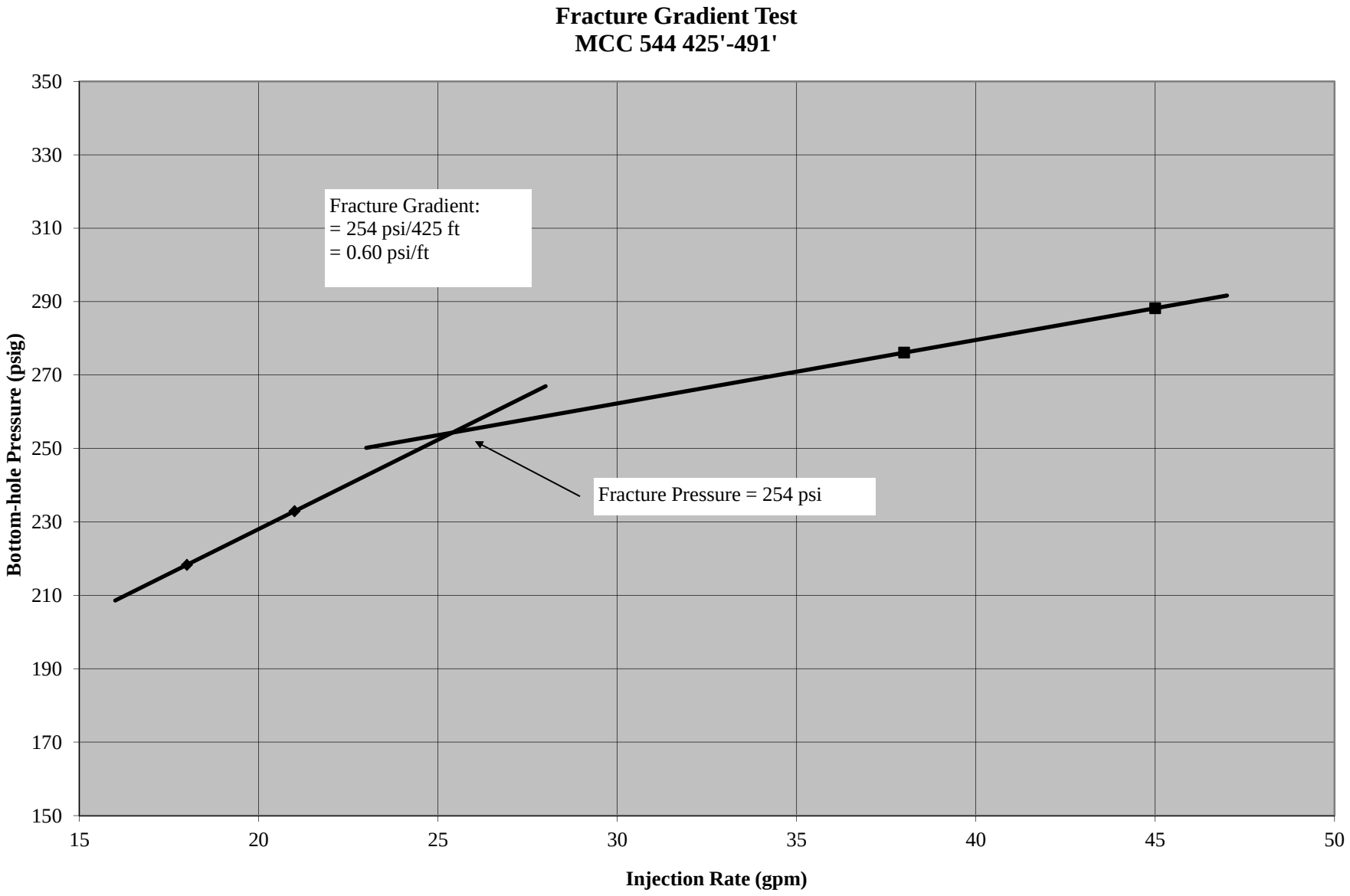
Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:57:43	13.962	0.019	1.140	0.001	389.4	0.944
13:57:45	13.962	0.019	1.140	0.001	389.4	0.944
13:57:47	13.963	0.020	1.200	0.001	389.4	0.944
13:57:48	13.963	0.020	1.200	0.001	389.4	0.944
13:57:50	13.964	0.021	1.260	0.001	389.4	0.944
13:57:51	13.964	0.021	1.260	0.001	389.4	0.944
13:57:53	13.965	0.022	1.320	0.001	389.4	0.944
13:57:55	13.965	0.022	1.320	0.001	389.4	0.944
13:57:56	13.966	0.023	1.380	0.001	389.4	0.944
13:57:58	13.966	0.023	1.380	0.001	389.4	0.944
13:57:59	13.966	0.023	1.380	0.001	389.4	0.944
13:58:01	13.967	0.024	1.440	0.001	389.3	0.942
13:58:02	13.967	0.024	1.440	0.001	389.3	0.942
13:58:04	13.968	0.025	1.500	0.001	389.3	0.942
13:58:06	13.968	0.025	1.500	0.001	389.3	0.942
13:58:07	13.969	0.026	1.560	0.001	389.2	0.940
13:58:38	13.977	0.034	2.040	0.001	389	0.937
13:59:08	13.985	0.042	2.520	0.002	388.7	0.931
13:59:38	13.994	0.051	3.060	0.002	388.5	0.928
14:00:08	14.002	0.059	3.540	0.002	388.2	0.922
14:00:39	14.011	0.068	4.080	0.003	387.9	0.917
14:01:09	14.019	0.076	4.560	0.003	387.7	0.913
14:01:39	14.028	0.085	5.100	0.004	387.3	0.906
14:02:10	14.036	0.093	5.580	0.004	387	0.900
14:02:40	14.044	0.101	6.060	0.004	386.8	0.897
14:04:21	14.072	0.129	7.740	0.005	385.9	0.880
14:04:51	14.081	0.138	8.280	0.006	385.8	0.879
14:05:21	14.089	0.146	8.760	0.006	385.5	0.873
14:05:51	14.098	0.155	9.300	0.006	385.2	0.868
14:06:23	14.106	0.163	9.780	0.007	385	0.864
14:06:54	14.115	0.172	10.320	0.007	384.8	0.861
14:07:24	14.123	0.180	10.800	0.007	384.5	0.855
14:07:54	14.132	0.189	11.340	0.008	384.2	0.850
14:08:25	14.14	0.197	11.820	0.008	384.1	0.848
14:08:55	14.149	0.206	12.360	0.009	383.7	0.841
14:09:27	14.157	0.214	12.840	0.009	383.6	0.839
14:09:57	14.166	0.223	13.380	0.009	383.2	0.832
14:10:58	14.183	0.240	14.400	0.010	382.9	0.826
14:11:58	14.199	0.256	15.360	0.011	382.3	0.815
14:12:59	14.216	0.273	16.380	0.011	381.9	0.808
14:13:59	14.233	0.290	17.400	0.012	381.5	0.801
14:15:00	14.25	0.307	18.420	0.013	381	0.792
14:16:01	14.267	0.324	19.440	0.014	380.4	0.781
14:17:01	14.284	0.341	20.460	0.014	380	0.774
14:18:00	14.3	0.357	21.420	0.015	380	0.774
14:19:01	14.317	0.374	22.440	0.016	379.9	0.772
14:20:01	14.334	0.391	23.460	0.016	379.4	0.763

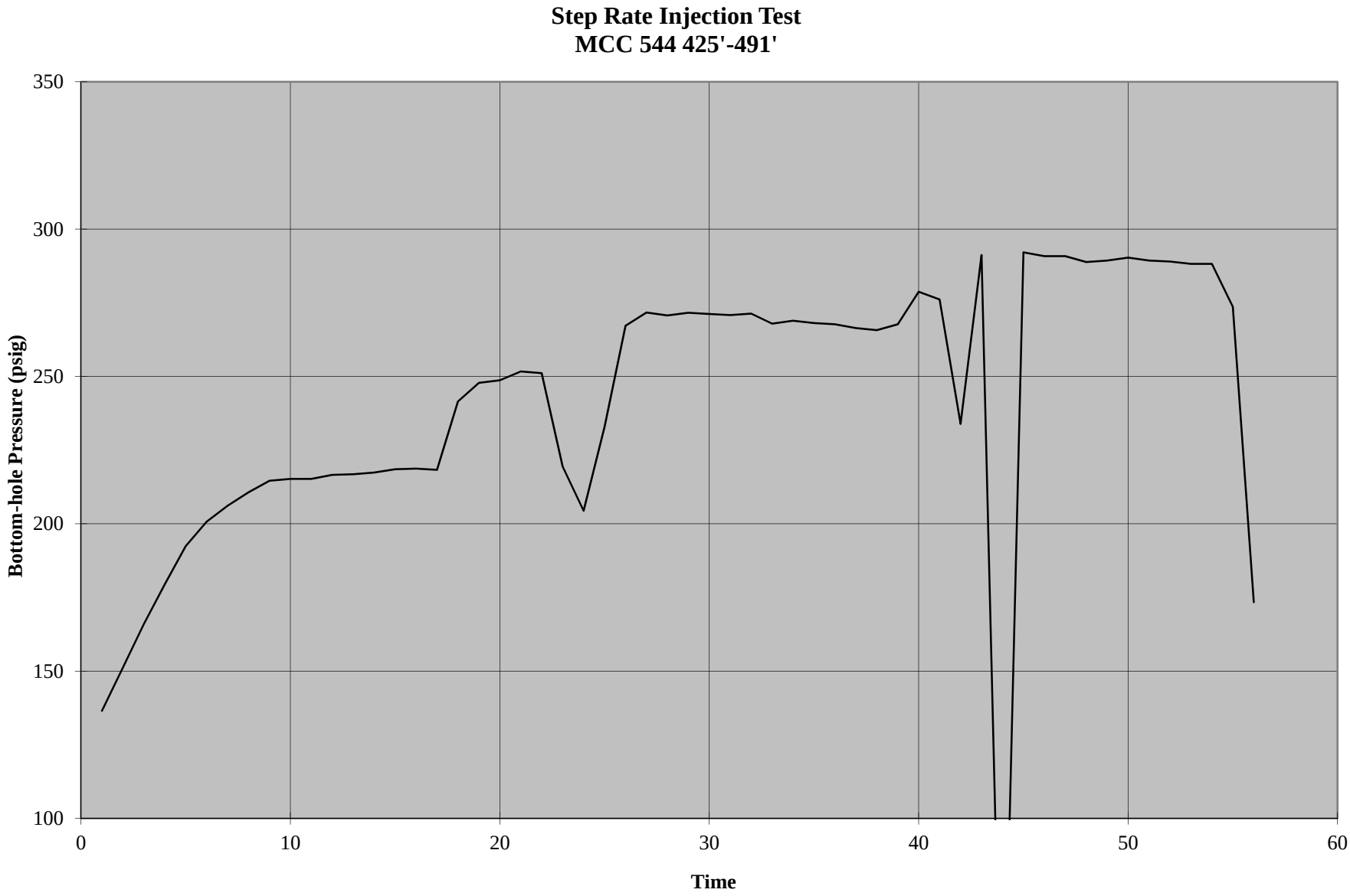
Slug Test Data MCC 544 913'-1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
14:21:02	14.351	0.408	24.480	0.017	378.9	0.754
14:22:03	14.367	0.424	25.440	0.018	378.5	0.746
14:23:03	14.384	0.441	26.460	0.018	378	0.737
14:24:04	14.401	0.458	27.480	0.019	377.8	0.734
14:27:18	14.455	0.512	30.720	0.021	376.6	0.712
14:33:24	14.557	0.614	36.840	0.026	374.4	0.672
14:36:24	14.607	0.664	39.840	0.028	373.4	0.654
14:39:24	14.657	0.714	42.840	0.030	372.4	0.636
14:42:26	14.707	0.764	45.840	0.032	371.6	0.621
14:45:26	14.757	0.814	48.840	0.034	370.6	0.603
14:49:37	14.827	0.884	53.040	0.037	369.4	0.582
14:52:38	14.877	0.934	56.040	0.039	368.6	0.567
14:55:39	14.927	0.984	59.040	0.041	367.8	0.553
14:58:39	14.978	1.035	62.100	0.043	367.1	0.540
15:01:41	15.028	1.085	65.100	0.045	366.2	0.524
15:04:41	15.078	1.135	68.100	0.047	365.4	0.509
15:07:41	15.128	1.185	71.100	0.049	364.9	0.500


Slug Test MCC 544
425'-491'
Bottom-hole Pressure (psi)
180
170
160
150
140
130
120
110
100
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed Time (min)


Horslev Plot MCC 544
425'-491'
10.000
1.000
0.100
0.010
0.001
h/h$_o$
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed Time (min)

Slug Test Data MCC 544 425'-491'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:23:41	13.395	-	-	-	124.2	-
13:24:13	13.404	0.000	0.000	0.000	170.8	1.000
13:24:44	13.412	0.008	0.480	0.000	160.5	0.779
13:25:14	13.42	0.016	0.960	0.001	155.1	0.663
13:25:44	13.429	0.025	1.500	0.001	150.4	0.562
13:26:14	13.437	0.033	1.980	0.001	147	0.489
13:26:45	13.446	0.042	2.520	0.002	143.9	0.423
13:27:15	13.454	0.050	3.000	0.002	141.5	0.371
13:27:45	13.463	0.059	3.540	0.002	139.2	0.322
13:28:16	13.471	0.067	4.020	0.003	137.4	0.283
13:28:46	13.479	0.075	4.500	0.003	135.8	0.249
13:29:18	13.488	0.084	5.040	0.003	134.3	0.217
13:29:48	13.497	0.093	5.580	0.004	133.2	0.193
13:30:18	13.505	0.101	6.060	0.004	131.9	0.165
13:30:49	13.513	0.109	6.540	0.005	131.1	0.148
13:31:19	13.522	0.118	7.080	0.005	130.1	0.127
13:31:51	13.531	0.127	7.620	0.005	129	0.103
13:32:21	13.539	0.135	8.100	0.006	128.6	0.094
13:32:51	13.548	0.144	8.640	0.006	127.9	0.079
13:33:22	13.556	0.152	9.120	0.006	127.4	0.069
13:33:52	13.564	0.160	9.600	0.007	126.7	0.054
13:34:24	13.573	0.169	10.140	0.007	126.3	0.045
13:34:54	13.582	0.178	10.680	0.007	126	0.039
13:35:24	13.59	0.186	11.160	0.008	125.5	0.028
13:35:55	13.598	0.194	11.640	0.008	125.1	0.019
13:36:26	13.607	0.203	12.180	0.008	124.8	0.013
13:36:57	13.616	0.212	12.720	0.009	124.5	0.006

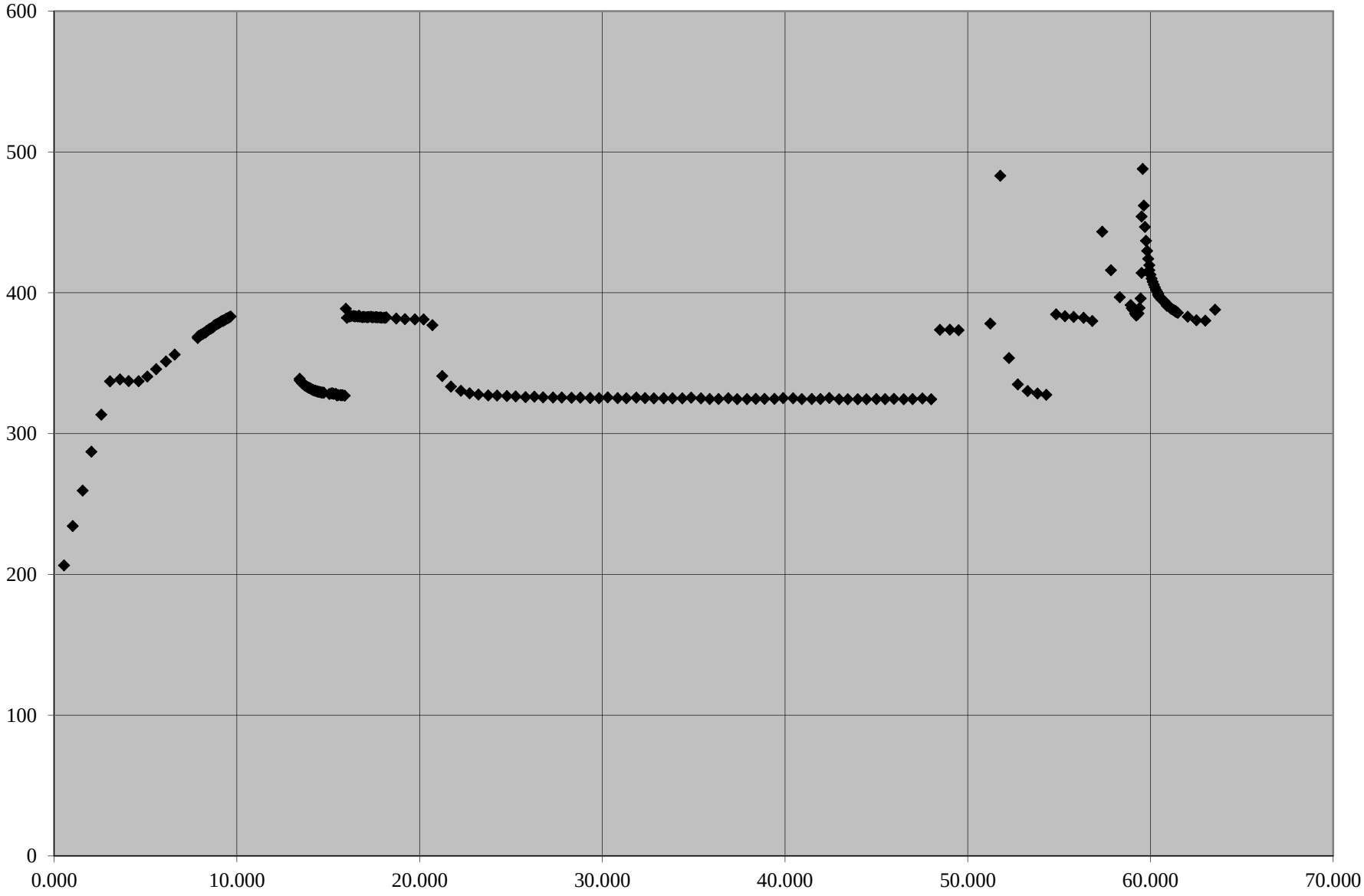

Fracture Gradient Test
MCC 544 425'-491'
Fracture Gradient:
= 254 psi/425 ft
= 0.60 psi/ft
Fracture Pressure = 254 psi
Bottom-hole Pressure (psig)
350
330
310
290
270
250
230
210
190
170
150
15
20
25
30
35
40
45
50
Injection Rate (gpm)


Step Rate Injection Test
MCC 544 425'-491'
Bottom-hole Pressure (psig)
350
300
250
200
150
100
0
10
20
30
40
50
60
Time

Step Rate Injection Test MCC 544 425'-491'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:42:31	14.709	0.000	0.000	18	136.5	
14:43:02	14.717	0.008	0.480	18	151.2	
14:43:32	14.726	0.017	1.020	18	166	
14:44:02	14.734	0.025	1.500	18	179.4	
14:44:34	14.743	0.034	2.040	18	192.4	
14:45:04	14.751	0.042	2.520	18	200.7	
14:45:35	14.76	0.051	3.060	18	206.1	
14:46:06	14.768	0.059	3.540	18	210.7	
14:47:21	14.789	0.080	4.800	18	214.6	
14:47:53	14.798	0.089	5.340	18	215.2	
14:48:23	14.807	0.098	5.880	18	215.2	
14:48:54	14.815	0.106	6.360	18	216.6	
14:49:24	14.823	0.114	6.840	18	216.8	
14:49:54	14.832	0.123	7.380	18	217.4	
14:50:26	14.841	0.132	7.920	18	218.5	
14:50:56	14.849	0.140	8.400	18	218.7	
14:51:27	14.857	0.148	8.880	18	218.3	
14:51:57	14.866	0.157	9.420	21	241.5	
14:52:27	14.874	0.165	9.900	21	247.8	
14:52:59	14.883	0.174	10.440	21	248.7	
14:53:29	14.892	0.183	10.980	21	251.7	
14:54:00	14.9	0.191	11.460	21	251.1	
14:54:30	14.908	0.199	11.940	21	219.4	
14:55:00	14.917	0.208	12.480	21	204.4	
14:55:31	14.925	0.216	12.960	21	232.9	
14:56:01	14.934	0.225	13.500	38	267.2	
14:56:17	14.938	0.229	13.740	38	271.7	
14:56:22	14.939	0.230	13.800	38	270.7	
14:56:27	14.941	0.232	13.920	38	271.6	
14:56:31	14.942	0.233	13.980	38	271.2	
14:57:01	14.95	0.241	14.460	38	270.8	
14:57:32	14.959	0.250	15.000	38	271.3	
14:58:02	14.967	0.258	15.480	38	267.9	
14:58:32	14.976	0.267	16.020	38	268.9	
14:59:03	14.984	0.275	16.500	38	268.1	
14:59:33	14.993	0.284	17.040	38	267.7	
15:00:03	15.001	0.292	17.520	38	266.4	
15:00:34	15.009	0.300	18.000	38	265.7	
15:01:04	15.018	0.309	18.540	38	267.7	
15:01:34	15.026	0.317	19.020	38	278.7	
15:02:05	15.035	0.326	19.560	38	276.1	
15:02:35	15.043	0.334	20.040	45	233.9	
15:03:05	15.051	0.342	20.520	45	291.2	

Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
15:03:36	15.06	0.351	21.060	45	292.1	
15:04:06	15.068	0.359	21.540	45	290.8	
15:04:36	15.077	0.368	22.080	45	290.8	
15:05:06	15.085	0.376	22.560	45	288.8	
15:05:37	15.094	0.385	23.100	45	289.3	
15:06:07	15.102	0.393	23.580	45	290.3	
15:06:37	15.11	0.401	24.060	45	289.3	
15:07:08	15.119	0.410	24.600	45	289	
15:07:38	15.127	0.418	25.080	45	288.2	
15:08:08	15.136	0.427	25.620	45	288.2	End Test
15:08:39	15.144	0.435	26.100		273.6	
15:09:09	15.153	0.444	26.640		173.4	

Slug Test Plot



Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
Static Pressure					
8:35:08	8.585	0.000	0.000	0.000	180.2
8:35:38	8.594	0.009	0.540	0.000	206.4
8:36:08	8.602	0.017	1.020	0.001	234.3
8:36:38	8.611	0.026	1.560	0.001	259.5
8:37:09	8.619	0.034	2.040	0.001	287.1
8:37:41	8.628	0.043	2.580	0.002	313.4
8:38:11	8.636	0.051	3.060	0.002	337.1
8:38:41	8.645	0.060	3.600	0.002	338.5
8:39:11	8.653	0.068	4.080	0.003	337.3
8:39:42	8.662	0.077	4.620	0.003	337.2
8:40:12	8.67	0.085	5.100	0.004	340.5
8:40:42	8.678	0.093	5.580	0.004	345.7
8:41:12	8.687	0.102	6.120	0.004	351.2
8:41:43	8.695	0.110	6.600	0.005	356.1
8:42:56	8.716	0.131	7.860	0.005	367.9
8:42:59	8.716	0.131	7.860	0.005	368.7
8:43:02	8.717	0.132	7.920	0.005	369.3
8:43:06	8.718	0.133	7.980	0.006	369.7
8:43:09	8.719	0.134	8.040	0.006	370.2
8:43:12	8.72	0.135	8.100	0.006	370.6
8:43:15	8.721	0.136	8.160	0.006	371
8:43:18	8.722	0.137	8.220	0.006	371.6
8:43:22	8.723	0.138	8.280	0.006	371.8
8:43:25	8.724	0.139	8.340	0.006	372.5
8:43:28	8.724	0.139	8.340	0.006	372.9
8:43:31	8.725	0.140	8.400	0.006	373.3
8:43:34	8.726	0.141	8.460	0.006	373.8
8:43:37	8.727	0.142	8.520	0.006	374.4
8:43:41	8.728	0.143	8.580	0.006	374.6
8:43:44	8.729	0.144	8.640	0.006	375.2
8:43:47	8.73	0.145	8.700	0.006	375.5
8:43:50	8.731	0.146	8.760	0.006	376.3
8:43:53	8.731	0.146	8.760	0.006	376.7
8:43:57	8.732	0.147	8.820	0.006	377.2
8:44:00	8.733	0.148	8.880	0.006	377.5
8:44:03	8.734	0.149	8.940	0.006	378
8:44:06	8.735	0.150	9.000	0.006	378.3
8:44:09	8.736	0.151	9.060	0.006	378.9
8:44:12	8.737	0.152	9.120	0.006	379.4
8:44:16	8.738	0.153	9.180	0.006	380
8:44:19	8.739	0.154	9.240	0.006	380
8:44:22	8.739	0.154	9.240	0.006	380.1
8:44:25	8.74	0.155	9.300	0.006	380.6
8:44:29	8.741	0.156	9.360	0.006	380.9

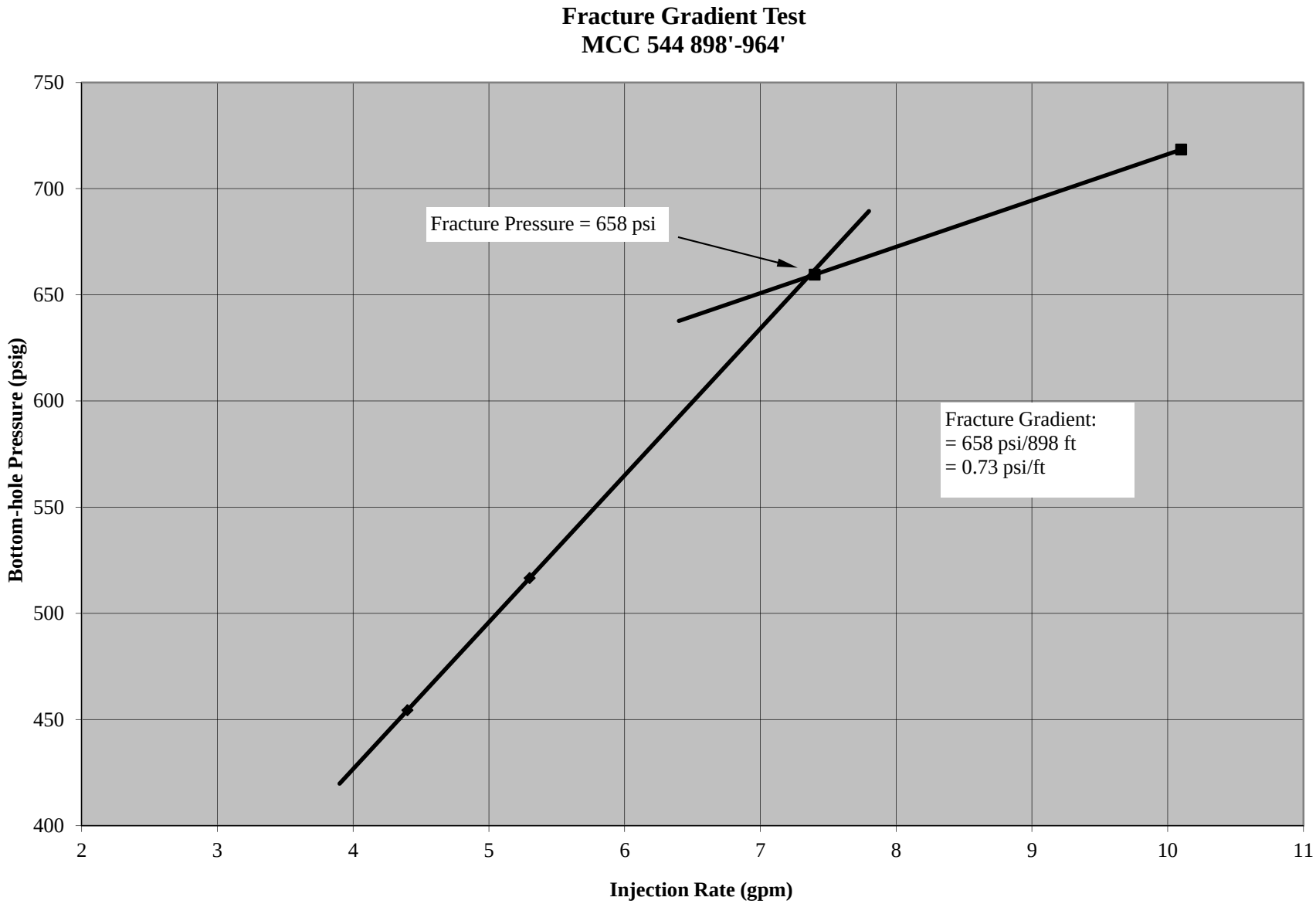
Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
8:44:32	8.742	0.157	9.420	0.007	381.6
8:44:35	8.743	0.158	9.480	0.007	381.8
8:44:38	8.744	0.159	9.540	0.007	382.2
8:44:41	8.745	0.160	9.600	0.007	382.7
8:44:44	8.746	0.161	9.660	0.007	383.2
8:48:31	8.809	0.224	13.440	0.009	338.9
8:48:34	8.809	0.224	13.440	0.009	337.8
8:48:37	8.81	0.225	13.500	0.009	337.2
8:48:40	8.811	0.226	13.560	0.009	335.9
8:48:44	8.812	0.227	13.620	0.009	335.4
8:48:47	8.813	0.228	13.680	0.009	334.7
8:48:52	8.814	0.229	13.740	0.010	334
8:48:55	8.815	0.230	13.800	0.010	333.5
8:48:58	8.816	0.231	13.860	0.010	333.1
8:49:01	8.817	0.232	13.920	0.010	332.6
8:49:04	8.818	0.233	13.980	0.010	332.3
8:49:08	8.819	0.234	14.040	0.010	331.9
8:49:12	8.82	0.235	14.100	0.010	331.4
8:49:16	8.821	0.236	14.160	0.010	331
8:49:19	8.822	0.237	14.220	0.010	330.7
8:49:22	8.823	0.238	14.280	0.010	330.5
8:49:25	8.824	0.239	14.340	0.010	330.2
8:49:28	8.825	0.240	14.400	0.010	330
8:49:31	8.825	0.240	14.400	0.010	330
8:49:35	8.826	0.241	14.460	0.010	329.7
8:49:38	8.827	0.242	14.520	0.010	329.6
8:49:41	8.828	0.243	14.580	0.010	329.4
8:49:44	8.829	0.244	14.640	0.010	329.1
8:49:47	8.83	0.245	14.700	0.010	329.2
8:49:51	8.831	0.246	14.760	0.010	329
8:50:08	8.836	0.251	15.060	0.010	328.1
8:50:16	8.838	0.253	15.180	0.011	328.6
8:50:21	8.839	0.254	15.240	0.011	328.6
8:50:26	8.84	0.255	15.300	0.011	328.2
8:50:30	8.842	0.257	15.420	0.011	328.2
8:50:35	8.843	0.258	15.480	0.011	327.1
8:50:40	8.844	0.259	15.540	0.011	327.4
8:50:45	8.846	0.261	15.660	0.011	327.4
8:50:50	8.847	0.262	15.720	0.011	327.2
8:50:54	8.848	0.263	15.780	0.011	327.3
8:50:59	8.85	0.265	15.900	0.011	326.9
8:51:04	8.851	0.266	15.960	0.011	388.7
8:51:09	8.852	0.267	16.020	0.011	382.2
8:51:13	8.854	0.269	16.140	0.011	383.2
8:51:18	8.855	0.270	16.200	0.011	383.3
8:51:23	8.856	0.271	16.260	0.011	383.5
8:51:28	8.858	0.273	16.380	0.011	383.5

Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
8:51:33	8.859	0.274	16.440	0.011	383.3
8:51:37	8.86	0.275	16.500	0.011	383.3
8:51:42	8.862	0.277	16.620	0.012	383.1
8:51:47	8.863	0.278	16.680	0.012	383.7
8:51:52	8.864	0.279	16.740	0.012	383
8:51:57	8.866	0.281	16.860	0.012	382.7
8:52:01	8.867	0.282	16.920	0.012	382.9
8:52:06	8.868	0.283	16.980	0.012	382.8
8:52:11	8.87	0.285	17.100	0.012	382.7
8:52:16	8.871	0.286	17.160	0.012	382.7
8:52:21	8.872	0.287	17.220	0.012	382.8
8:52:25	8.874	0.289	17.340	0.012	383
8:52:30	8.875	0.290	17.400	0.012	382.6
8:52:35	8.876	0.291	17.460	0.012	382.7
8:52:39	8.878	0.293	17.580	0.012	382.7
8:52:44	8.879	0.294	17.640	0.012	382.7
8:52:49	8.88	0.295	17.700	0.012	382.5
8:52:54	8.882	0.297	17.820	0.012	382.5
8:52:59	8.883	0.298	17.880	0.012	382.5
8:53:03	8.884	0.299	17.940	0.012	382.3
8:53:08	8.886	0.301	18.060	0.013	382.3
8:53:13	8.887	0.302	18.120	0.013	382.2
8:53:18	8.888	0.303	18.180	0.013	382.6
8:53:48	8.897	0.312	18.720	0.013	381.7
8:54:18	8.905	0.320	19.200	0.013	381.3
8:54:49	8.914	0.329	19.740	0.014	381.1
8:55:19	8.922	0.337	20.220	0.014	381.1
8:55:49	8.93	0.345	20.700	0.014	377
8:56:20	8.939	0.354	21.240	0.015	340.9
8:56:50	8.947	0.362	21.720	0.015	333.4
8:57:20	8.956	0.371	22.260	0.015	330.4
8:57:51	8.964	0.379	22.740	0.016	328.6
8:58:21	8.972	0.387	23.220	0.016	327.7
8:58:51	8.981	0.396	23.760	0.017	327.1
8:59:22	8.989	0.404	24.240	0.017	327
8:59:52	8.998	0.413	24.780	0.017	326.7
9:00:22	9.006	0.421	25.260	0.018	326.4
9:00:52	9.015	0.430	25.800	0.018	325.9
9:01:23	9.023	0.438	26.280	0.018	326.2
9:01:53	9.031	0.446	26.760	0.019	325.7
9:02:23	9.04	0.455	27.300	0.019	325.6
9:02:54	9.048	0.463	27.780	0.019	325.6
9:03:24	9.057	0.472	28.320	0.020	325.4
9:03:54	9.065	0.480	28.800	0.020	325.5
9:04:25	9.074	0.489	29.340	0.020	325.3
9:04:55	9.082	0.497	29.820	0.021	325.2
9:05:25	9.09	0.505	30.300	0.021	325.7

Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:05:56	9.099	0.514	30.840	0.021	325.2
9:06:26	9.107	0.522	31.320	0.022	325.1
9:06:56	9.116	0.531	31.860	0.022	325.5
9:07:26	9.124	0.539	32.340	0.022	325.2
9:07:57	9.132	0.547	32.820	0.023	325
9:08:27	9.141	0.556	33.360	0.023	325.1
9:08:58	9.149	0.564	33.840	0.023	325
9:09:28	9.158	0.573	34.380	0.024	325
9:09:58	9.166	0.581	34.860	0.024	325.5
9:10:28	9.175	0.590	35.400	0.025	325
9:10:59	9.183	0.598	35.880	0.025	324.6
9:11:29	9.191	0.606	36.360	0.025	324.6
9:11:59	9.2	0.615	36.900	0.026	325.1
9:12:30	9.208	0.623	37.380	0.026	324.5
9:13:00	9.217	0.632	37.920	0.026	324.5
9:13:30	9.225	0.640	38.400	0.027	324.7
9:14:00	9.233	0.648	38.880	0.027	324.7
9:14:31	9.242	0.657	39.420	0.027	324.7
9:15:01	9.25	0.665	39.900	0.028	325.2
9:15:31	9.259	0.674	40.440	0.028	325.1
9:16:02	9.267	0.682	40.920	0.028	324.5
9:16:32	9.276	0.691	41.460	0.029	324.6
9:17:02	9.284	0.699	41.940	0.029	324.6
9:17:33	9.292	0.707	42.420	0.029	325.3
9:18:03	9.301	0.716	42.960	0.030	324.4
9:18:33	9.309	0.724	43.440	0.030	324.4
9:19:04	9.318	0.733	43.980	0.031	324.4
9:19:34	9.326	0.741	44.460	0.031	324.4
9:20:04	9.335	0.750	45.000	0.031	324.5
9:20:35	9.343	0.758	45.480	0.032	324.5
9:21:05	9.351	0.766	45.960	0.032	324.7
9:21:35	9.36	0.775	46.500	0.032	324.4
9:22:06	9.368	0.783	46.980	0.033	324.5
9:22:36	9.377	0.792	47.520	0.033	324.9
9:23:06	9.385	0.800	48.000	0.033	324.4
9:23:36	9.393	0.808	48.480	0.034	373.7
9:24:07	9.402	0.817	49.020	0.034	373.8
9:24:37	9.41	0.825	49.500	0.034	373.4
9:26:21	9.439	0.854	51.240	0.036	378.1
9:26:51	9.448	0.863	51.780	0.036	483.1
9:27:21	9.456	0.871	52.260	0.036	353.7
9:27:52	9.464	0.879	52.740	0.037	334.9
9:28:24	9.473	0.888	53.280	0.037	330.2
9:28:54	9.482	0.897	53.820	0.037	328.5
9:29:24	9.49	0.905	54.300	0.038	327.5
9:29:55	9.499	0.914	54.840	0.038	384.7
9:30:25	9.507	0.922	55.320	0.038	383.4

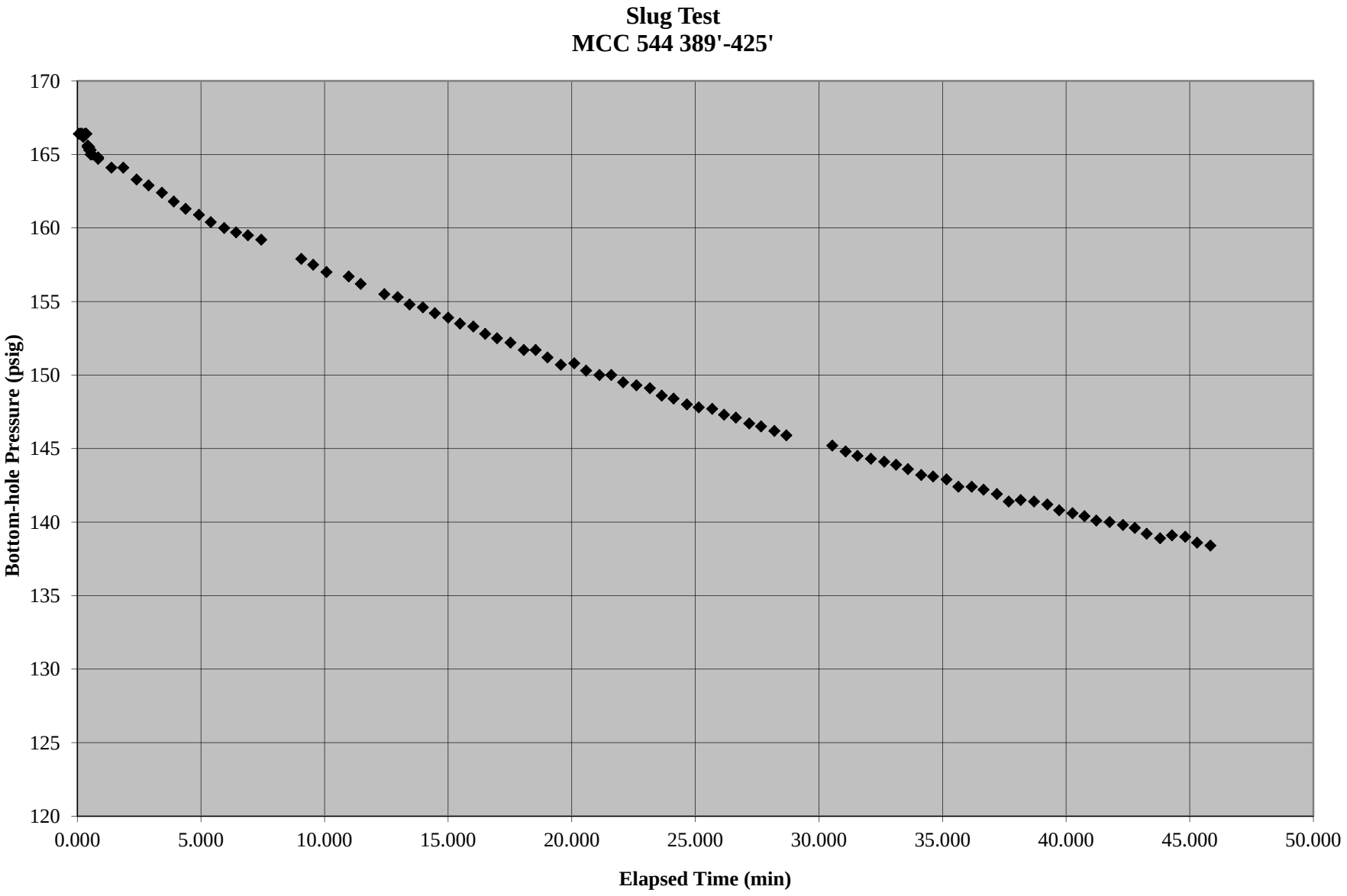
Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:30:55	9.515	0.930	55.800	0.039	382.8
9:31:26	9.524	0.939	56.340	0.039	382.2
9:31:56	9.532	0.947	56.820	0.039	380
9:32:26	9.541	0.956	57.360	0.040	443.4
9:32:57	9.549	0.964	57.840	0.040	416
9:33:27	9.557	0.972	58.320	0.041	396.9
9:34:00	9.567	0.982	58.920	0.041	391.3
9:34:04	9.568	0.983	58.980	0.041	389.1
9:34:07	9.569	0.984	59.040	0.041	388.6
9:34:10	9.569	0.984	59.040	0.041	388.1
9:34:13	9.57	0.985	59.100	0.041	387.6
9:34:16	9.571	0.986	59.160	0.041	385.2
9:34:20	9.572	0.987	59.220	0.041	383.9
9:34:23	9.573	0.988	59.280	0.041	384.5
9:34:26	9.574	0.989	59.340	0.041	385.4
9:34:29	9.575	0.990	59.400	0.041	389.2
9:34:32	9.576	0.991	59.460	0.041	396
9:34:35	9.577	0.992	59.520	0.041	414.1
9:34:39	9.577	0.992	59.520	0.041	454.2
9:34:42	9.578	0.993	59.580	0.041	488
9:34:45	9.579	0.994	59.640	0.041	461.9
9:34:48	9.58	0.995	59.700	0.041	446.8
9:34:51	9.581	0.996	59.760	0.041	436.9
9:34:55	9.582	0.997	59.820	0.042	429.8
9:34:58	9.583	0.998	59.880	0.042	424.1
9:35:01	9.584	0.999	59.940	0.042	419.6
9:35:04	9.584	0.999	59.940	0.042	416
9:35:07	9.585	1.000	60.000	0.042	412.9
9:35:11	9.586	1.001	60.060	0.042	410.1
9:35:14	9.587	1.002	60.120	0.042	407.8
9:35:17	9.588	1.003	60.180	0.042	405.8
9:35:20	9.589	1.004	60.240	0.042	403.9
9:35:23	9.59	1.005	60.300	0.042	402.2
9:35:26	9.591	1.006	60.360	0.042	400.8
9:35:30	9.592	1.007	60.420	0.042	399.5
9:35:33	9.592	1.007	60.420	0.042	398.3
9:35:36	9.593	1.008	60.480	0.042	397.2
9:35:39	9.594	1.009	60.540	0.042	396.3
9:35:42	9.595	1.010	60.600	0.042	395.3
9:35:46	9.596	1.011	60.660	0.042	395.1
9:35:49	9.597	1.012	60.720	0.042	394.3
9:35:52	9.598	1.013	60.780	0.042	393.7
9:35:55	9.599	1.014	60.840	0.042	392.7
9:35:58	9.6	1.015	60.900	0.042	391.5
9:36:02	9.6	1.015	60.900	0.042	390.8
9:36:05	9.601	1.016	60.960	0.042	391.1
9:36:08	9.602	1.017	61.020	0.042	390.3

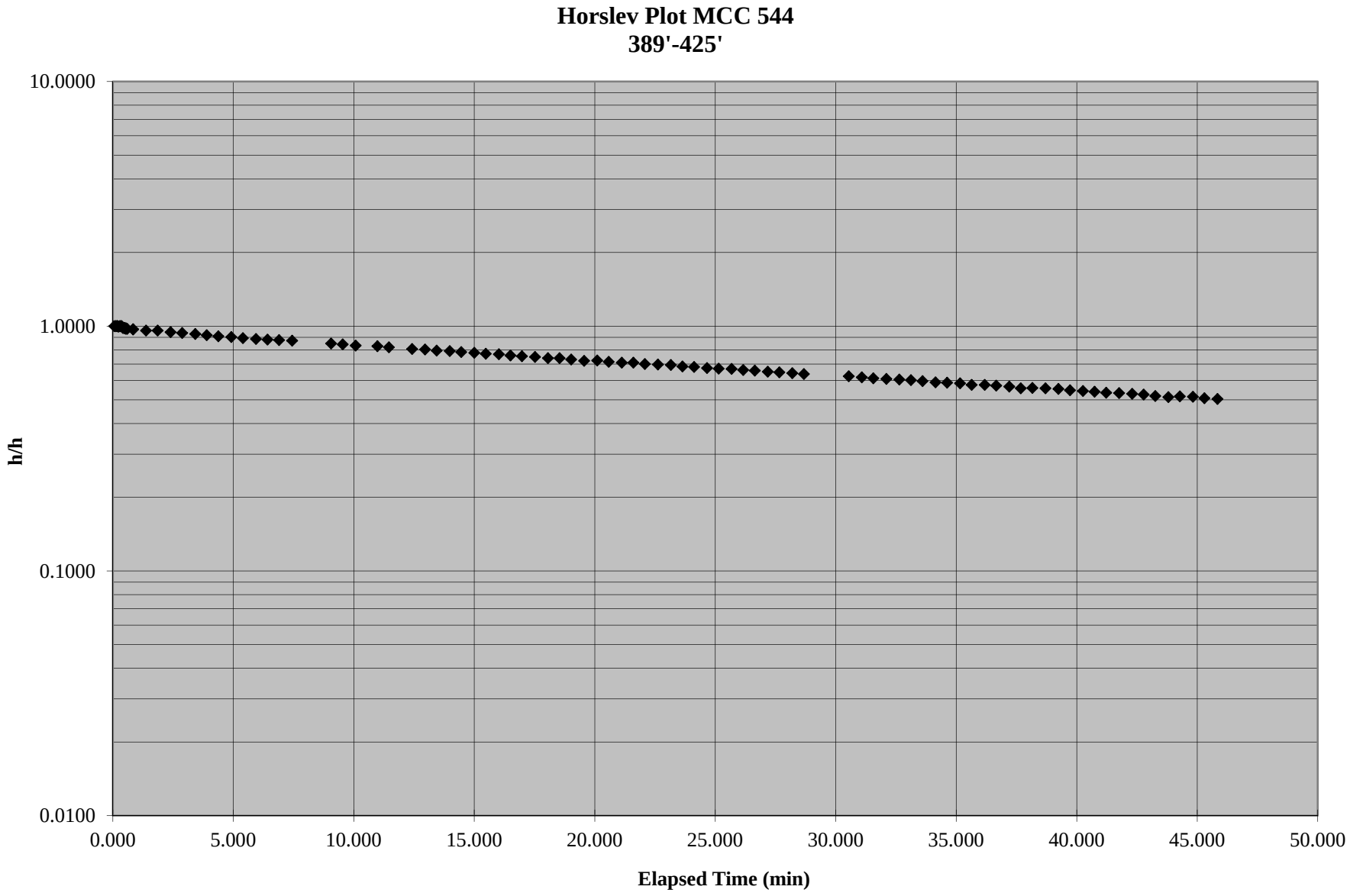
Slug Test Data MCC 544 898'-964'					
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)
9:36:11	9.603	1.018	61.080	0.042	389.2
9:36:14	9.604	1.019	61.140	0.042	388.6
9:36:18	9.605	1.020	61.200	0.043	388.2
9:36:21	9.606	1.021	61.260	0.043	387.7
9:36:24	9.607	1.022	61.320	0.043	387.3
9:36:27	9.608	1.023	61.380	0.043	387
9:36:30	9.608	1.023	61.380	0.043	386.6
9:36:34	9.609	1.024	61.440	0.043	386.2
9:36:37	9.61	1.025	61.500	0.043	385.8
9:37:07	9.619	1.034	62.040	0.043	383
9:37:37	9.627	1.042	62.520	0.043	380.5
9:38:08	9.635	1.050	63.000	0.044	380.2
9:38:38	9.644	1.059	63.540	0.044	388


Fracture Gradient Test
MCC 544 898'-964'
Fracture Pressure = 658 psi
Fracture Gradient:
= 658 psi/898 ft
= 0.73 psi/ft
Bottom-hole Pressure (psig)
750
700
650
600
550
500
450
400
2
3
4
5
6
7
8
9
10
11
Injection Rate (gpm)

Step Rate Injection Test Data MCC 544 898'-964'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
9:39:08	9.652	0.000	0.000	4.4	413	
9:39:39	9.661	0.009	0.540	4.4	433.9	
9:40:09	9.669	0.017	1.020	4.4	455.8	
9:40:39	9.678	0.026	1.560	4.4	452.1	
9:41:10	9.686	0.034	2.040	4.4	451.9	
9:41:40	9.694	0.042	2.520	4.4	452.6	
9:42:10	9.703	0.051	3.060	4.4	452.2	
9:42:41	9.711	0.059	3.540	4.4	452.5	
9:43:11	9.72	0.068	4.080	4.4	452.4	
9:43:41	9.728	0.076	4.560	4.4	452.6	
9:44:11	9.737	0.085	5.100	4.4	452.6	
9:44:42	9.745	0.093	5.580	4.4	453.1	
9:45:12	9.753	0.101	6.060	4.4	454.1	
9:45:42	9.762	0.110	6.600	4.4	453.1	
9:46:13	9.77	0.118	7.080	4.4	453.7	
9:46:43	9.779	0.127	7.620	4.4	453.8	
9:47:13	9.787	0.135	8.100	4.4	452.6	
9:47:44	9.795	0.143	8.580	4.4	452.2	
9:48:14	9.804	0.152	9.120	4.4	470.9	
9:48:44	9.812	0.160	9.600	4.4	457.1	
9:49:15	9.821	0.169	10.140	4.4	454.5	
9:49:45	9.829	0.177	10.620	4.4	454.5	
9:50:15	9.838	0.186	11.160	4.4	453.5	
9:50:45	9.846	0.194	11.640	4.4	452.8	
9:51:16	9.854	0.202	12.120	4.4	452.2	
9:51:46	9.863	0.211	12.660	4.4	452.6	
9:52:17	9.871	0.219	13.140	4.4	452.8	
9:52:47	9.88	0.228	13.680	4.4	452.8	
9:53:17	9.888	0.236	14.160	4.4	452.5	
9:53:47	9.896	0.244	14.640	4.4	453.1	
9:54:18	9.905	0.253	15.180	4.4	453.2	
9:54:48	9.913	0.261	15.660	4.4	452.6	
9:55:18	9.922	0.270	16.200	4.4	452.9	
9:55:49	9.93	0.278	16.680	4.4	453	
9:56:19	9.939	0.287	17.220	4.4	453.6	
9:56:49	9.947	0.295	17.700	4.4	454.2	
9:57:20	9.955	0.303	18.180	4.4	454.4	
9:57:50	9.964	0.312	18.720	5.3	467.6	
9:58:20	9.972	0.320	19.200	5.3	515.1	
9:58:51	9.981	0.329	19.740	5.3	513.1	
9:59:21	9.989	0.337	20.220	5.3	516.3	
9:59:51	9.998	0.346	20.760	5.3	515.7	
10:00:21	10.006	0.354	21.240	5.3	517.4	
10:00:52	10.014	0.362	21.720	5.3	516.9	
10:01:22	10.023	0.371	22.260	5.3	517	

10:01:52	10.031	0.379	22.740	5.3	516.1	
10:02:23	10.04	0.388	23.280	5.3	517.1	
10:02:53	10.048	0.396	23.760	5.3	518.7	
10:03:23	10.056	0.404	24.240	5.3	519.4	
10:03:54	10.065	0.413	24.780	5.3	519	
10:04:24	10.073	0.421	25.260	5.3	519.5	
10:04:54	10.082	0.430	25.800	5.3	518.2	
10:05:25	10.09	0.438	26.280	5.3	517.3	
10:05:55	10.099	0.447	26.820	5.3	515.6	
10:06:25	10.107	0.455	27.300	5.3	516	
10:06:56	10.115	0.463	27.780	5.3	516.2	
10:07:26	10.124	0.472	28.320	5.3	516.6	
10:07:56	10.132	0.480	28.800	7.4	616.2	
10:08:27	10.141	0.489	29.340	7.4	668.8	
10:08:57	10.149	0.497	29.820	7.4	666.3	
10:09:27	10.158	0.506	30.360	7.4	655.6	
10:09:57	10.166	0.514	30.840	7.4	654.1	
10:10:28	10.174	0.522	31.320	7.4	653	
10:10:58	10.183	0.531	31.860	7.4	652.6	
10:11:28	10.191	0.539	32.340	7.4	659.9	
10:11:59	10.2	0.548	32.880	7.4	651.1	
10:12:29	10.208	0.556	33.360	7.4	653.1	
10:12:59	10.216	0.564	33.840	7.4	652.2	
10:13:30	10.225	0.573	34.380	7.4	654.8	
10:14:00	10.233	0.581	34.860	7.4	655.6	
10:14:30	10.242	0.590	35.400	7.4	655.5	
10:15:00	10.25	0.598	35.880	7.4	660.6	
10:16:58	10.283	0.631	37.860	7.4	665.1	
10:17:29	10.291	0.639	38.340	7.4	659.5	
10:20:00	10.333	0.681	40.860	10.1	718.3	
10:20:31	10.342	0.690	41.400	10.1	709.8	
10:21:01	10.35	0.698	41.880	10.1	712.7	
10:21:31	10.359	0.707	42.420	10.1	708.9	
10:22:38	10.377	0.725	43.500	10.1	714.1	
10:23:08	10.386	0.734	44.040	10.1	707	
10:23:39	10.394	0.742	44.520	10.1	712.7	
10:24:09	10.403	0.751	45.060	10.1	709.5	
10:24:39	10.411	0.759	45.540	10.1	715.9	
10:25:10	10.419	0.767	46.020	10.1	714.2	
10:25:40	10.428	0.776	46.560	10.1	717.9	
10:26:10	10.436	0.784	47.040	10.1	718.4	End Test
10:26:41	10.445	0.793	47.580	-	394.4	
10:27:12	10.453	0.801	48.060	-	383.7	

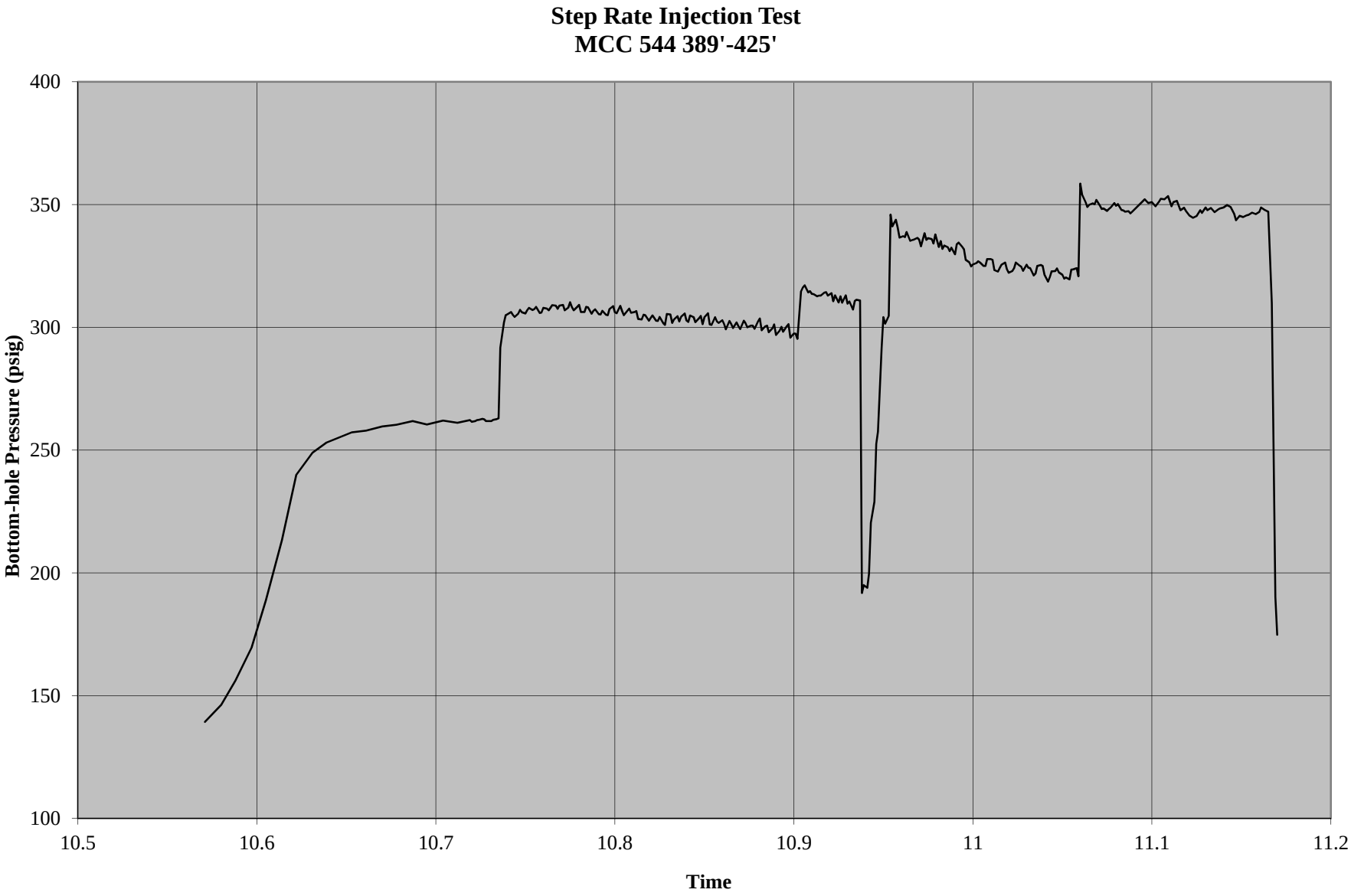

Slug Test
MCC 544 389'-425'
Bottom-hole Pressure (psig)
170
165
160
155
150
145
140
135
130
125
120
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

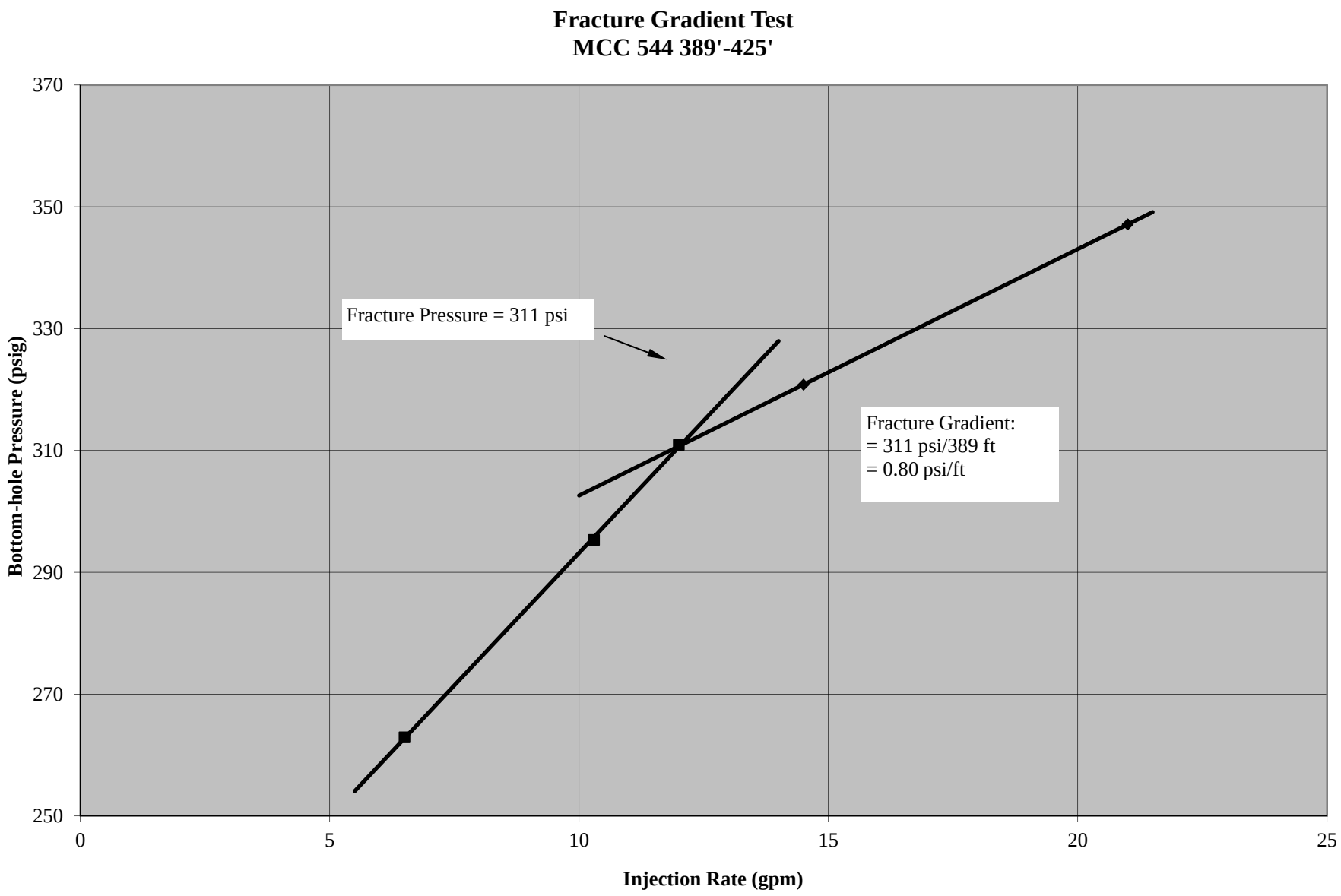

Horslev Plot MCC 544
389'-425'
10.0000
1.0000
0.1000
0.0100
h/h
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
9:47:56	9.799	-	-	-	109.9	-
9:48:01	9.8	0.001	0.060	0.000	166.4	1.0000
9:48:02	9.801	0.002	0.120	0.000	166.4	1.0000
9:48:04	9.801	0.002	0.120	0.000	166.4	1.0000
9:48:06	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:07	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:09	9.802	0.003	0.180	0.000	166.4	1.0000
9:48:10	9.803	0.004	0.240	0.000	166.2	0.9965
9:48:12	9.803	0.004	0.240	0.000	166.2	0.9965
9:48:14	9.804	0.005	0.300	0.000	166.4	1.0000
9:48:15	9.804	0.005	0.300	0.000	166.4	1.0000
9:48:17	9.805	0.006	0.360	0.000	166.4	1.0000
9:48:18	9.805	0.006	0.360	0.000	166.4	1.0000
9:48:20	9.806	0.007	0.420	0.000	165.6	0.9858
9:48:22	9.806	0.007	0.420	0.000	165.6	0.9858
9:48:23	9.806	0.007	0.420	0.000	165.5	0.9841
9:48:25	9.807	0.008	0.480	0.000	165.5	0.9841
9:48:26	9.807	0.008	0.480	0.000	165.3	0.9805
9:48:28	9.808	0.009	0.540	0.000	165.3	0.9805
9:48:30	9.808	0.009	0.540	0.000	165	0.9752
9:48:31	9.809	0.010	0.600	0.000	165	0.9752
9:48:47	9.813	0.014	0.840	0.001	164.7	0.9699
9:48:49	9.813	0.014	0.840	0.001	164.8	0.9717
9:49:19	9.822	0.023	1.380	0.001	164.1	0.9593
9:49:49	9.83	0.031	1.860	0.001	164.1	0.9593
9:50:19	9.839	0.040	2.400	0.002	163.3	0.9451
9:50:50	9.847	0.048	2.880	0.002	162.9	0.9381
9:51:20	9.856	0.057	3.420	0.002	162.4	0.9292
9:51:50	9.864	0.065	3.900	0.003	161.8	0.9186
9:52:20	9.872	0.073	4.380	0.003	161.3	0.9097
9:52:50	9.881	0.082	4.920	0.003	160.9	0.9027
9:53:21	9.889	0.090	5.400	0.004	160.4	0.8938
9:53:51	9.898	0.099	5.940	0.004	160	0.8867
9:54:21	9.906	0.107	6.420	0.004	159.7	0.8814
9:54:52	9.914	0.115	6.900	0.005	159.5	0.8779
9:55:22	9.923	0.124	7.440	0.005	159.2	0.8726
9:56:59	9.95	0.151	9.060	0.006	157.9	0.8496
9:57:29	9.958	0.159	9.540	0.007	157.5	0.8425
9:58:00	9.967	0.168	10.080	0.007	157	0.8336
9:58:55	9.982	0.183	10.980	0.008	156.7	0.8283
9:59:25	9.99	0.191	11.460	0.008	156.2	0.8195
10:00:21	10.006	0.207	12.420	0.009	155.5	0.8071
10:00:53	10.015	0.216	12.960	0.009	155.3	0.8035
10:01:23	10.023	0.224	13.440	0.009	154.8	0.7947
10:01:54	10.032	0.233	13.980	0.010	154.6	0.7912

Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:02:24	10.04	0.241	14.460	0.010	154.2	0.7841
10:02:56	10.049	0.250	15.000	0.010	153.9	0.7788
10:03:26	10.057	0.258	15.480	0.011	153.5	0.7717
10:03:56	10.066	0.267	16.020	0.011	153.3	0.7681
10:04:26	10.074	0.275	16.500	0.011	152.8	0.7593
10:04:57	10.082	0.283	16.980	0.012	152.5	0.7540
10:05:27	10.091	0.292	17.520	0.012	152.2	0.7487
10:05:59	10.1	0.301	18.060	0.013	151.7	0.7398
10:06:29	10.108	0.309	18.540	0.013	151.7	0.7398
10:06:59	10.116	0.317	19.020	0.013	151.2	0.7310
10:07:31	10.125	0.326	19.560	0.014	150.7	0.7221
10:08:01	10.134	0.335	20.100	0.014	150.8	0.7239
10:08:32	10.142	0.343	20.580	0.014	150.3	0.7150
10:09:02	10.151	0.352	21.120	0.015	150	0.7097
10:09:32	10.159	0.360	21.600	0.015	150	0.7097
10:10:03	10.167	0.368	22.080	0.015	149.5	0.7009
10:10:34	10.176	0.377	22.620	0.016	149.3	0.6973
10:11:04	10.185	0.386	23.160	0.016	149.1	0.6938
10:11:35	10.193	0.394	23.640	0.016	148.6	0.6850
10:12:05	10.201	0.402	24.120	0.017	148.4	0.6814
10:12:35	10.21	0.411	24.660	0.017	148	0.6743
10:13:06	10.218	0.419	25.140	0.017	147.8	0.6708
10:13:36	10.227	0.428	25.680	0.018	147.7	0.6690
10:14:06	10.235	0.436	26.160	0.018	147.3	0.6619
10:14:36	10.243	0.444	26.640	0.019	147.1	0.6584
10:15:07	10.252	0.453	27.180	0.019	146.7	0.6513
10:15:37	10.26	0.461	27.660	0.019	146.5	0.6478
10:16:09	10.269	0.470	28.200	0.020	146.2	0.6425
10:16:39	10.277	0.478	28.680	0.020	145.9	0.6372
10:18:31	10.308	0.509	30.540	0.021	145.2	0.6248
10:19:01	10.317	0.518	31.080	0.022	144.8	0.6177
10:19:31	10.325	0.526	31.560	0.022	144.5	0.6124
10:20:01	10.334	0.535	32.100	0.022	144.3	0.6088
10:20:33	10.343	0.544	32.640	0.023	144.1	0.6053
10:21:03	10.351	0.552	33.120	0.023	143.9	0.6018
10:21:34	10.359	0.560	33.600	0.023	143.6	0.5965
10:22:04	10.368	0.569	34.140	0.024	143.2	0.5894
10:22:34	10.376	0.577	34.620	0.024	143.1	0.5876
10:23:05	10.385	0.586	35.160	0.024	142.9	0.5841
10:23:35	10.393	0.594	35.640	0.025	142.4	0.5752
10:24:06	10.402	0.603	36.180	0.025	142.4	0.5752
10:24:37	10.41	0.611	36.660	0.025	142.2	0.5717
10:25:07	10.419	0.620	37.200	0.026	141.9	0.5664
10:25:37	10.427	0.628	37.680	0.026	141.4	0.5575
10:26:08	10.435	0.636	38.160	0.027	141.5	0.5593
10:26:38	10.444	0.645	38.700	0.027	141.4	0.5575
10:27:10	10.453	0.654	39.240	0.027	141.2	0.5540

Slug Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:27:40	10.461	0.662	39.720	0.028	140.8	0.5469
10:28:10	10.47	0.671	40.260	0.028	140.6	0.5434
10:28:41	10.478	0.679	40.740	0.028	140.4	0.5398
10:29:11	10.486	0.687	41.220	0.029	140.1	0.5345
10:29:43	10.495	0.696	41.760	0.029	140	0.5327
10:30:13	10.504	0.705	42.300	0.029	139.8	0.5292
10:30:43	10.512	0.713	42.780	0.030	139.6	0.5257
10:31:13	10.52	0.721	43.260	0.030	139.2	0.5186
10:31:44	10.529	0.730	43.800	0.030	138.9	0.5133
10:32:14	10.537	0.738	44.280	0.031	139.1	0.5168
10:32:44	10.546	0.747	44.820	0.031	139	0.5150
10:33:16	10.554	0.755	45.300	0.031	138.6	0.5080
10:33:46	10.563	0.764	45.840	0.032	138.4	0.5044


Step Rate Injection Test
MCC 544 389'-425'
Bottom-hole Pressure (psig)
400
350
300
250
200
150
100
10.5
10.6
10.7
10.8
10.9
11
11.1
11.2
Time


Fracture Gradient Test
MCC 544 389'-425'
Bottom-hole Pressure (psig)
370
350
330
310
290
270
250
0
5
10
15
20
25
Injection Rate (gpm)
Fracture Pressure = 311 psi
Fracture Gradient:
= 311 psi/389 ft
= 0.80 psi/ft

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:34:17	10.571	0.000	0.000	6.5	139.3	
10:34:47	10.58	0.009	0.540	6.5	146.2	
10:35:17	10.588	0.017	1.020	6.5	156.1	
10:35:49	10.597	0.026	1.560	6.5	169.5	
10:36:19	10.605	0.034	2.040	6.5	188.8	
10:36:50	10.614	0.043	2.580	6.5	213.3	
10:37:20	10.622	0.051	3.060	6.5	239.9	
10:37:50	10.631	0.060	3.600	6.5	248.9	
10:38:20	10.639	0.068	4.080	6.5	253.1	
10:39:10	10.653	0.082	4.920	6.5	257.2	
10:39:40	10.661	0.090	5.400	6.5	257.9	
10:40:10	10.67	0.099	5.940	6.5	259.6	
10:40:41	10.678	0.107	6.420	6.5	260.3	
10:41:12	10.687	0.116	6.960	6.5	261.8	
10:41:43	10.695	0.124	7.440	6.5	260.4	
10:42:13	10.704	0.133	7.980	6.5	262	
10:42:45	10.712	0.141	8.460	6.5	261.1	
10:43:08	10.719	0.148	8.880	6.5	262.2	
10:43:13	10.72	0.149	8.940	6.5	261.5	
10:43:18	10.722	0.151	9.060	6.5	261.8	
10:43:23	10.723	0.152	9.120	6.5	262.2	
10:43:28	10.724	0.153	9.180	6.5	262.3	
10:43:32	10.726	0.155	9.300	6.5	262.7	
10:43:37	10.727	0.156	9.360	6.5	262.5	
10:43:42	10.728	0.157	9.420	6.5	261.8	
10:43:47	10.73	0.159	9.540	6.5	261.8	
10:43:52	10.731	0.160	9.600	6.5	261.8	
10:43:56	10.732	0.161	9.660	6.5	262.3	
10:44:01	10.734	0.163	9.780	6.5	262.6	
10:44:06	10.735	0.164	9.840	6.5	262.9	
10:44:11	10.736	0.165	9.900	10.3	291.7	
10:44:15	10.738	0.167	10.020	10.3	302	
10:44:20	10.739	0.168	10.080	10.3	304.9	
10:44:25	10.74	0.169	10.140	10.3	305.3	
10:44:30	10.742	0.171	10.260	10.3	306.2	
10:44:35	10.743	0.172	10.320	10.3	305	
10:44:39	10.744	0.173	10.380	10.3	304.2	
10:44:44	10.746	0.175	10.500	10.3	305.5	
10:44:49	10.747	0.176	10.560	10.3	307.1	
10:44:54	10.748	0.177	10.620	10.3	306.1	
10:44:59	10.75	0.179	10.740	10.3	305.6	
10:45:03	10.751	0.180	10.800	10.3	306.9	
10:45:08	10.752	0.181	10.860	10.3	307.9	
10:45:13	10.754	0.183	10.980	10.3	307	
10:45:18	10.755	0.184	11.040	10.3	307.4	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:45:22	10.756	0.185	11.100	10.3	308.3	
10:45:27	10.758	0.187	11.220	10.3	305.8	
10:45:32	10.759	0.188	11.280	10.3	306	
10:45:37	10.76	0.189	11.340	10.3	307.9	
10:45:42	10.762	0.191	11.460	10.3	307.6	
10:45:46	10.763	0.192	11.520	10.3	306.9	
10:45:51	10.764	0.193	11.580	10.3	307.9	
10:45:56	10.765	0.194	11.640	10.3	309	
10:46:01	10.767	0.196	11.760	10.3	308.8	
10:46:05	10.768	0.197	11.820	10.3	307.5	
10:46:10	10.769	0.198	11.880	10.3	308.8	
10:46:15	10.771	0.200	12.000	10.3	309.1	
10:46:20	10.772	0.201	12.060	10.3	306.9	
10:46:25	10.774	0.203	12.180	10.3	308	
10:46:29	10.775	0.204	12.240	10.3	310.2	
10:46:34	10.776	0.205	12.300	10.3	308.2	
10:46:39	10.777	0.206	12.360	10.3	306.9	
10:46:44	10.779	0.208	12.480	10.3	308.3	
10:46:48	10.78	0.209	12.540	10.3	309.1	
10:46:53	10.781	0.210	12.600	10.3	306.2	
10:46:58	10.783	0.212	12.720	10.3	306.2	
10:47:03	10.784	0.213	12.780	10.3	308.3	
10:47:07	10.785	0.214	12.840	10.3	308.1	
10:47:12	10.787	0.216	12.960	10.3	305.5	
10:47:17	10.788	0.217	13.020	10.3	306.7	
10:47:22	10.789	0.218	13.080	10.3	307.3	
10:47:26	10.791	0.220	13.200	10.3	305.3	
10:47:31	10.792	0.221	13.260	10.3	305.2	
10:47:36	10.793	0.222	13.320	10.3	306.7	
10:47:41	10.795	0.224	13.440	10.3	305.1	
10:47:46	10.796	0.225	13.500	10.3	304.9	
10:47:50	10.797	0.226	13.560	10.3	307.4	
10:47:55	10.799	0.228	13.680	10.3	308.6	
10:48:00	10.8	0.229	13.740	10.3	306.1	
10:48:05	10.801	0.230	13.800	10.3	305.7	
10:48:10	10.803	0.232	13.920	10.3	308.7	
10:48:14	10.804	0.233	13.980	10.3	306.6	
10:48:19	10.805	0.234	14.040	10.3	304.9	
10:48:24	10.807	0.236	14.160	10.3	306.7	
10:48:29	10.808	0.237	14.220	10.3	307.6	
10:48:34	10.809	0.238	14.280	10.3	305.9	
10:48:38	10.811	0.240	14.400	10.3	306.2	
10:48:43	10.812	0.241	14.460	10.3	306.6	
10:48:48	10.813	0.242	14.520	10.3	303.4	
10:48:53	10.815	0.244	14.640	10.3	303.2	
10:48:57	10.816	0.245	14.700	10.3	305.1	
10:49:02	10.817	0.246	14.760	10.3	304.9	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:49:07	10.819	0.248	14.880	10.3	302.7	
10:49:12	10.82	0.249	14.940	10.3	303.8	
10:49:16	10.821	0.250	15.000	10.3	304.8	
10:49:21	10.823	0.252	15.120	10.3	302.7	
10:49:26	10.824	0.253	15.180	10.3	302.6	
10:49:31	10.825	0.254	15.240	10.3	304.2	
10:49:36	10.827	0.256	15.360	10.3	301.7	
10:49:40	10.828	0.257	15.420	10.3	301	
10:49:45	10.829	0.258	15.480	10.3	305.4	
10:49:50	10.831	0.260	15.600	10.3	305.2	
10:49:55	10.832	0.261	15.660	10.3	301.8	
10:49:59	10.833	0.262	15.720	10.3	303.2	
10:50:04	10.835	0.264	15.840	10.3	304.5	
10:50:09	10.836	0.265	15.900	10.3	302.4	
10:50:14	10.837	0.266	15.960	10.3	304.3	
10:50:19	10.839	0.268	16.080	10.3	305.6	
10:50:23	10.84	0.269	16.140	10.3	302.8	
10:50:28	10.841	0.270	16.200	10.3	302.2	
10:50:33	10.842	0.271	16.260	10.3	304.8	
10:50:38	10.844	0.273	16.380	10.3	304.1	
10:50:42	10.845	0.274	16.440	10.3	302.1	
10:50:47	10.847	0.276	16.560	10.3	303.7	
10:50:52	10.848	0.277	16.620	10.3	304.6	
10:50:57	10.849	0.278	16.680	10.3	301.3	
10:51:02	10.85	0.279	16.740	10.3	304.1	
10:51:06	10.852	0.281	16.860	10.3	305.7	
10:51:11	10.853	0.282	16.920	10.3	301.2	
10:51:16	10.854	0.283	16.980	10.3	301	
10:51:21	10.856	0.285	17.100	10.3	304.1	
10:51:25	10.857	0.286	17.160	10.3	302.4	
10:51:30	10.858	0.287	17.220	10.3	301.8	
10:51:35	10.86	0.289	17.340	10.3	302.9	
10:51:40	10.861	0.290	17.400	10.3	301.4	
10:51:45	10.862	0.291	17.460	10.3	299.2	
10:51:49	10.864	0.293	17.580	10.3	302.6	
10:51:54	10.865	0.294	17.640	10.3	301.3	
10:51:59	10.866	0.295	17.700	10.3	299.7	
10:52:04	10.868	0.297	17.820	10.3	302	
10:52:08	10.869	0.298	17.880	10.3	300.5	
10:52:13	10.87	0.299	17.940	10.3	299.3	
10:52:18	10.872	0.301	18.060	10.3	302.7	
10:52:23	10.873	0.302	18.120	10.3	301.7	
10:52:27	10.874	0.303	18.180	10.3	300	
10:52:33	10.876	0.305	18.300	10.3	300.7	
10:52:37	10.877	0.306	18.360	10.3	300.7	
10:52:42	10.878	0.307	18.420	10.3	299.4	
10:52:47	10.88	0.309	18.540	10.3	302.5	

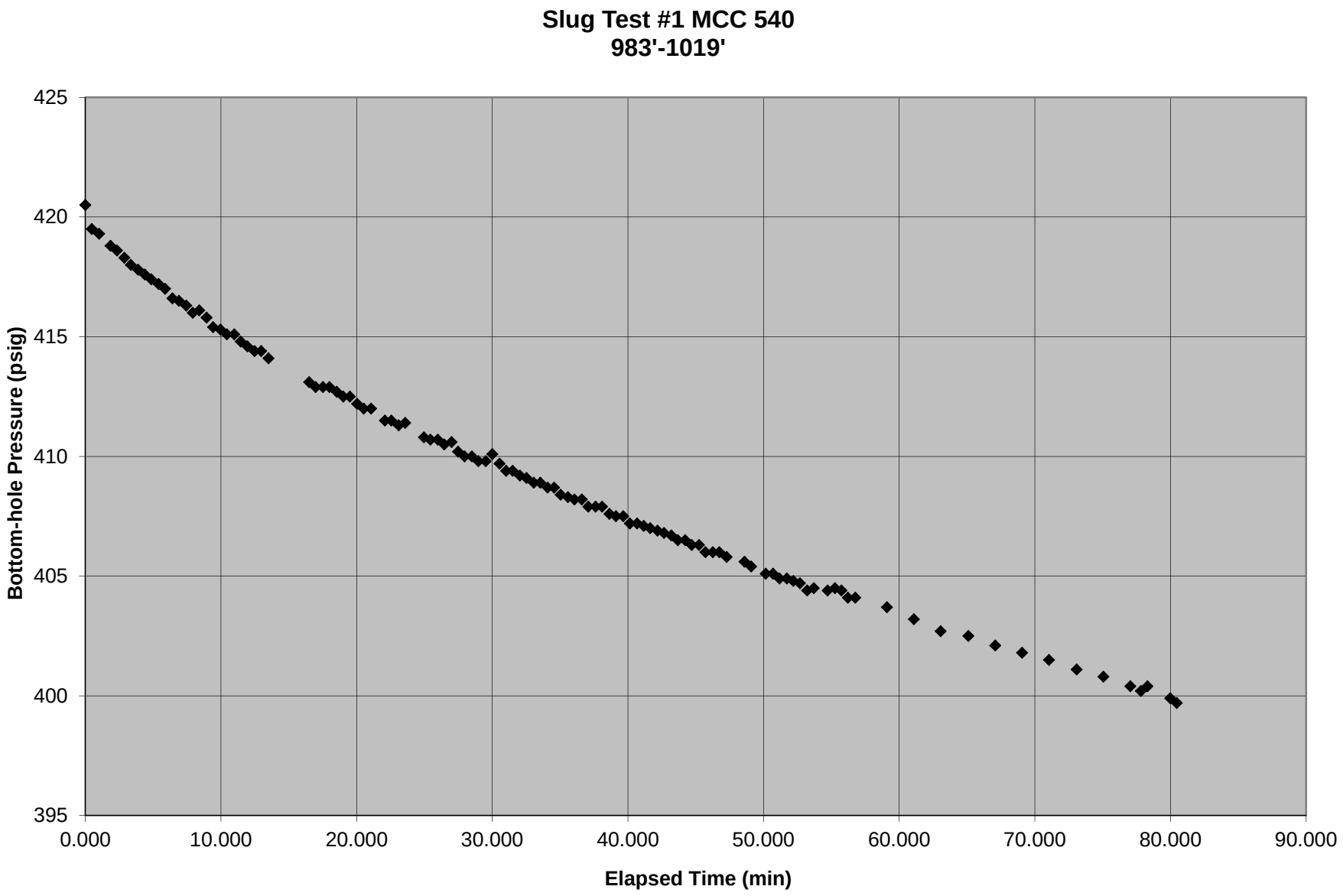
Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:52:51	10.881	0.310	18.600	10.3	303.6	
10:52:56	10.882	0.311	18.660	10.3	298.8	
10:53:01	10.884	0.313	18.780	10.3	300.4	
10:53:06	10.885	0.314	18.840	10.3	300.7	
10:53:10	10.886	0.315	18.900	10.3	298	
10:53:15	10.888	0.317	19.020	10.3	299.6	
10:53:20	10.889	0.318	19.080	10.3	301.2	
10:53:25	10.89	0.319	19.140	10.3	296.9	
10:53:30	10.892	0.321	19.260	10.3	298.6	
10:53:34	10.893	0.322	19.320	10.3	300.2	
10:53:39	10.894	0.323	19.380	10.3	298.2	
10:53:44	10.896	0.325	19.500	10.3	300.4	
10:53:49	10.897	0.326	19.560	10.3	301.3	
10:53:53	10.898	0.327	19.620	10.3	295.8	
10:53:58	10.9	0.329	19.740	10.3	297.5	
10:54:03	10.901	0.330	19.800	10.3	297.4	
10:54:08	10.902	0.331	19.860	10.3	295.3	
10:54:13	10.904	0.333	19.980	12	314.6	
10:54:17	10.905	0.334	20.040	12	316.2	
10:54:22	10.906	0.335	20.100	12	317.1	
10:54:27	10.908	0.337	20.220	12	314.2	
10:54:32	10.909	0.338	20.280	12	314.7	
10:54:37	10.91	0.339	20.340	12	313.6	
10:54:41	10.911	0.340	20.400	12	313.5	
10:54:46	10.913	0.342	20.520	12	312.6	
10:54:51	10.914	0.343	20.580	12	312.9	
10:54:56	10.915	0.344	20.640	12	312.9	
10:55:00	10.917	0.346	20.760	12	314.1	
10:55:05	10.918	0.347	20.820	12	314.3	
10:55:10	10.919	0.348	20.880	12	312.9	
10:55:15	10.921	0.350	21.000	12	313.9	
10:55:20	10.922	0.351	21.060	12	310.6	
10:55:24	10.923	0.352	21.120	12	313	
10:55:29	10.925	0.354	21.240	12	310.1	
10:55:34	10.926	0.355	21.300	12	312.6	
10:55:39	10.927	0.356	21.360	12	310	
10:55:43	10.929	0.358	21.480	12	313	
10:55:48	10.93	0.359	21.540	12	309.6	
10:55:53	10.931	0.360	21.600	12	310.5	
10:55:58	10.933	0.362	21.720	12	307.2	
10:56:02	10.934	0.363	21.780	12	310.7	
10:56:07	10.935	0.364	21.840	12	311.2	
10:56:12	10.937	0.366	21.960	12	310.9	
10:56:17	10.938	0.367	22.020	14.5	191.8	
10:56:22	10.939	0.368	22.080	14.5	195	
10:56:26	10.941	0.370	22.200	14.5	193.9	
10:56:31	10.942	0.371	22.260	14.5	199.7	

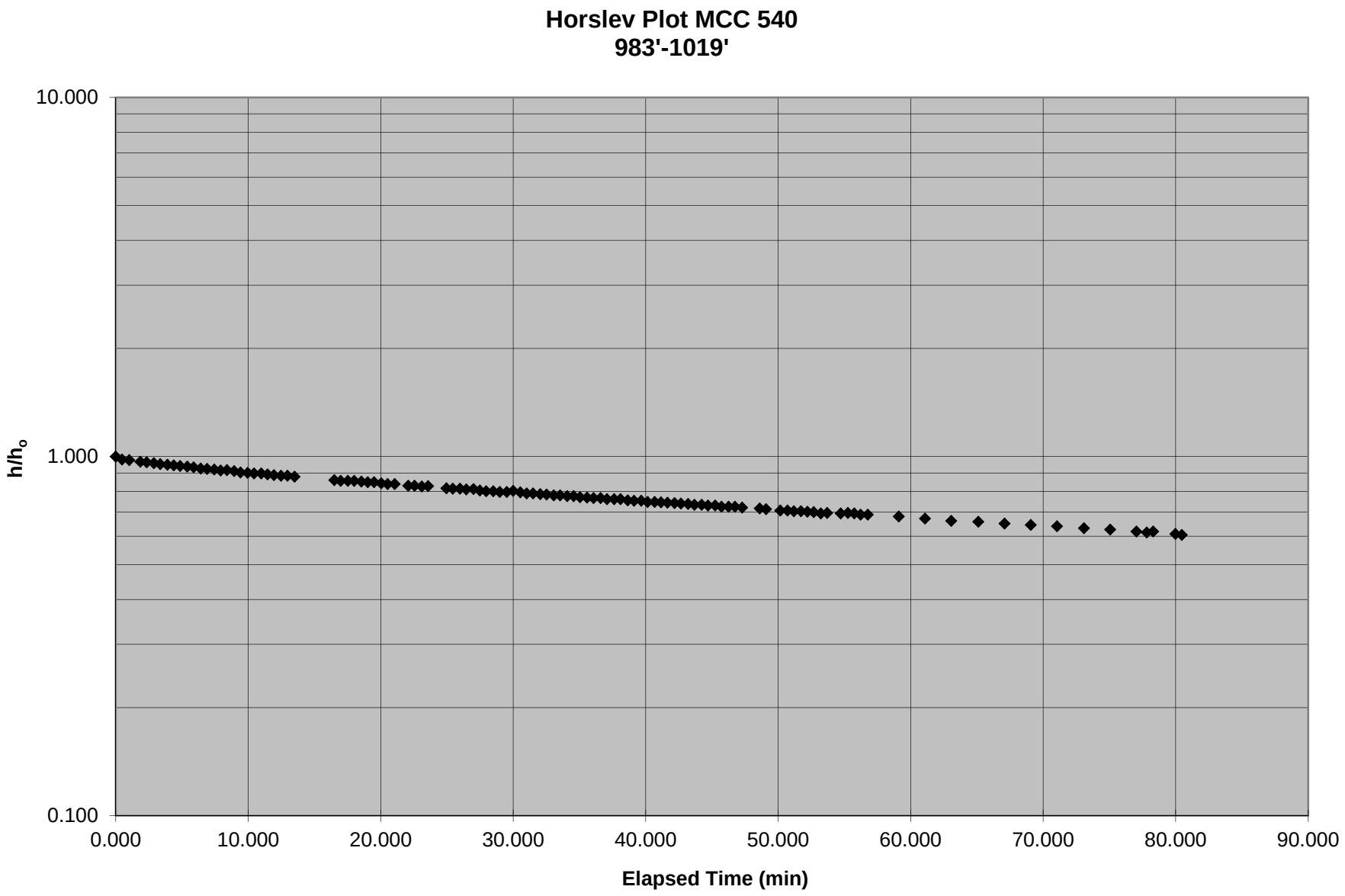
Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
10:56:36	10.943	0.372	22.320	14.5	220.4	
10:56:41	10.945	0.374	22.440	14.5	229	
10:56:46	10.946	0.375	22.500	14.5	252.5	
10:56:50	10.947	0.376	22.560	14.5	257.5	
10:56:55	10.949	0.378	22.680	14.5	291.7	
10:57:00	10.95	0.379	22.740	14.5	304.1	
10:57:05	10.951	0.380	22.800	14.5	301.5	
10:57:09	10.953	0.382	22.920	14.5	304.6	
10:57:14	10.954	0.383	22.980	14.5	345.9	
10:57:19	10.955	0.384	23.040	14.5	341.1	
10:57:24	10.957	0.386	23.160	14.5	343.8	
10:57:29	10.958	0.387	23.220	14.5	340.6	
10:57:33	10.959	0.388	23.280	14.5	336.5	
10:57:38	10.961	0.390	23.400	14.5	337.1	
10:57:43	10.962	0.391	23.460	14.5	336.8	
10:57:48	10.963	0.392	23.520	14.5	338.8	
10:57:53	10.965	0.394	23.640	14.5	335.2	
10:57:57	10.966	0.395	23.700	14.5	335.5	
10:58:02	10.967	0.396	23.760	14.5	335.7	
10:58:07	10.969	0.398	23.880	14.5	336.4	
10:58:12	10.97	0.399	23.940	14.5	335.7	
10:58:16	10.971	0.400	24.000	14.5	333	
10:58:21	10.973	0.402	24.120	14.5	338.3	
10:58:26	10.974	0.403	24.180	14.5	335.6	
10:58:31	10.975	0.404	24.240	14.5	336.3	
10:58:35	10.977	0.406	24.360	14.5	335.9	
10:58:40	10.978	0.407	24.420	14.5	334.1	
10:58:45	10.979	0.408	24.480	14.5	337.8	
10:58:50	10.981	0.410	24.600	14.5	332.7	
10:58:55	10.982	0.411	24.660	14.5	335.1	
10:58:59	10.983	0.412	24.720	14.5	331.9	
10:59:04	10.984	0.413	24.780	14.5	333.3	
10:59:09	10.986	0.415	24.900	14.5	332.6	
10:59:14	10.987	0.416	24.960	14.5	331	
10:59:18	10.988	0.417	25.020	14.5	332.4	
10:59:23	10.99	0.419	25.140	14.5	329.7	
10:59:28	10.991	0.420	25.200	14.5	333.8	
10:59:33	10.992	0.421	25.260	14.5	334.5	
10:59:38	10.994	0.423	25.380	14.5	332.8	
10:59:42	10.995	0.424	25.440	14.5	331.7	
10:59:47	10.996	0.425	25.500	14.5	327.5	
10:59:52	10.998	0.427	25.620	14.5	326.5	
10:59:57	10.999	0.428	25.680	14.5	324.8	
11:00:02	11	0.429	25.740	14.5	325.6	
11:00:06	11.002	0.431	25.860	14.5	326.2	
11:00:11	11.003	0.432	25.920	14.5	326.9	
11:00:16	11.004	0.433	25.980	14.5	326.4	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:00:21	11.006	0.435	26.100	14.5	325	
11:00:26	11.007	0.436	26.160	14.5	325	
11:00:30	11.008	0.437	26.220	14.5	327.8	
11:00:35	11.01	0.439	26.340	14.5	327.8	
11:00:40	11.011	0.440	26.400	14.5	327.5	
11:00:45	11.012	0.441	26.460	14.5	323.3	
11:00:49	11.014	0.443	26.580	14.5	322.7	
11:00:54	11.015	0.444	26.640	14.5	324.2	
11:00:59	11.016	0.445	26.700	14.5	325.5	
11:01:04	11.018	0.447	26.820	14.5	326.4	
11:01:08	11.019	0.448	26.880	14.5	323.7	
11:01:13	11.02	0.449	26.940	14.5	322.2	
11:01:18	11.022	0.451	27.060	14.5	322.9	
11:01:23	11.023	0.452	27.120	14.5	324.1	
11:01:27	11.024	0.453	27.180	14.5	326.4	
11:01:32	11.026	0.455	27.300	14.5	325.2	
11:01:37	11.027	0.456	27.360	14.5	324.7	
11:01:42	11.028	0.457	27.420	14.5	323	
11:01:47	11.03	0.459	27.540	14.5	325.5	
11:01:51	11.031	0.460	27.600	14.5	324.3	
11:01:56	11.032	0.461	27.660	14.5	324.1	
11:02:01	11.034	0.463	27.780	14.5	321.1	
11:02:06	11.035	0.464	27.840	14.5	321.9	
11:02:10	11.036	0.465	27.900	14.5	325	
11:02:15	11.038	0.467	28.020	14.5	325.4	
11:02:20	11.039	0.468	28.080	14.5	325	
11:02:25	11.04	0.469	28.140	14.5	321.4	
11:02:30	11.042	0.471	28.260	14.5	318.6	
11:02:34	11.043	0.472	28.320	14.5	320.5	
11:02:39	11.044	0.473	28.380	14.5	322.8	
11:02:44	11.046	0.475	28.500	14.5	322.9	
11:02:49	11.047	0.476	28.560	14.5	324	
11:02:54	11.048	0.477	28.620	14.5	322.4	
11:02:58	11.05	0.479	28.740	14.5	321.4	
11:03:03	11.051	0.480	28.800	14.5	319.8	
11:03:08	11.052	0.481	28.860	14.5	320.3	
11:03:13	11.054	0.483	28.980	14.5	319.5	
11:03:17	11.055	0.484	29.040	14.5	323.5	
11:03:22	11.056	0.485	29.100	14.5	323.6	
11:03:27	11.058	0.487	29.220	14.5	324.1	
11:03:32	11.059	0.488	29.280	14.5	320.8	
11:03:37	11.06	0.489	29.340	21	358.5	
11:03:41	11.061	0.490	29.400	21	354	
11:03:46	11.063	0.492	29.520	21	350.9	
11:03:51	11.064	0.493	29.580	21	349	
11:03:56	11.065	0.494	29.640	21	349.9	
11:04:00	11.067	0.496	29.760	21	350.5	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:04:05	11.068	0.497	29.820	21	350.1	
11:04:10	11.069	0.498	29.880	21	351.9	
11:04:15	11.071	0.500	30.000	21	349.5	
11:04:20	11.072	0.501	30.060	21	348.2	
11:04:24	11.073	0.502	30.120	21	348.4	
11:04:29	11.075	0.504	30.240	21	347.4	
11:04:34	11.076	0.505	30.300	21	348.2	
11:04:39	11.077	0.506	30.360	21	348.8	
11:04:44	11.079	0.508	30.480	21	350.6	
11:04:48	11.08	0.509	30.540	21	349.5	
11:04:53	11.081	0.510	30.600	21	350.2	
11:04:58	11.083	0.512	30.720	21	347.8	
11:05:02	11.084	0.513	30.780	21	347.6	
11:05:08	11.085	0.514	30.840	21	347.1	
11:05:12	11.087	0.516	30.960	21	347.3	
11:05:17	11.088	0.517	31.020	21	346.4	
11:05:22	11.089	0.518	31.080	21	347.1	
11:05:47	11.096	0.525	31.500	21	352.1	
11:05:54	11.098	0.527	31.620	21	350.6	
11:06:00	11.1	0.529	31.740	21	351	
11:06:06	11.102	0.531	31.860	21	349.3	
11:06:13	11.104	0.533	31.980	21	351.2	
11:06:19	11.105	0.534	32.040	21	352.3	
11:06:25	11.107	0.536	32.160	21	352.1	
11:06:32	11.109	0.538	32.280	21	353.4	
11:06:38	11.111	0.540	32.400	21	349.3	
11:06:45	11.112	0.541	32.460	21	351	
11:06:51	11.114	0.543	32.580	21	351.5	
11:06:57	11.116	0.545	32.700	21	347.7	
11:07:04	11.118	0.547	32.820	21	348.7	
11:07:10	11.119	0.548	32.880	21	347.4	
11:07:16	11.121	0.550	33.000	21	345.5	
11:07:23	11.123	0.552	33.120	21	344.6	
11:07:29	11.125	0.554	33.240	21	345.3	
11:07:36	11.127	0.556	33.360	21	347.7	
11:07:42	11.128	0.557	33.420	21	346.6	
11:07:47	11.13	0.559	33.540	21	348.8	
11:07:53	11.131	0.560	33.600	21	347.7	
11:07:59	11.133	0.562	33.720	21	348.6	
11:08:06	11.135	0.564	33.840	21	346.9	
11:08:12	11.137	0.566	33.960	21	348	
11:08:18	11.138	0.567	34.020	21	348.4	
11:08:25	11.14	0.569	34.140	21	348.8	
11:08:31	11.142	0.571	34.260	21	349.8	
11:08:38	11.144	0.573	34.380	21	349	
11:08:44	11.146	0.575	34.500	21	346.2	
11:08:50	11.147	0.576	34.560	21	343.6	

Step Rate Injection Test Data MCC 544 389'-425'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (gpm)	
11:08:57	11.149	0.578	34.680	21	345.4	
11:09:03	11.151	0.580	34.800	21	344.9	
11:09:09	11.153	0.582	34.920	21	345.6	
11:09:16	11.154	0.583	34.980	21	345.8	
11:09:22	11.156	0.585	35.100	21	346.7	
11:09:29	11.158	0.587	35.220	21	346.1	
11:09:35	11.16	0.589	35.340	21	347	
11:09:41	11.161	0.590	35.400	21	348.8	
11:09:48	11.163	0.592	35.520	21	347.8	
11:09:54	11.165	0.594	35.640	21	347.1	
11:10:00	11.167	0.596	35.760		309.8	
11:10:07	11.169	0.598	35.880		190.2	
11:10:13	11.17	0.599	35.940		174.8	

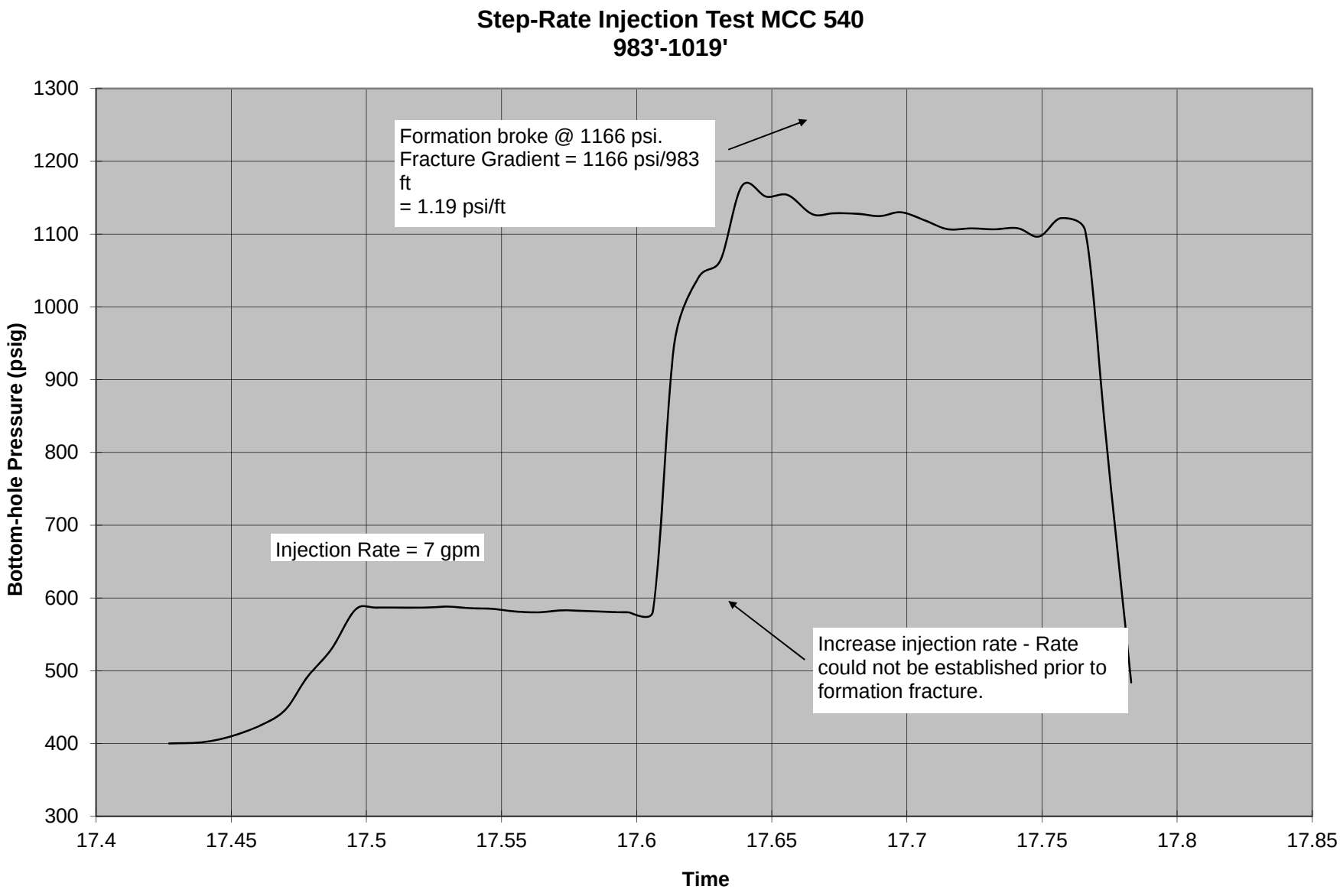

Slug Test #1 MCC 540
983'-1019'
Bottom-hole Pressure (psig)
425
420
415
410
405
400
395
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
90.000
Elapsed Time (min)


Horslev Plot MCC 540
983'-1019'
10.000
1.000
0.100
h/h$_o$
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
80.000
90.000
Elapsed Time (min)

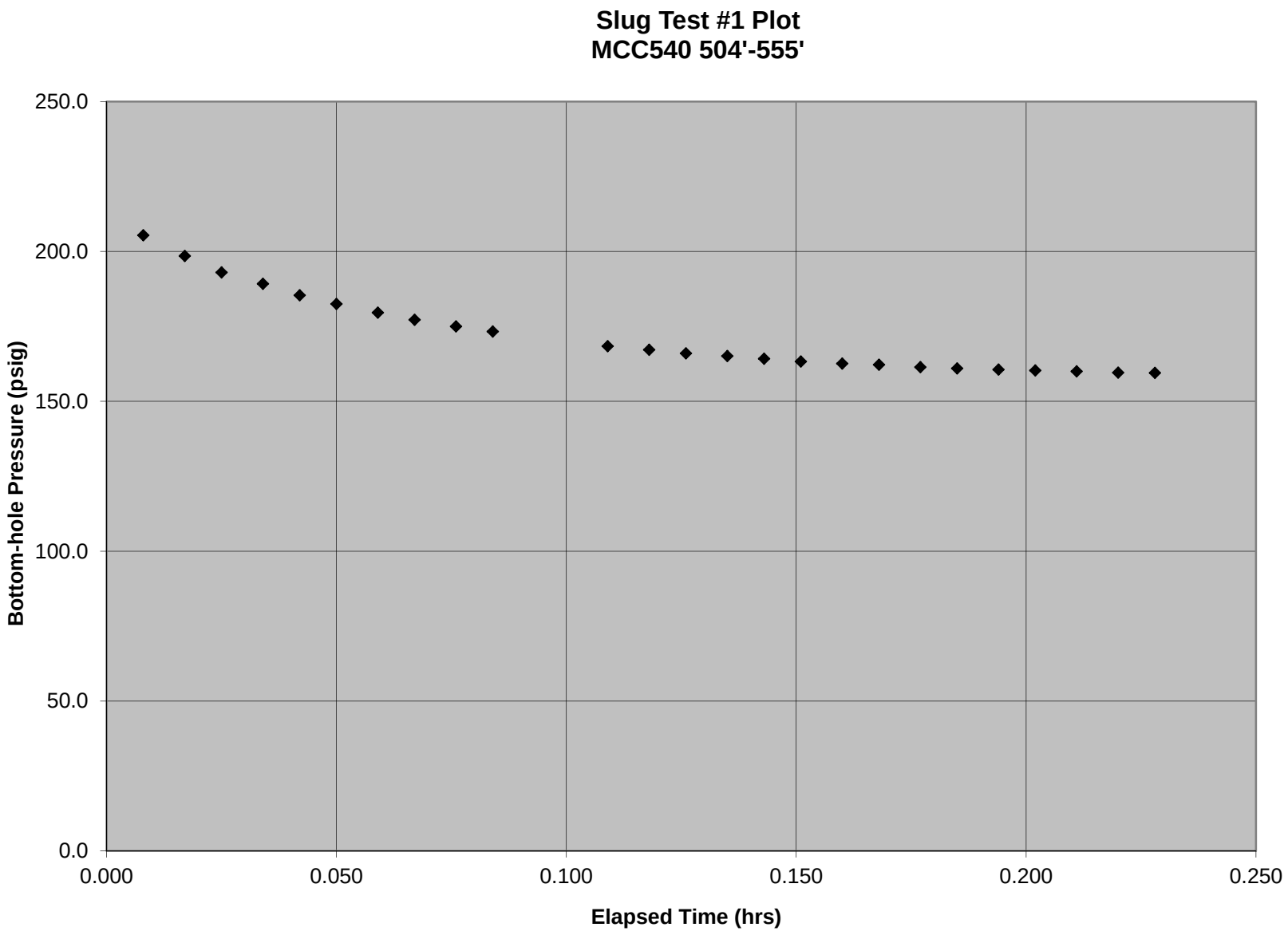
Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
16:00:37	16.01	-	-	-	367.8	-
16:04:40	16.078	0.000	0.000	0.000	420.5	1.000
16:05:11	16.086	0.008	0.480	0.000	419.5	0.981
16:05:41	16.095	0.017	1.020	0.001	419.3	0.977
16:06:32	16.109	0.031	1.860	0.001	418.8	0.968
16:07:02	16.117	0.039	2.340	0.002	418.6	0.964
16:07:33	16.126	0.048	2.880	0.002	418.3	0.958
16:08:03	16.134	0.056	3.360	0.002	418	0.953
16:08:33	16.143	0.065	3.900	0.003	417.8	0.949
16:09:04	16.151	0.073	4.380	0.003	417.6	0.945
16:09:34	16.159	0.081	4.860	0.003	417.4	0.941
16:10:04	16.168	0.090	5.400	0.004	417.2	0.937
16:10:35	16.176	0.098	5.880	0.004	417	0.934
16:11:05	16.185	0.107	6.420	0.004	416.6	0.926
16:11:35	16.193	0.115	6.900	0.005	416.5	0.924
16:12:06	16.202	0.124	7.440	0.005	416.3	0.920
16:12:36	16.21	0.132	7.920	0.006	416	0.915
16:13:06	16.218	0.140	8.400	0.006	416.1	0.917
16:13:37	16.227	0.149	8.940	0.006	415.8	0.911
16:14:07	16.235	0.157	9.420	0.007	415.4	0.903
16:14:37	16.244	0.166	9.960	0.007	415.3	0.901
16:15:08	16.252	0.174	10.440	0.007	415.1	0.898
16:15:38	16.261	0.183	10.980	0.008	415.1	0.898
16:16:08	16.269	0.191	11.460	0.008	414.8	0.892
16:16:39	16.277	0.199	11.940	0.008	414.6	0.888
16:17:09	16.286	0.208	12.480	0.009	414.4	0.884
16:17:39	16.294	0.216	12.960	0.009	414.4	0.884
16:18:10	16.303	0.225	13.500	0.009	414.1	0.879
16:21:10	16.353	0.275	16.500	0.011	413.1	0.860
16:21:41	16.361	0.283	16.980	0.012	412.9	0.856
16:22:11	16.37	0.292	17.520	0.012	412.9	0.856
16:22:41	16.378	0.300	18.000	0.013	412.9	0.856
16:23:12	16.387	0.309	18.540	0.013	412.7	0.852
16:23:42	16.395	0.317	19.020	0.013	412.5	0.848
16:24:12	16.403	0.325	19.500	0.014	412.5	0.848
16:24:43	16.412	0.334	20.040	0.014	412.2	0.843
16:25:13	16.42	0.342	20.520	0.014	412	0.839
16:25:43	16.429	0.351	21.060	0.015	412	0.839
16:26:46	16.446	0.368	22.080	0.015	411.5	0.829
16:27:16	16.454	0.376	22.560	0.016	411.5	0.829
16:27:46	16.463	0.385	23.100	0.016	411.3	0.825
16:28:17	16.471	0.393	23.580	0.016	411.4	0.827
16:29:38	16.494	0.416	24.960	0.017	410.8	0.816
16:30:08	16.502	0.424	25.440	0.018	410.7	0.814
16:30:39	16.511	0.433	25.980	0.018	410.7	0.814

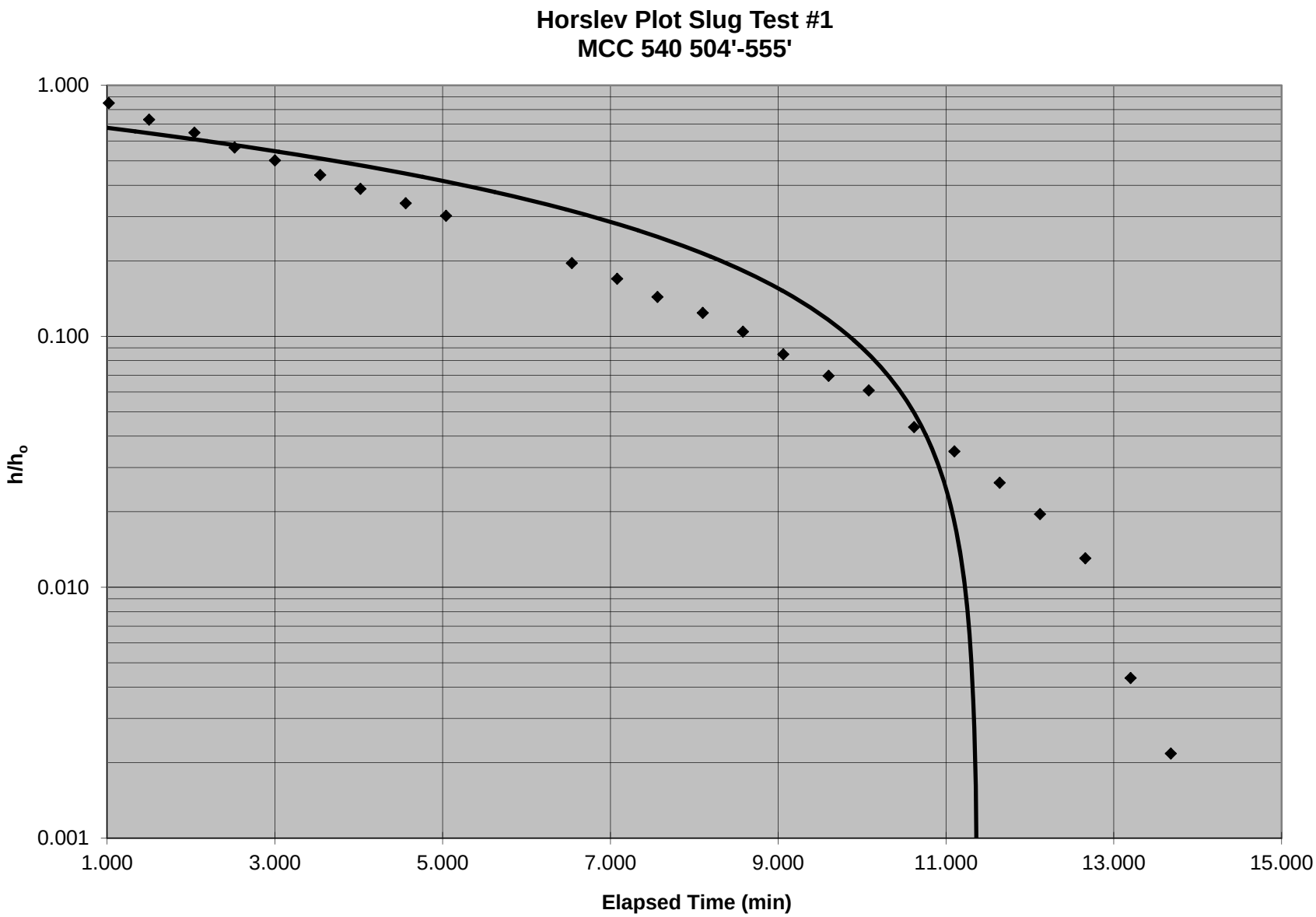
Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
16:31:09	16.519	0.441	26.460	0.018	410.5	0.810
16:31:39	16.528	0.450	27.000	0.019	410.6	0.812
16:32:10	16.536	0.458	27.480	0.019	410.2	0.805
16:32:40	16.544	0.466	27.960	0.019	410	0.801
16:33:10	16.553	0.475	28.500	0.020	410	0.801
16:33:41	16.561	0.483	28.980	0.020	409.8	0.797
16:34:11	16.57	0.492	29.520	0.021	409.8	0.797
16:34:41	16.578	0.500	30.000	0.021	410.1	0.803
16:35:12	16.587	0.509	30.540	0.021	409.7	0.795
16:35:42	16.595	0.517	31.020	0.022	409.4	0.789
16:36:13	16.603	0.525	31.500	0.022	409.4	0.789
16:36:43	16.612	0.534	32.040	0.022	409.2	0.786
16:37:13	16.62	0.542	32.520	0.023	409.1	0.784
16:37:44	16.629	0.551	33.060	0.023	408.9	0.780
16:38:14	16.637	0.559	33.540	0.023	408.9	0.780
16:38:44	16.646	0.568	34.080	0.024	408.7	0.776
16:39:14	16.654	0.576	34.560	0.024	408.7	0.776
16:39:45	16.662	0.584	35.040	0.024	408.4	0.770
16:40:15	16.671	0.593	35.580	0.025	408.3	0.769
16:40:45	16.679	0.601	36.060	0.025	408.2	0.767
16:41:16	16.688	0.610	36.600	0.025	408.2	0.767
16:41:46	16.696	0.618	37.080	0.026	407.9	0.761
16:42:16	16.705	0.627	37.620	0.026	407.9	0.761
16:42:47	16.713	0.635	38.100	0.026	407.9	0.761
16:43:19	16.722	0.644	38.640	0.027	407.6	0.755
16:43:49	16.73	0.652	39.120	0.027	407.5	0.753
16:44:19	16.739	0.661	39.660	0.028	407.5	0.753
16:44:50	16.747	0.669	40.140	0.028	407.2	0.748
16:45:20	16.756	0.678	40.680	0.028	407.2	0.748
16:45:50	16.764	0.686	41.160	0.029	407.1	0.746
16:46:21	16.772	0.694	41.640	0.029	407	0.744
16:46:51	16.781	0.703	42.180	0.029	406.9	0.742
16:47:21	16.789	0.711	42.660	0.030	406.8	0.740
16:47:52	16.798	0.720	43.200	0.030	406.7	0.738
16:48:22	16.806	0.728	43.680	0.030	406.5	0.734
16:48:53	16.815	0.737	44.220	0.031	406.5	0.734
16:49:24	16.823	0.745	44.700	0.031	406.3	0.731
16:49:55	16.832	0.754	45.240	0.031	406.3	0.731
16:50:25	16.84	0.762	45.720	0.032	406	0.725
16:50:55	16.849	0.771	46.260	0.032	406	0.725
16:51:26	16.857	0.779	46.740	0.032	406	0.725
16:51:56	16.866	0.788	47.280	0.033	405.8	0.721
16:53:16	16.888	0.810	48.600	0.034	405.6	0.717
16:53:46	16.896	0.818	49.080	0.034	405.4	0.713
16:54:52	16.914	0.836	50.160	0.035	405.1	0.708
16:55:22	16.923	0.845	50.700	0.035	405.1	0.708
16:55:52	16.931	0.853	51.180	0.036	404.9	0.704

Slug Test Data MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
16:56:23	16.94	0.862	51.720	0.036	404.9	0.704
16:56:53	16.948	0.870	52.200	0.036	404.8	0.702
16:57:23	16.956	0.878	52.680	0.037	404.7	0.700
16:57:54	16.965	0.887	53.220	0.037	404.4	0.694
16:58:24	16.973	0.895	53.700	0.037	404.5	0.696
16:59:25	16.99	0.912	54.720	0.038	404.4	0.694
16:59:55	16.999	0.921	55.260	0.038	404.5	0.696
17:00:25	17.007	0.929	55.740	0.039	404.4	0.694
17:00:56	17.015	0.937	56.220	0.039	404.1	0.689
17:01:26	17.024	0.946	56.760	0.039	404.1	0.689
17:03:46	17.063	0.985	59.100	0.041	403.7	0.681
17:05:46	17.096	1.018	61.080	0.042	403.2	0.672
17:07:46	17.129	1.051	63.060	0.044	402.7	0.662
17:09:45	17.163	1.085	65.100	0.045	402.5	0.658
17:11:45	17.196	1.118	67.080	0.047	402.1	0.651
17:13:45	17.229	1.151	69.060	0.048	401.8	0.645
17:15:45	17.262	1.184	71.040	0.049	401.5	0.639
17:17:45	17.296	1.218	73.080	0.051	401.1	0.632
17:19:44	17.329	1.251	75.060	0.052	400.8	0.626
17:21:44	17.362	1.284	77.040	0.054	400.4	0.619
17:22:29	17.375	1.297	77.820	0.054	400.2	0.615
17:22:59	17.383	1.305	78.300	0.054	400.4	0.619
17:24:38	17.411	1.333	79.980	0.056	399.9	0.609
17:25:08	17.419	1.341	80.460	0.056	399.7	0.605

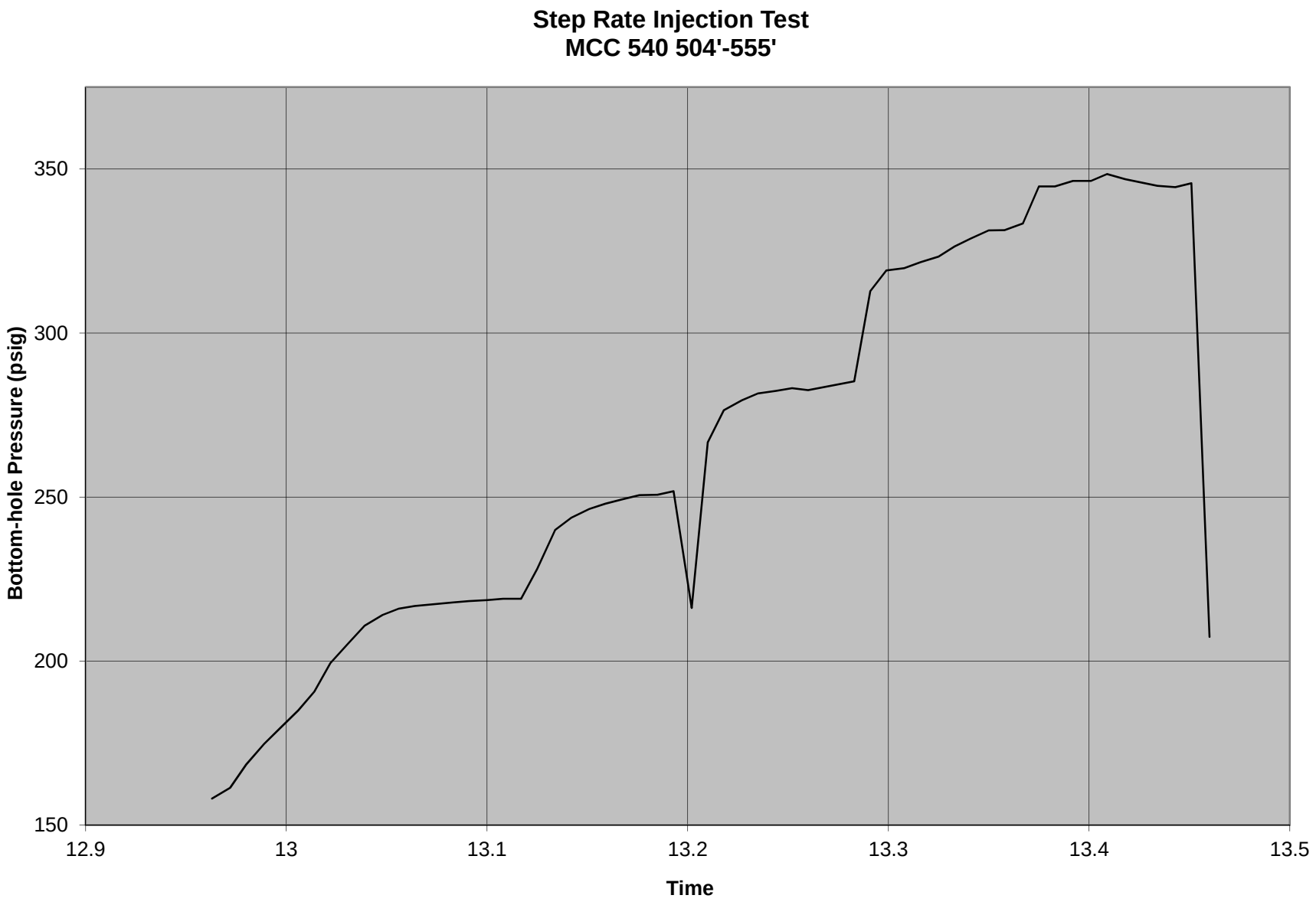

Step-Rate Injection Test MCC 540
983'-1019'
Formation broke @ 1166 psi.
Fracture Gradient = 1166 psi/983 ft
= 1.19 psi/ft
Injection Rate = 7 gpm
Increase injection rate - Rate could not be established prior to formation fracture.
Bottom-hole Pressure (psig)
1300
1200
1100
1000
900
800
700
600
500
400
300
17.4
17.45
17.5
17.55
17.6
17.65
17.7
17.75
17.8
17.85
Time

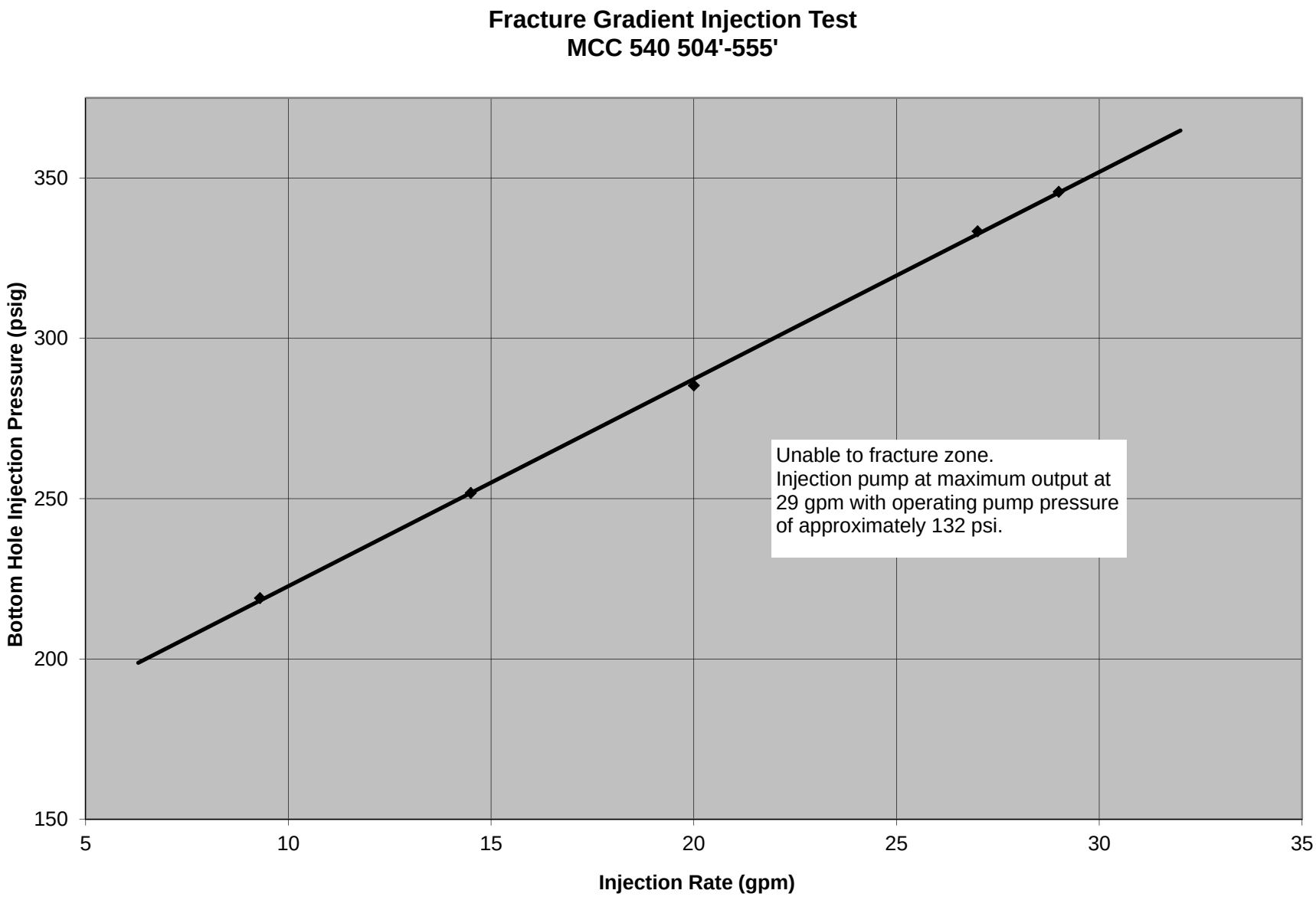
Step Rate Injection Test MCC 540 983'-1019'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
17:25:39	17.427	0.000	0.000	7	400	
17:26:09	17.436	0.009	0.540	7	401	
17:26:39	17.444	0.017	1.020	7	404.2	
17:27:10	17.453	0.026	1.560	7	413.6	
17:27:40	17.461	0.034	2.040	7	425.2	
17:28:10	17.47	0.043	2.580	7	446.2	
17:28:41	17.478	0.051	3.060	7	490.7	
17:29:14	17.487	0.060	3.600	7	529.3	
17:29:45	17.496	0.069	4.140	7	584.1	
17:30:15	17.504	0.077	4.620	7	586.7	
17:31:17	17.521	0.094	5.640	7	586.6	
17:31:47	17.53	0.103	6.180	7	588.1	
17:32:18	17.538	0.111	6.660	7	586	
17:32:48	17.547	0.120	7.200	7	584.9	
17:33:19	17.555	0.128	7.680	7	581.4	
17:33:49	17.564	0.137	8.220	7	580.3	
17:34:19	17.572	0.145	8.700	7	582.9	
17:34:50	17.58	0.153	9.180	7	582.2	
17:35:20	17.589	0.162	9.720	7	580.9	
17:35:50	17.597	0.170	10.200	7	580.3	
17:36:21	17.606	0.179	10.740	7	581.4	Increase Rate
17:36:51	17.614	0.187	11.220		950.9	
17:37:21	17.623	0.196	11.760		1040.8	
17:37:52	17.631	0.204	12.240		1063.8	
17:38:22	17.639	0.212	12.720		1166.2	Fm. Fractured
17:38:52	17.648	0.221	13.260		1151.3	
17:39:23	17.656	0.229	13.740		1153.5	
17:39:53	17.665	0.238	14.280		1127.2	
17:40:23	17.673	0.246	14.760		1128.6	
17:40:54	17.682	0.255	15.300		1127.8	
17:41:24	17.69	0.263	15.780		1124.6	
17:41:54	17.698	0.271	16.260		1129.9	
17:42:25	17.707	0.280	16.800		1118.2	
17:42:55	17.715	0.288	17.280		1106.7	
17:43:25	17.724	0.297	17.820		1107.8	
17:43:56	17.732	0.305	18.300		1106.4	
17:44:26	17.741	0.314	18.840		1108	
17:44:57	17.749	0.322	19.320		1096.6	
17:45:27	17.757	0.330	19.800		1121.8	
17:45:57	17.766	0.339	20.340		1104.2	
17:46:27	17.774	0.347	20.820		807.1	
17:46:58	17.783	0.356	21.360		483.8	
Note: Could not establish rate before formation fractured at 1166 psi.						
Fracture gradient = 1166 psi/983 ft = 1.19 psi/ft.						


Slug Test #1 Plot
MCC540 504'-555'
250.0
200.0
150.0
100.0
50.0
0.0
Bottom-hole Pressure (psig)
0.000
0.050
0.100
0.150
0.200
0.250
Elapsed Time (hrs)


Horslev Plot Slug Test #1
MCC 540 504'-555'
1.000
0.100
0.010
0.001
h/h$_o$
1.000
3.000
5.000
7.000
9.000
11.000
13.000
15.000
Elapsed Time (min)

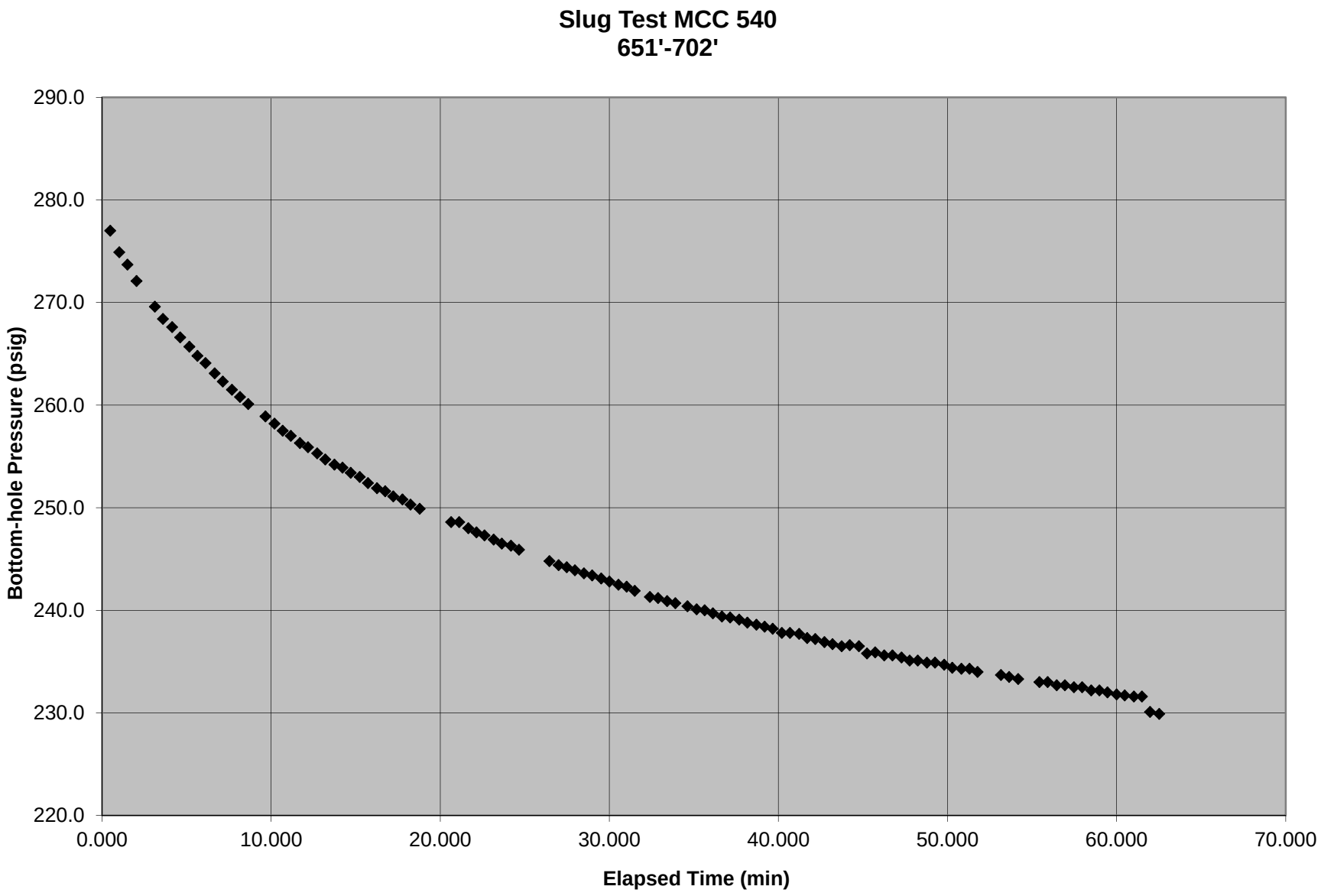
Slug Test Data MCC 540 504'-555'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
12:32:33	12.543	0.000	0.000	0.000	159.4	-
12:33:05	12.551	0.008	0.480	3.33E-04	205.4	1.000
12:33:35	12.560	0.017	1.020	7.08E-04	198.5	0.850
12:34:06	12.568	0.025	1.500	1.04E-03	193.0	0.730
12:34:36	12.577	0.034	2.040	1.42E-03	189.2	0.648
12:35:06	12.585	0.042	2.520	1.75E-03	185.4	0.565
12:35:36	12.593	0.050	3.000	2.08E-03	182.5	0.502
12:36:07	12.602	0.059	3.540	2.46E-03	179.6	0.439
12:36:37	12.610	0.067	4.020	2.79E-03	177.2	0.387
12:37:07	12.619	0.076	4.560	3.17E-03	175.0	0.339
12:37:38	12.627	0.084	5.040	3.50E-03	173.3	0.302
12:39:08	12.652	0.109	6.540	4.54E-03	168.4	0.196
12:39:39	12.661	0.118	7.080	4.92E-03	167.2	0.170
12:40:09	12.669	0.126	7.560	5.25E-03	166.0	0.143
12:40:39	12.678	0.135	8.100	5.63E-03	165.1	0.124
12:41:10	12.686	0.143	8.580	5.96E-03	164.2	0.104
12:41:40	12.694	0.151	9.060	6.29E-03	163.3	0.085
12:42:10	12.703	0.160	9.600	6.67E-03	162.6	0.070
12:42:40	12.711	0.168	10.080	7.00E-03	162.2	0.061
12:43:11	12.720	0.177	10.620	7.38E-03	161.4	0.043
12:43:42	12.728	0.185	11.100	7.71E-03	161.0	0.035
12:44:13	12.737	0.194	11.640	8.08E-03	160.6	0.026
12:44:43	12.745	0.202	12.120	8.42E-03	160.3	0.020
12:45:13	12.754	0.211	12.660	8.79E-03	160.0	0.013
12:45:45	12.763	0.220	13.200	9.17E-03	159.6	0.004
12:46:15	12.771	0.228	13.680	9.50E-03	159.5	0.002

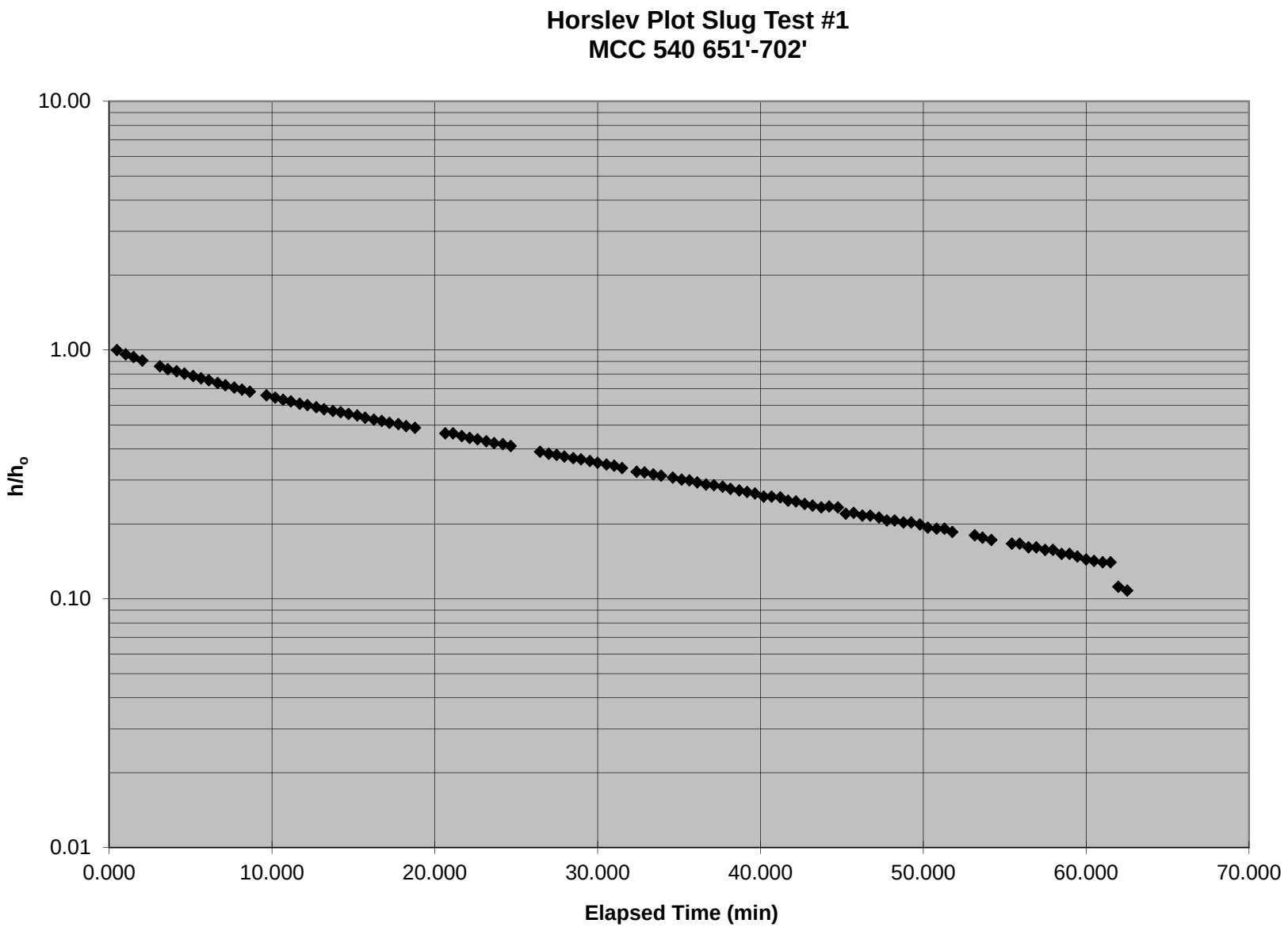

Step Rate Injection Test
MCC 540 504'-555'
Bottom-hole Pressure (psig)
350
300
250
200
150
12.9
13
13.1
13.2
13.3
13.4
13.5
Time


Fracture Gradient Injection Test
MCC 540 504'-555'
Bottom Hole Injection Pressure (psig)
350
300
250
200
150
5
10
15
20
25
30
35
Injection Rate (gpm)
Unable to fracture zone.
Injection pump at maximum output at 29 gpm with operating pump pressure of approximately 132 psi.

Step Rate Injection Test Data MCC 540 504'-555'						
Time	Time	Injection Rate (gpm)	Elapsed Time (hrs)	Elapsed Time (min)	Pressure (psig)	
Static Pressure						
12:57:18	12.955				157.3	
12:57:49	12.963	9.3	0.008	0.48	158.1	
12:58:19	12.972	9.3	0.017	1.02	161.4	
12:58:49	12.98	9.3	0.025	1.5	168.5	
12:59:19	12.989	9.3	0.034	2.04	174.8	
12:59:50	12.997	9.3	0.042	2.52	179.6	
13:00:20	13.006	9.3	0.051	3.06	185	
13:00:50	13.014	9.3	0.059	3.54	190.7	
13:01:21	13.022	9.3	0.067	4.02	199.4	
13:01:51	13.031	9.3	0.076	4.56	205.5	
13:02:21	13.039	9.3	0.084	5.04	210.8	
13:02:51	13.048	9.3	0.093	5.58	214.1	
13:03:22	13.056	9.3	0.101	6.06	216	
13:03:52	13.064	9.3	0.109	6.54	216.8	
13:04:59	13.083	9.3	0.128	7.68	217.9	
13:05:29	13.091	9.3	0.136	8.16	218.3	
13:05:59	13.1	9.3	0.145	8.7	218.6	
13:06:30	13.108	9.3	0.153	9.18	219	
13:07:00	13.117	9.3	0.162	9.72	219	
13:07:32	13.125	14.5	0.17	10.2	228.1	
13:08:02	13.134	14.5	0.179	10.74	240	
13:08:32	13.142	14.5	0.187	11.22	243.7	
13:09:03	13.151	14.5	0.196	11.76	246.4	
13:09:33	13.159	14.5	0.204	12.24	248	
13:10:03	13.168	14.5	0.213	12.78	249.4	
13:10:33	13.176	14.5	0.221	13.26	250.6	
13:11:05	13.185	14.5	0.23	13.8	250.7	
13:11:35	13.193	14.5	0.238	14.28	251.8	
13:12:06	13.202	20	0.247	14.82	216.2	
13:12:36	13.21	20	0.255	15.3	266.7	
13:13:06	13.218	20	0.263	15.78	276.5	
13:13:37	13.227	20	0.272	16.32	279.5	
13:14:07	13.235	20	0.28	16.8	281.6	
13:14:37	13.244	20	0.289	17.34	282.4	
13:15:07	13.252	20	0.297	17.82	283.2	
13:15:38	13.26	20	0.305	18.3	282.6	
13:16:57	13.283	20	0.328	19.68	285.3	
13:17:28	13.291	27	0.336	20.16	312.8	
13:17:58	13.299	27	0.344	20.64	319.1	
13:18:28	13.308	27	0.353	21.18	319.8	
13:18:58	13.316	27	0.361	21.66	321.6	
13:19:29	13.325	27	0.37	22.2	323.3	
13:19:59	13.333	27	0.378	22.68	326.4	
13:20:29	13.341	27	0.386	23.16	328.8	

Step Rate Injection Test Data MCC 540 504'-555'						
Time	Time	Injection Rate (gpm)	Elapsed Time (hrs)	Elapsed Time (min)	Pressure (psig)	
13:20:59	13.35	27	0.395	23.7	331.3	
13:21:30	13.358	27	0.403	24.18	331.4	
13:22:00	13.367	27	0.412	24.72	333.4	
13:22:30	13.375	29	0.42	25.2	344.7	
13:23:01	13.383	29	0.428	25.68	344.7	
13:23:31	13.392	29	0.437	26.22	346.4	
13:24:03	13.401	29	0.446	26.76	346.4	
13:24:33	13.409	29	0.454	27.24	348.5	
13:25:03	13.418	29	0.463	27.78	346.9	
13:25:34	13.426	29	0.471	28.26	345.9	
13:26:04	13.434	29	0.479	28.74	344.9	
13:26:34	13.443	29	0.488	29.28	344.5	
13:27:04	13.451	29	0.496	29.76	345.7	End Test
13:27:35	13.46		0.505	30.3	207.4	

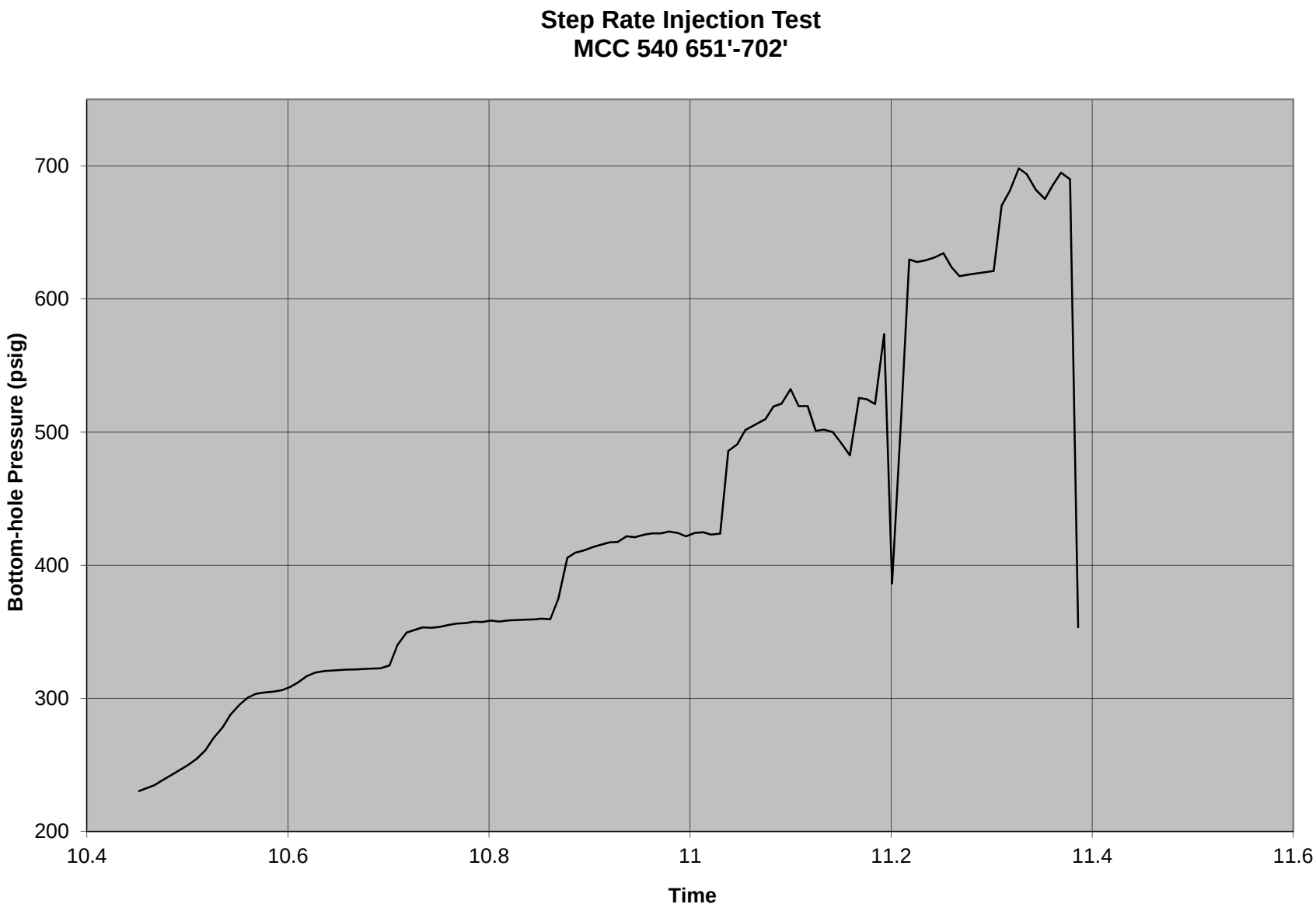

Slug Test MCC 540
651'-702'
Bottom-hole Pressure (psig)
290.0
280.0
270.0
260.0
250.0
240.0
230.0
220.0
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Elapsed Time (min)

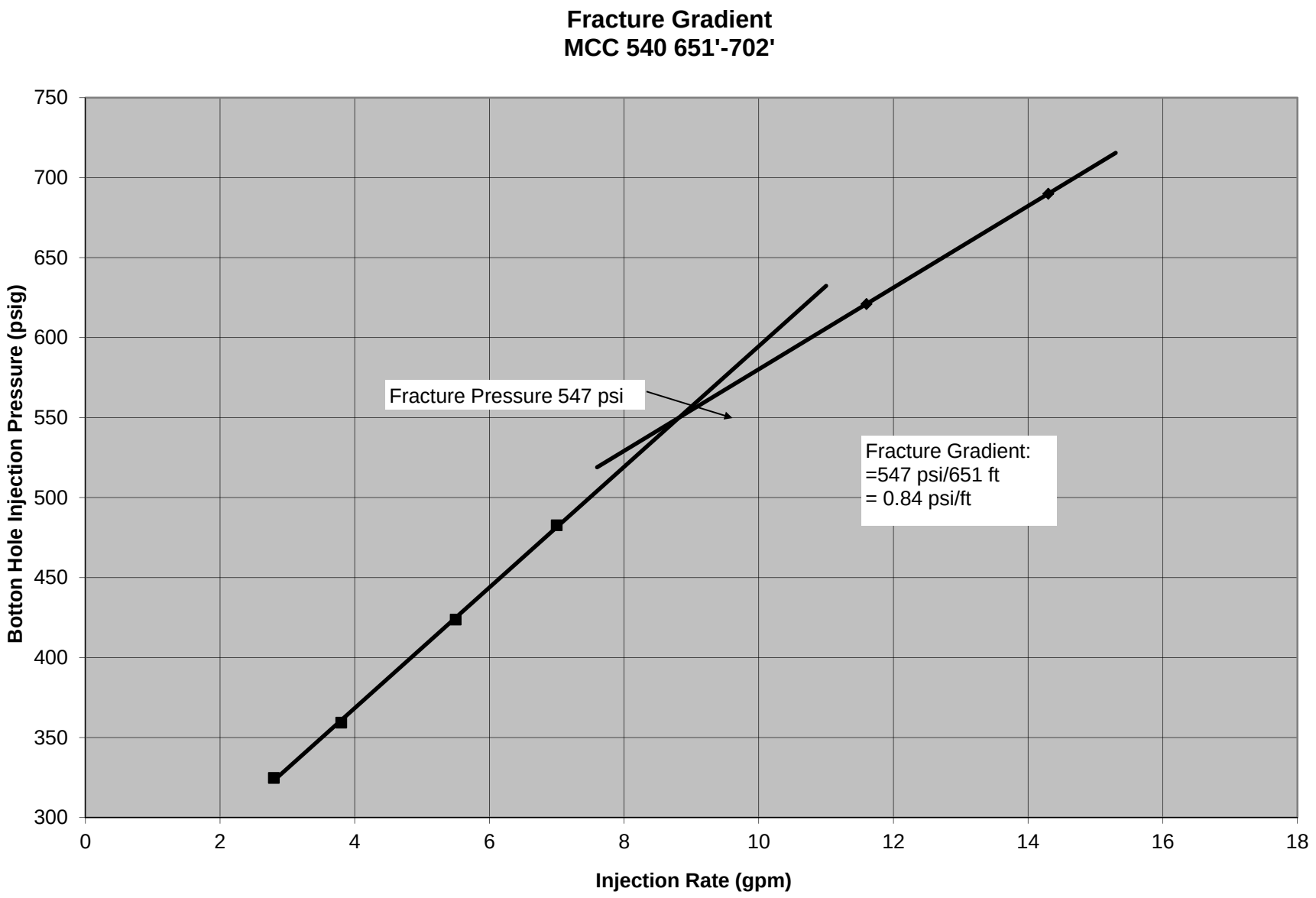

Horslev Plot Slug Test #1
MCC 540 651'-702'
10.00
1.00
0.10
0.01
h/h$_o$
0.000
10.000
20.000
30.000
40.000
50.000
60.000
70.000
Elapsed Time (min)

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
9:24:07	9.402	-	-	-	224.2	-
9:24:38	9.410	0.008	0.480	3.33E-04	277.0	1.00
9:25:08	9.419	0.017	1.020	7.08E-04	274.9	0.96
9:25:38	9.427	0.025	1.500	1.04E-03	273.7	0.94
9:26:09	9.436	0.034	2.040	1.42E-03	272.1	0.91
9:27:14	9.454	0.052	3.120	2.17E-03	269.6	0.86
9:27:44	9.462	0.060	3.600	2.50E-03	268.4	0.84
9:28:15	9.471	0.069	4.140	2.88E-03	267.6	0.82
9:28:45	9.479	0.077	4.620	3.21E-03	266.6	0.80
9:29:15	9.488	0.086	5.160	3.58E-03	265.7	0.79
9:29:45	9.496	0.094	5.640	3.92E-03	264.8	0.77
9:30:16	9.504	0.102	6.120	4.25E-03	264.1	0.76
9:30:46	9.513	0.111	6.660	4.63E-03	263.1	0.74
9:31:16	9.521	0.119	7.140	4.96E-03	262.3	0.72
9:31:47	9.530	0.128	7.680	5.33E-03	261.5	0.71
9:32:17	9.538	0.136	8.160	5.67E-03	260.8	0.69
9:32:47	9.546	0.144	8.640	6.00E-03	260.1	0.68
9:33:48	9.563	0.161	9.660	6.71E-03	258.9	0.66
9:34:18	9.572	0.170	10.200	7.08E-03	258.2	0.64
9:34:48	9.580	0.178	10.680	7.42E-03	257.5	0.63
9:35:18	9.588	0.186	11.160	7.75E-03	257.0	0.62
9:35:49	9.597	0.195	11.700	8.13E-03	256.3	0.61
9:36:19	9.605	0.203	12.180	8.46E-03	255.9	0.60
9:36:49	9.614	0.212	12.720	8.83E-03	255.3	0.59
9:37:20	9.622	0.220	13.200	9.17E-03	254.7	0.58
9:37:50	9.631	0.229	13.740	9.54E-03	254.2	0.57
9:38:20	9.639	0.237	14.220	9.88E-03	253.9	0.56
9:38:51	9.647	0.245	14.700	1.02E-02	253.4	0.55
9:39:21	9.656	0.254	15.240	1.06E-02	253.0	0.55
9:39:51	9.664	0.262	15.720	1.09E-02	252.4	0.53
9:40:22	9.673	0.271	16.260	1.13E-02	251.9	0.52
9:40:52	9.681	0.279	16.740	1.16E-02	251.6	0.52
9:41:22	9.689	0.287	17.220	1.20E-02	251.1	0.51
9:41:52	9.698	0.296	17.760	1.23E-02	250.8	0.50
9:42:23	9.706	0.304	18.240	1.27E-02	250.3	0.49
9:42:53	9.715	0.313	18.780	1.30E-02	249.9	0.49
9:44:45	9.746	0.344	20.640	1.43E-02	248.6	0.46
9:45:15	9.754	0.352	21.120	1.47E-02	248.6	0.46
9:45:45	9.763	0.361	21.660	1.50E-02	248.0	0.45
9:46:16	9.771	0.369	22.140	1.54E-02	247.6	0.44
9:46:46	9.779	0.377	22.620	1.57E-02	247.3	0.44
9:47:16	9.788	0.386	23.160	1.61E-02	246.9	0.43
9:47:46	9.796	0.394	23.640	1.64E-02	246.5	0.42
9:48:17	9.805	0.403	24.180	1.68E-02	246.3	0.42

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
9:48:47	9.813	0.411	24.660	1.71E-02	245.9	0.41
9:50:36	9.843	0.441	26.460	1.84E-02	244.8	0.39
9:51:06	9.852	0.450	27.000	1.88E-02	244.4	0.38
9:51:36	9.860	0.458	27.480	1.91E-02	244.2	0.38
9:52:06	9.868	0.466	27.960	1.94E-02	243.9	0.37
9:52:37	9.877	0.475	28.500	1.98E-02	243.6	0.37
9:53:07	9.885	0.483	28.980	2.01E-02	243.4	0.36
9:53:37	9.894	0.492	29.520	2.05E-02	243.1	0.36
9:54:08	9.902	0.500	30.000	2.08E-02	242.8	0.35
9:54:38	9.911	0.509	30.540	2.12E-02	242.5	0.35
9:55:08	9.919	0.517	31.020	2.15E-02	242.3	0.34
9:55:38	9.927	0.525	31.500	2.19E-02	241.9	0.34
9:56:31	9.942	0.540	32.400	2.25E-02	241.3	0.32
9:57:01	9.950	0.548	32.880	2.28E-02	241.2	0.32
9:57:32	9.959	0.557	33.420	2.32E-02	240.9	0.32
9:58:02	9.967	0.565	33.900	2.35E-02	240.7	0.31
9:58:45	9.979	0.577	34.620	2.40E-02	240.4	0.31
9:59:15	9.988	0.586	35.160	2.44E-02	240.1	0.30
9:59:46	9.996	0.594	35.640	2.48E-02	240.0	0.30
10:00:16	10.004	0.602	36.120	2.51E-02	239.7	0.29
10:00:46	10.013	0.611	36.660	2.55E-02	239.4	0.29
10:01:17	10.021	0.619	37.140	2.58E-02	239.3	0.29
10:01:47	10.030	0.628	37.680	2.62E-02	239.1	0.28
10:02:17	10.038	0.636	38.160	2.65E-02	238.8	0.28
10:02:47	10.047	0.645	38.700	2.69E-02	238.6	0.27
10:03:18	10.055	0.653	39.180	2.72E-02	238.4	0.27
10:03:48	10.063	0.661	39.660	2.75E-02	238.2	0.27
10:04:18	10.072	0.670	40.200	2.79E-02	237.8	0.26
10:04:49	10.080	0.678	40.680	2.83E-02	237.8	0.26
10:05:19	10.089	0.687	41.220	2.86E-02	237.7	0.26
10:05:49	10.097	0.695	41.700	2.90E-02	237.3	0.25
10:06:20	10.105	0.703	42.180	2.93E-02	237.2	0.25
10:06:50	10.114	0.712	42.720	2.97E-02	236.9	0.24
10:07:20	10.122	0.720	43.200	3.00E-02	236.7	0.24
10:07:50	10.131	0.729	43.740	3.04E-02	236.5	0.23
10:08:21	10.139	0.737	44.220	3.07E-02	236.6	0.23
10:08:51	10.148	0.746	44.760	3.11E-02	236.5	0.23
10:09:21	10.156	0.754	45.240	3.14E-02	235.8	0.22
10:09:52	10.164	0.762	45.720	3.18E-02	235.9	0.22
10:10:22	10.173	0.771	46.260	3.21E-02	235.6	0.22
10:10:52	10.181	0.779	46.740	3.25E-02	235.6	0.22
10:11:23	10.190	0.788	47.280	3.28E-02	235.4	0.21
10:11:53	10.198	0.796	47.760	3.32E-02	235.1	0.21
10:12:23	10.206	0.804	48.240	3.35E-02	235.1	0.21
10:12:53	10.215	0.813	48.780	3.39E-02	234.9	0.20
10:13:24	10.223	0.821	49.260	3.42E-02	234.9	0.20
10:13:54	10.232	0.830	49.800	3.46E-02	234.7	0.20

Slug Test Data MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
10:14:24	10.240	0.838	50.280	3.49E-02	234.4	0.19
10:14:55	10.249	0.847	50.820	3.53E-02	234.3	0.19
10:15:25	10.257	0.855	51.300	3.56E-02	234.3	0.19
10:15:55	10.265	0.863	51.780	3.60E-02	234.0	0.19
10:17:17	10.288	0.886	53.160	3.69E-02	233.7	0.18
10:17:47	10.296	0.894	53.640	3.73E-02	233.5	0.18
10:18:17	10.305	0.903	54.180	3.76E-02	233.3	0.17
10:19:34	10.326	0.924	55.440	3.85E-02	233.0	0.17
10:20:04	10.334	0.932	55.920	3.88E-02	233.0	0.17
10:20:34	10.343	0.941	56.460	3.92E-02	232.7	0.16
10:21:04	10.351	0.949	56.940	3.95E-02	232.7	0.16
10:21:35	10.360	0.958	57.480	3.99E-02	232.5	0.16
10:22:05	10.368	0.966	57.960	4.03E-02	232.5	0.16
10:22:35	10.377	0.975	58.500	4.06E-02	232.2	0.15
10:23:06	10.385	0.983	58.980	4.10E-02	232.2	0.15
10:23:36	10.393	0.991	59.460	4.13E-02	232.0	0.15
10:24:07	10.402	1.000	60.000	4.17E-02	231.8	0.14
10:24:37	10.410	1.008	60.480	4.20E-02	231.7	0.14
10:25:07	10.419	1.017	61.020	4.24E-02	231.6	0.14
10:25:37	10.427	1.025	61.500	4.27E-02	231.6	0.14
10:26:08	10.435	1.033	61.980	4.30E-02	230.1	0.11
10:26:38	10.444	1.042	62.520	4.34E-02	229.9	0.11

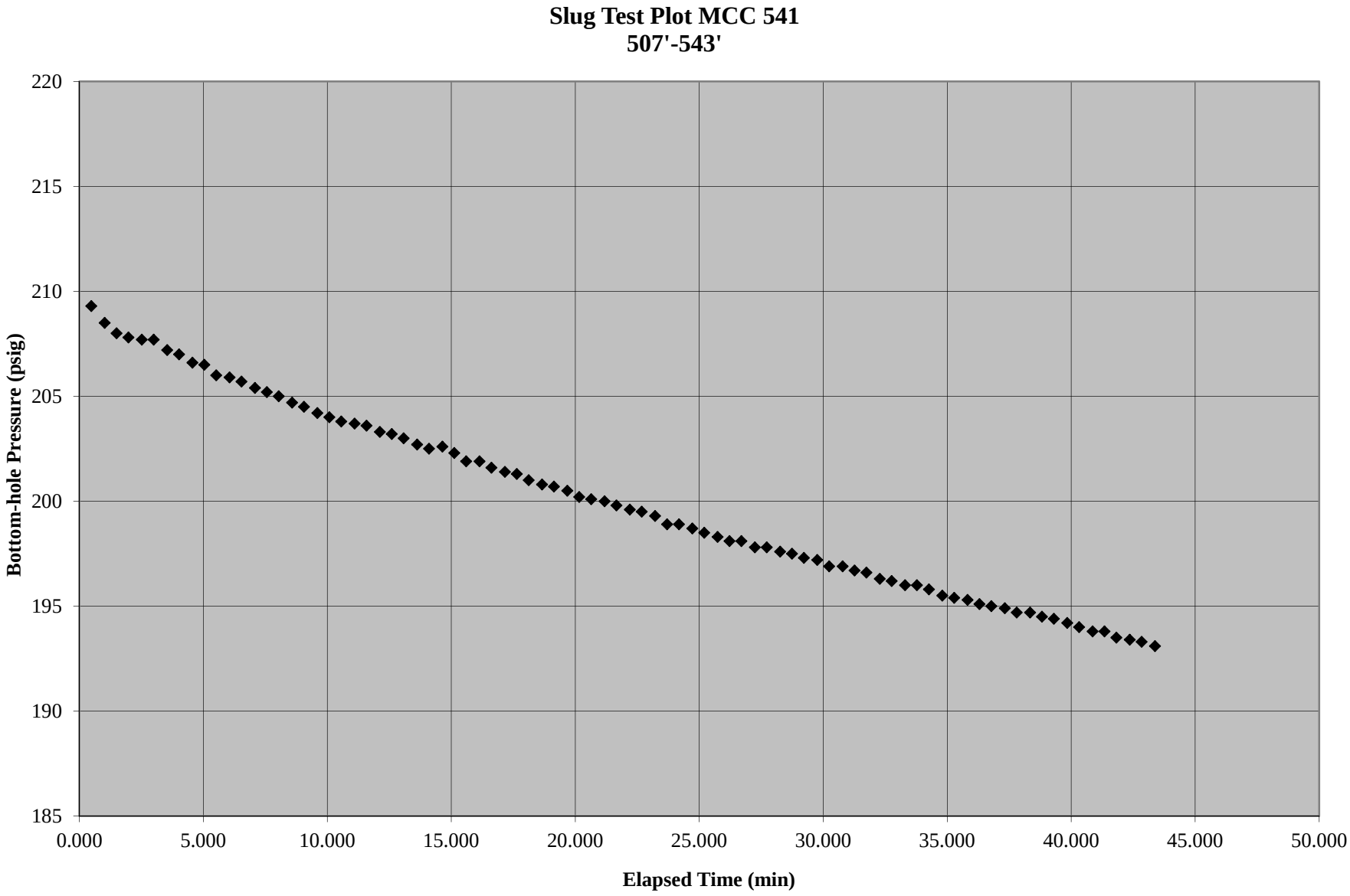

Step Rate Injection Test
MCC 540 651'-702'
Bottom-hole Pressure (psig)
700
600
500
400
300
200
10.4
10.6
10.8
11
11.2
11.4
11.6
Time

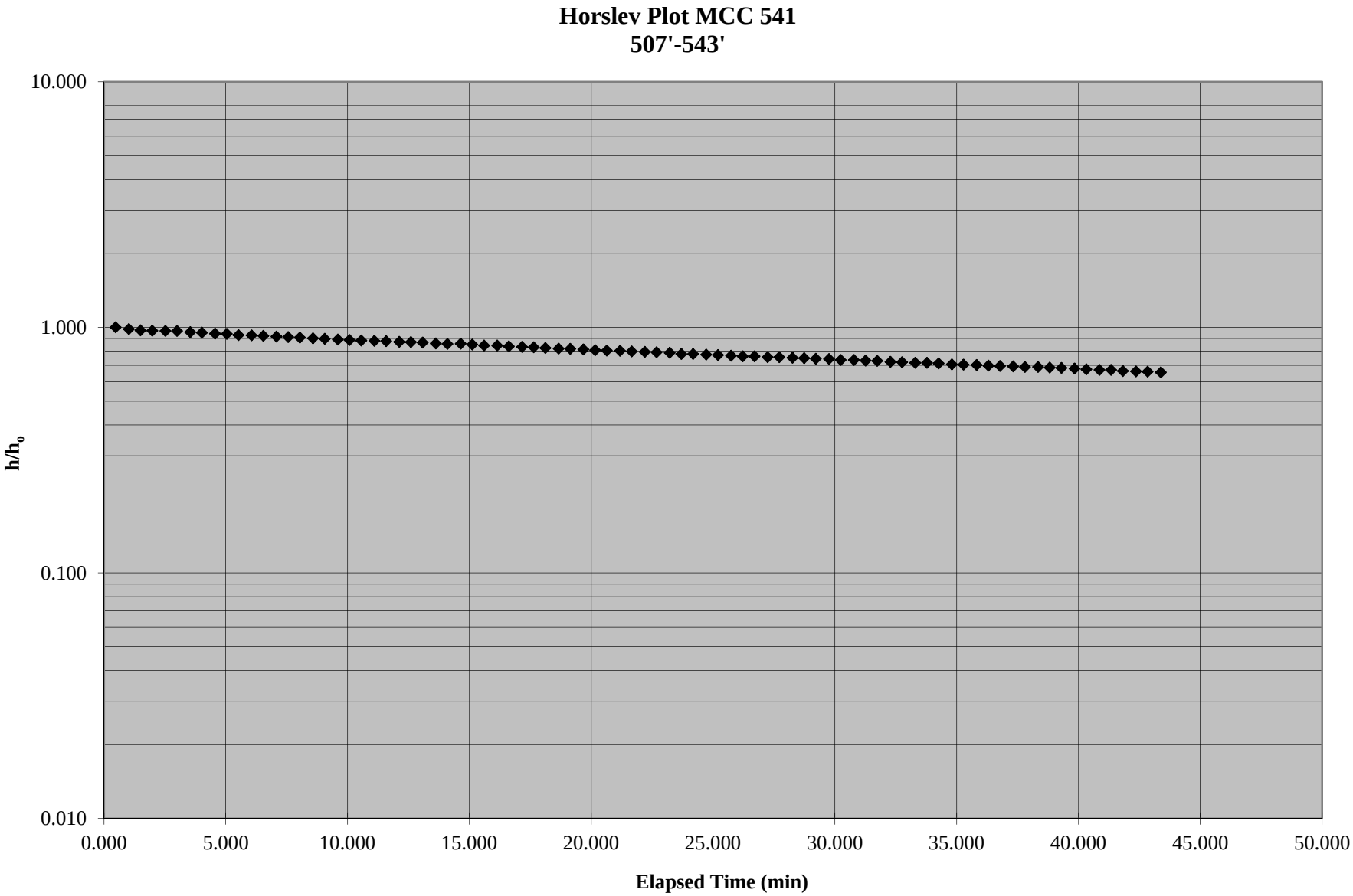

Fracture Gradient
MCC 540 651'-702'
Botton Hole Injection Pressure (psig)
750
700
650
600
550
500
450
400
350
300
0
2
4
6
8
10
12
14
16
18
Injection Rate (gpm)
Fracture Pressure 547 psi
Fracture Gradient:
=547 psi/651 ft
= 0.84 psi/ft

Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
10:26:38	10.444	-	-	-	229.9	
10:27:08	10.452	0.008	0.48	2.8	230.4	Start Test
10:28:03	10.467	0.023	1.38	2.8	234.7	
10:28:33	10.476	0.032	1.92	2.8	238.9	
10:29:03	10.484	0.04	2.4	2.8	242.4	
10:29:33	10.493	0.049	2.94	2.8	246.4	
10:30:04	10.501	0.057	3.42	2.8	250.1	
10:30:34	10.509	0.065	3.9	2.8	254.5	
10:31:04	10.518	0.074	4.44	2.8	261	
10:31:35	10.526	0.082	4.92	2.8	270.2	
10:32:05	10.535	0.091	5.46	2.8	278.2	
10:32:35	10.543	0.099	5.94	2.8	287.8	
10:33:05	10.552	0.108	6.48	2.8	295.3	
10:33:36	10.56	0.116	6.96	2.8	300.5	
10:34:06	10.568	0.124	7.44	2.8	303.4	
10:34:36	10.577	0.133	7.98	2.8	304.4	
10:35:07	10.585	0.141	8.46	2.8	305	
10:35:37	10.594	0.15	9	2.8	306.1	
10:36:07	10.602	0.158	9.48	2.8	308.5	
10:36:38	10.61	0.166	9.96	2.8	311.9	
10:37:08	10.619	0.175	10.5	2.8	316.8	
10:37:38	10.627	0.183	10.98	2.8	319.3	
10:38:09	10.636	0.192	11.52	2.8	320.5	
10:39:32	10.659	0.215	12.9	2.8	321.6	
10:40:02	10.667	0.223	13.38	2.8	321.7	
10:41:02	10.684	0.24	14.4	2.8	322.4	
10:41:33	10.692	0.248	14.88	2.8	322.6	
10:42:03	10.701	0.257	15.42	2.8	324.7	
10:42:33	10.709	0.265	15.9	3.8	340	
10:43:03	10.718	0.274	16.44	3.8	349.4	
10:44:04	10.734	0.29	17.4	3.8	353.3	
10:44:34	10.743	0.299	17.94	3.8	353	
10:45:05	10.751	0.307	18.42	3.8	353.7	
10:45:35	10.76	0.316	18.96	3.8	355.2	
10:46:05	10.768	0.324	19.44	3.8	356.2	
10:46:36	10.777	0.333	19.98	3.8	356.6	
10:47:06	10.785	0.341	20.46	3.8	357.6	
10:47:36	10.793	0.349	20.94	3.8	357.3	
10:48:07	10.802	0.358	21.48	3.8	358.4	
10:48:37	10.81	0.366	21.96	3.8	357.7	
10:49:07	10.819	0.375	22.5	3.8	358.5	
10:49:37	10.827	0.383	22.98	3.8	358.8	
10:50:08	10.835	0.391	23.46	3.8	359.1	
10:50:38	10.844	0.4	24	3.8	359.3	
10:51:08	10.852	0.408	24.48	5.5	359.8	
10:51:39	10.861	0.417	25.02	5.5	359.5	

Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
10:52:09	10.869	0.425	25.5	5.5	375	
10:52:39	10.878	0.434	26.04	5.5	405.6	
10:53:09	10.886	0.442	26.52	5.5	409.4	
10:53:40	10.894	0.45	27	5.5	411	
10:54:10	10.903	0.459	27.54	5.5	413.5	
10:54:40	10.911	0.467	28.02	5.5	415.3	
10:55:12	10.92	0.476	28.56	5.5	417.2	
10:55:42	10.928	0.484	29.04	5.5	417.5	
10:56:13	10.937	0.493	29.58	5.5	421.8	
10:56:43	10.945	0.501	30.06	5.5	421	
10:57:13	10.954	0.51	30.6	5.5	422.9	
10:57:44	10.962	0.518	31.08	5.5	423.9	
10:58:15	10.971	0.527	31.62	5.5	423.9	
10:58:46	10.979	0.535	32.1	5.5	425.3	
10:59:16	10.988	0.544	32.64	5.5	424.2	
10:59:46	10.996	0.552	33.12	5.5	421.7	
11:00:17	11.005	0.561	33.66	5.5	424.3	
11:00:47	11.013	0.569	34.14	5.5	424.8	
11:01:17	11.021	0.577	34.62	5.5	423	
11:01:47	11.03	0.586	35.16	5.5	423.7	
11:02:18	11.038	0.594	35.64	7	485.9	
11:02:48	11.047	0.603	36.18	7	490.8	
11:03:18	11.055	0.611	36.66	7	501.6	
11:04:29	11.075	0.631	37.86	7	509.8	
11:04:59	11.083	0.639	38.34	7	519.2	
11:05:29	11.091	0.647	38.82	7	521.4	
11:05:59	11.1	0.656	39.36	7	532.3	
11:06:30	11.108	0.664	39.84	7	519.5	
11:07:00	11.117	0.673	40.38	7	519.6	
11:07:30	11.125	0.681	40.86	7	500.9	
11:08:01	11.133	0.689	41.34	7	501.8	
11:08:31	11.142	0.698	41.88	7	500.1	
11:09:01	11.15	0.706	42.36	7	492.1	
11:09:31	11.159	0.715	42.9	7	482.6	
11:10:03	11.168	0.724	43.44	11.6	525.7	
11:10:33	11.176	0.732	43.92	11.6	524.6	
11:11:04	11.184	0.74	44.4	11.6	521.1	
11:11:34	11.193	0.749	44.94	11.6	573.6	
11:12:04	11.201	0.757	45.42	11.6	386.3	
11:12:35	11.21	0.766	45.96	11.6	510.8	
11:13:05	11.218	0.774	46.44	11.6	629.6	
11:13:35	11.226	0.782	46.92	11.6	627.8	
11:14:05	11.235	0.791	47.46	11.6	629.2	
11:14:36	11.243	0.799	47.94	11.6	631.1	
11:15:06	11.252	0.808	48.48	11.6	634.4	
11:15:36	11.26	0.816	48.96	11.6	624	
11:16:07	11.268	0.824	49.44	11.6	617.1	

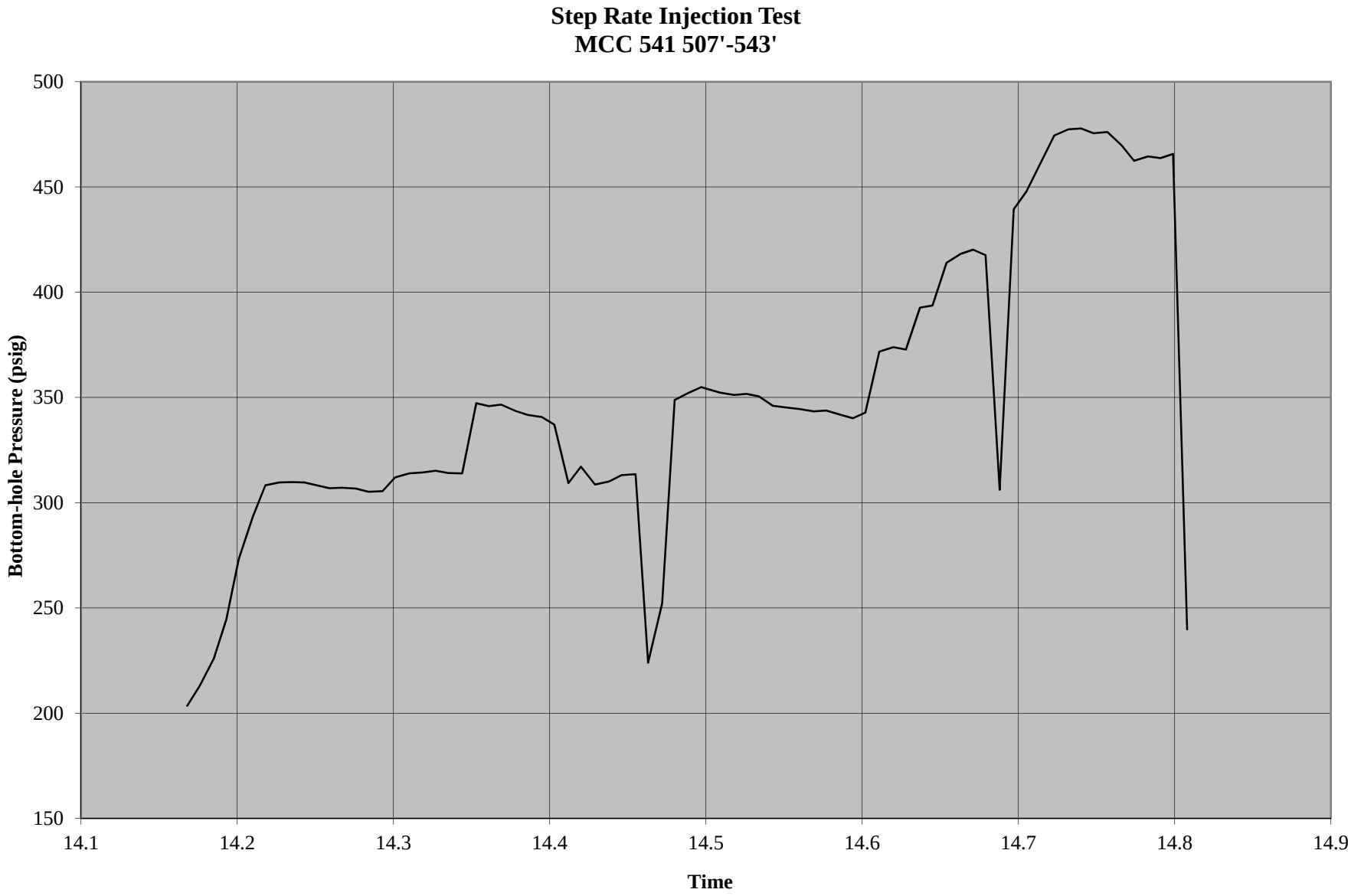
Step Rate Injection Test MCC 540 651'-702'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
11:16:37	11.277	0.833	49.98	11.6	618.3	
11:18:06	11.302	0.858	51.48	11.6	621	
11:18:36	11.31	0.866	51.96	14.3	670.2	
11:19:07	11.318	0.874	52.44	14.3	681.1	
11:19:37	11.327	0.883	52.98	14.3	698.1	
11:20:07	11.335	0.891	53.46	14.3	693.7	
11:20:39	11.344	0.9	54	14.3	681.9	
11:21:09	11.353	0.909	54.54	14.3	675.1	
11:21:39	11.361	0.917	55.02	14.3	685.8	
11:22:10	11.369	0.925	55.5	14.3	694.8	
11:22:40	11.378	0.934	56.04	14.3	689.9	End Test
11:23:10	11.386	0.942	56.52	-	353.5	

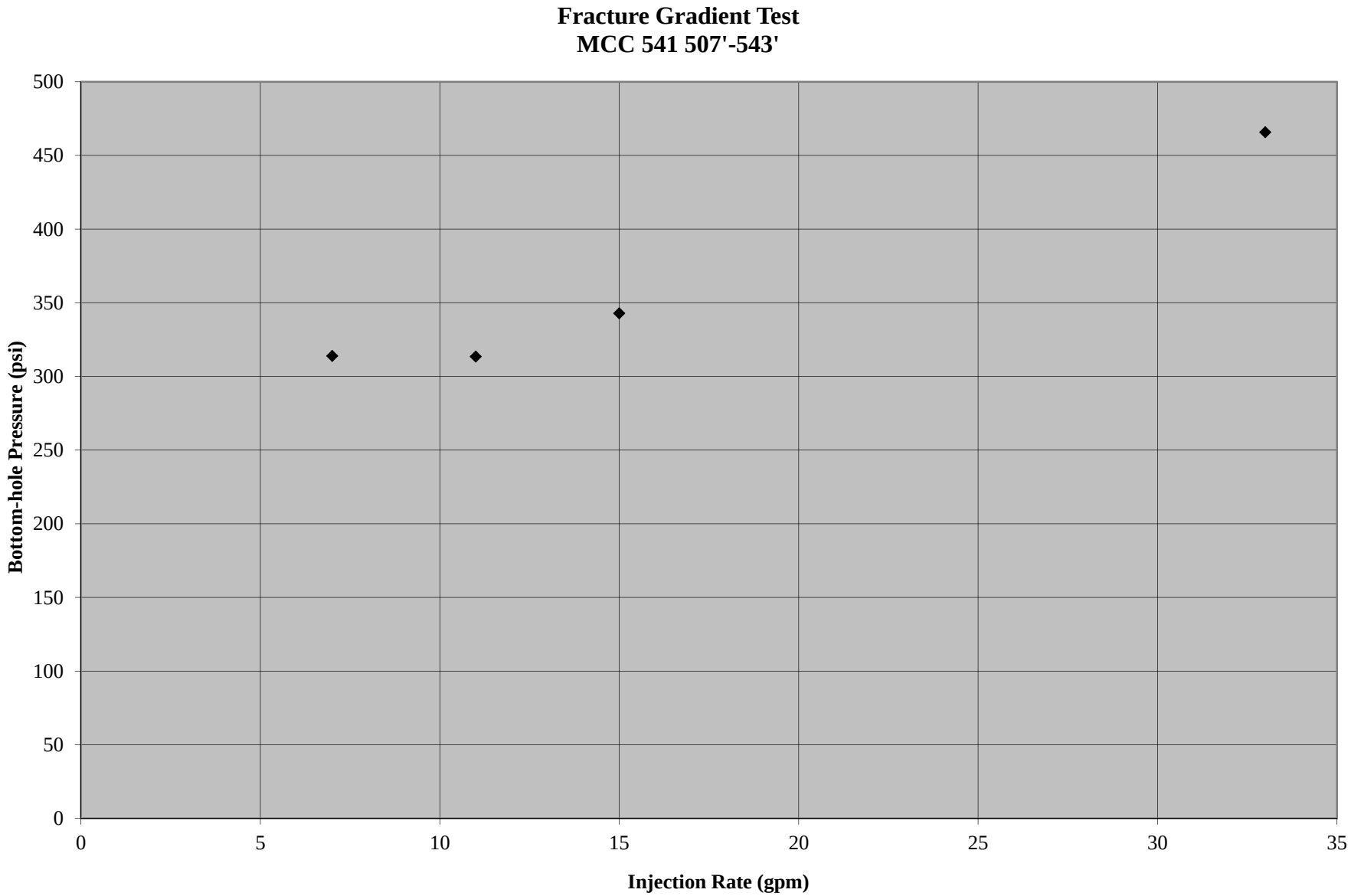

Slug Test Plot MCC 541
507'-543'
Bottom-hole Pressure (psig)
220
215
210
205
200
195
190
185
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)


Horslev Plot MCC 541
507'-543'
10.000
1.000
0.100
0.010
h/h$_o$
0.000
5.000
10.000
15.000
20.000
25.000
30.000
35.000
40.000
45.000
50.000
Elapsed Time (min)

Slug Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:24:11	13.403	0.000	0.000	0.000	162.3	-
13:24:41	13.411	0.008	0.480	0.000	209.3	1.000
13:25:11	13.42	0.017	1.020	0.001	208.5	0.983
13:25:41	13.428	0.025	1.500	0.001	208	0.972
13:26:11	13.436	0.033	1.980	0.001	207.8	0.968
13:26:42	13.445	0.042	2.520	0.002	207.7	0.966
13:27:12	13.453	0.050	3.000	0.002	207.7	0.966
13:27:42	13.462	0.059	3.540	0.002	207.2	0.955
13:28:13	13.47	0.067	4.020	0.003	207	0.951
13:28:43	13.479	0.076	4.560	0.003	206.6	0.943
13:29:13	13.487	0.084	5.040	0.003	206.5	0.940
13:29:43	13.495	0.092	5.520	0.004	206	0.930
13:30:14	13.504	0.101	6.060	0.004	205.9	0.928
13:30:44	13.512	0.109	6.540	0.005	205.7	0.923
13:31:14	13.521	0.118	7.080	0.005	205.4	0.917
13:31:44	13.529	0.126	7.560	0.005	205.2	0.913
13:32:15	13.537	0.134	8.040	0.006	205	0.909
13:32:45	13.546	0.143	8.580	0.006	204.7	0.902
13:33:15	13.554	0.151	9.060	0.006	204.5	0.898
13:33:45	13.563	0.160	9.600	0.007	204.2	0.891
13:34:16	13.571	0.168	10.080	0.007	204	0.887
13:34:46	13.579	0.176	10.560	0.007	203.8	0.883
13:35:16	13.588	0.185	11.100	0.008	203.7	0.881
13:35:46	13.596	0.193	11.580	0.008	203.6	0.879
13:36:17	13.605	0.202	12.120	0.008	203.3	0.872
13:36:47	13.613	0.210	12.600	0.009	203.2	0.870
13:37:17	13.621	0.218	13.080	0.009	203	0.866
13:37:47	13.63	0.227	13.620	0.009	202.7	0.860
13:38:18	13.638	0.235	14.100	0.010	202.5	0.855
13:38:48	13.647	0.244	14.640	0.010	202.6	0.857
13:39:18	13.655	0.252	15.120	0.011	202.3	0.851
13:39:49	13.663	0.260	15.600	0.011	201.9	0.843
13:40:19	13.672	0.269	16.140	0.011	201.9	0.843
13:40:49	13.68	0.277	16.620	0.012	201.6	0.836
13:41:19	13.689	0.286	17.160	0.012	201.4	0.832
13:41:49	13.697	0.294	17.640	0.012	201.3	0.830
13:42:20	13.705	0.302	18.120	0.013	201	0.823
13:42:50	13.714	0.311	18.660	0.013	200.8	0.819
13:43:20	13.722	0.319	19.140	0.013	200.7	0.817
13:43:51	13.731	0.328	19.680	0.014	200.5	0.813
13:44:21	13.739	0.336	20.160	0.014	200.2	0.806
13:44:51	13.747	0.344	20.640	0.014	200.1	0.804
13:45:21	13.756	0.353	21.180	0.015	200	0.802
13:45:51	13.764	0.361	21.660	0.015	199.8	0.798
13:46:22	13.773	0.370	22.200	0.015	199.6	0.794

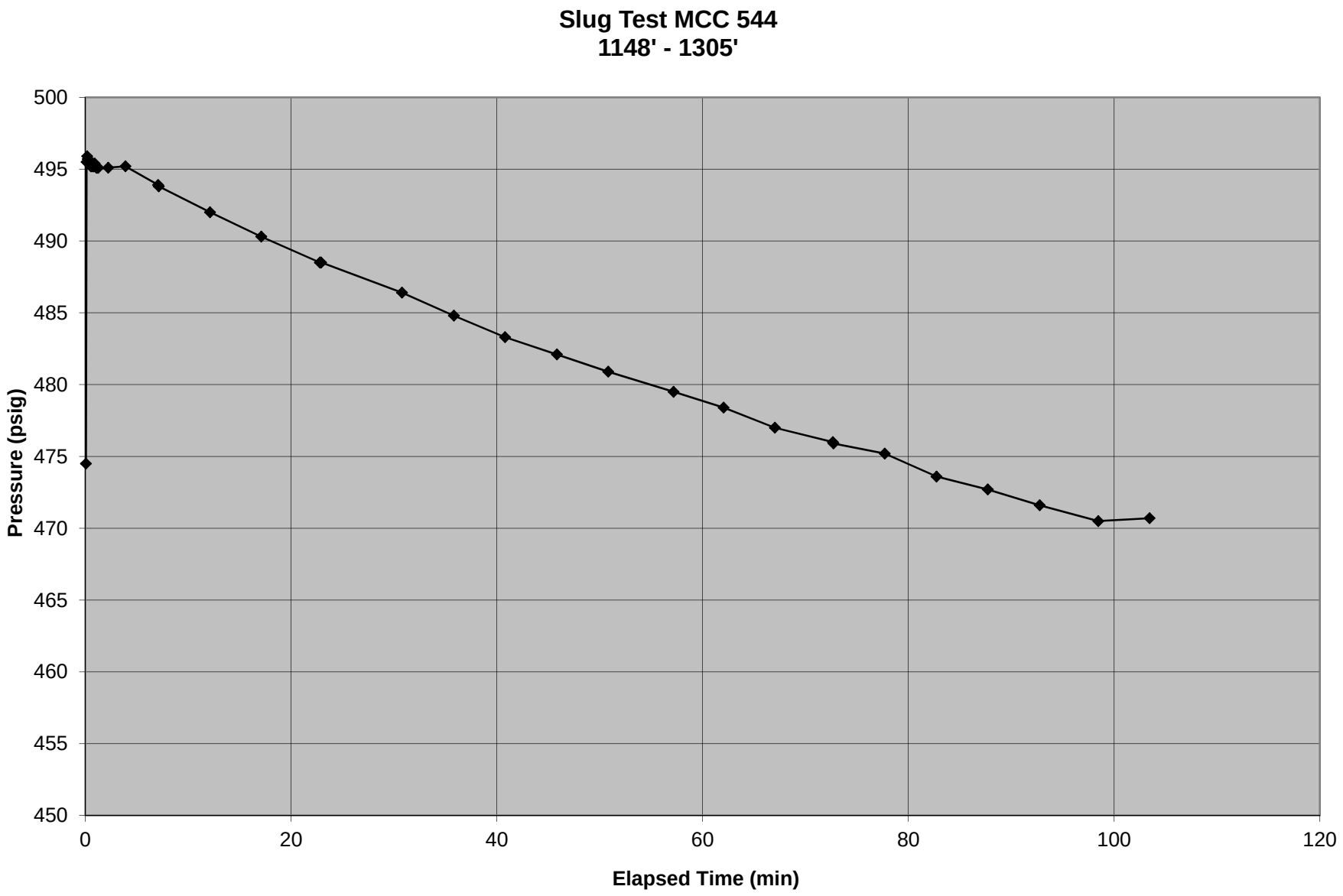
Slug Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:46:52	13.781	0.378	22.680	0.016	199.5	0.791
13:47:22	13.79	0.387	23.220	0.016	199.3	0.787
13:47:53	13.798	0.395	23.700	0.016	198.9	0.779
13:48:23	13.806	0.403	24.180	0.017	198.9	0.779
13:48:53	13.815	0.412	24.720	0.017	198.7	0.774
13:49:23	13.823	0.420	25.200	0.018	198.5	0.770
13:49:54	13.832	0.429	25.740	0.018	198.3	0.766
13:50:24	13.84	0.437	26.220	0.018	198.1	0.762
13:50:54	13.848	0.445	26.700	0.019	198.1	0.762
13:51:24	13.857	0.454	27.240	0.019	197.8	0.755
13:51:54	13.865	0.462	27.720	0.019	197.8	0.755
13:52:25	13.874	0.471	28.260	0.020	197.6	0.751
13:52:55	13.882	0.479	28.740	0.020	197.5	0.749
13:53:25	13.89	0.487	29.220	0.020	197.3	0.745
13:53:56	13.899	0.496	29.760	0.021	197.2	0.743
13:54:26	13.907	0.504	30.240	0.021	196.9	0.736
13:54:56	13.916	0.513	30.780	0.021	196.9	0.736
13:55:26	13.924	0.521	31.260	0.022	196.7	0.732
13:55:57	13.932	0.529	31.740	0.022	196.6	0.730
13:56:27	13.941	0.538	32.280	0.022	196.3	0.723
13:56:57	13.949	0.546	32.760	0.023	196.2	0.721
13:57:27	13.958	0.555	33.300	0.023	196	0.717
13:57:58	13.966	0.563	33.780	0.023	196	0.717
13:58:28	13.974	0.571	34.260	0.024	195.8	0.713
13:58:58	13.983	0.580	34.800	0.024	195.5	0.706
13:59:28	13.991	0.588	35.280	0.025	195.4	0.704
13:59:59	14	0.597	35.820	0.025	195.3	0.702
14:00:29	14.008	0.605	36.300	0.025	195.1	0.698
14:00:59	14.016	0.613	36.780	0.026	195	0.696
14:01:29	14.025	0.622	37.320	0.026	194.9	0.694
14:02:00	14.033	0.630	37.800	0.026	194.7	0.689
14:02:30	14.042	0.639	38.340	0.027	194.7	0.689
14:03:00	14.05	0.647	38.820	0.027	194.5	0.685
14:03:31	14.058	0.655	39.300	0.027	194.4	0.683
14:04:01	14.067	0.664	39.840	0.028	194.2	0.679
14:04:31	14.075	0.672	40.320	0.028	194	0.674
14:05:01	14.084	0.681	40.860	0.028	193.8	0.670
14:05:31	14.092	0.689	41.340	0.029	193.8	0.670
14:06:02	14.1	0.697	41.820	0.029	193.5	0.664
14:06:32	14.109	0.706	42.360	0.029	193.4	0.662
14:07:02	14.117	0.714	42.840	0.030	193.3	0.660
14:07:33	14.126	0.723	43.380	0.030	193.1	0.655

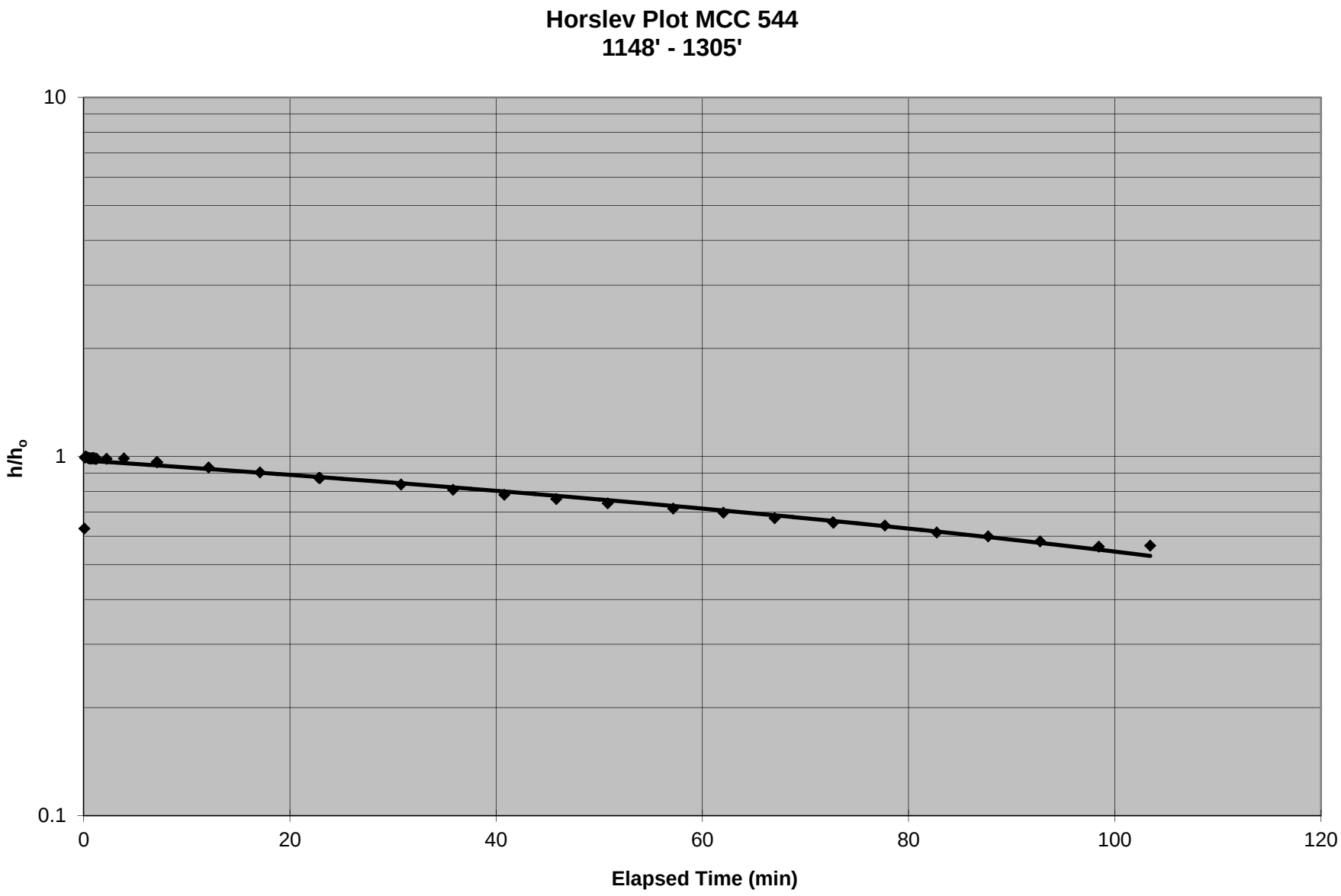

Step Rate Injection Test
MCC 541 507'-543'
Bottom-hole Pressure (psig)
500
450
400
350
300
250
200
150
14.1
14.2
14.3
14.4
14.5
14.6
14.7
14.8
14.9
Time


Fracture Gradient Test
MCC 541 507'-543'
Bottom-hole Pressure (psi)
500
450
400
350
300
250
200
150
100
50
0
0
5
10
15
20
25
30
35
Injection Rate (gpm)

Step Rate Injection Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:10:04	14.168	0.000	0.000	7	203.5	
14:10:34	14.176	0.008	0.480	7	213	
14:11:04	14.185	0.017	1.020	7	225.9	
14:11:34	14.193	0.025	1.500	7	244.5	
14:12:05	14.201	0.033	1.980	7	273.3	
14:12:35	14.21	0.042	2.520	7	293.4	
14:13:05	14.218	0.050	3.000	7	308.3	
14:13:36	14.227	0.059	3.540	7	309.6	
14:14:06	14.235	0.067	4.020	7	309.8	
14:14:36	14.243	0.075	4.500	7	309.6	
14:15:32	14.259	0.091	5.460	7	306.9	
14:16:02	14.267	0.099	5.940	7	307.1	
14:16:32	14.276	0.108	6.480	7	306.7	
14:17:03	14.284	0.116	6.960	7	305.2	
14:17:34	14.293	0.125	7.500	7	305.5	
14:18:05	14.301	0.133	7.980	7	312	
14:18:35	14.31	0.142	8.520	7	313.9	
14:19:07	14.319	0.151	9.060	7	314.4	
14:19:37	14.327	0.159	9.540	7	315.2	
14:20:07	14.335	0.167	10.020	7	314.1	
14:20:38	14.344	0.176	10.560	7	313.9	
14:21:09	14.353	0.185	11.100	11	347.3	
14:21:40	14.361	0.193	11.580	11	345.9	
14:22:10	14.369	0.201	12.060	11	346.6	
14:22:40	14.378	0.210	12.600	11	343.6	
14:23:10	14.386	0.218	13.080	11	341.7	
14:23:41	14.395	0.227	13.620	11	340.7	
14:24:13	14.403	0.235	14.100	11	337.1	
14:24:43	14.412	0.244	14.640	11	309.3	
14:25:13	14.42	0.252	15.120	11	317.1	
14:25:45	14.429	0.261	15.660	11	308.6	
14:26:15	14.438	0.270	16.200	11	310.1	
14:26:47	14.446	0.278	16.680	11	313.1	
14:27:17	14.455	0.287	17.220	11	313.5	
14:27:48	14.463	0.295	17.700	15	224	
14:28:18	14.472	0.304	18.240	15	252.2	
14:28:49	14.48	0.312	18.720	15	348.8	
14:29:20	14.489	0.321	19.260	15	352.2	
14:29:50	14.497	0.329	19.740	15	354.9	
14:30:33	14.509	0.341	20.460	15	352.3	
14:31:03	14.518	0.350	21.000	15	351.2	
14:31:34	14.526	0.358	21.480	15	351.7	
14:32:04	14.534	0.366	21.960	15	350.5	
14:32:35	14.543	0.375	22.500	15	346	
14:33:06	14.552	0.384	23.040	15	345.2	

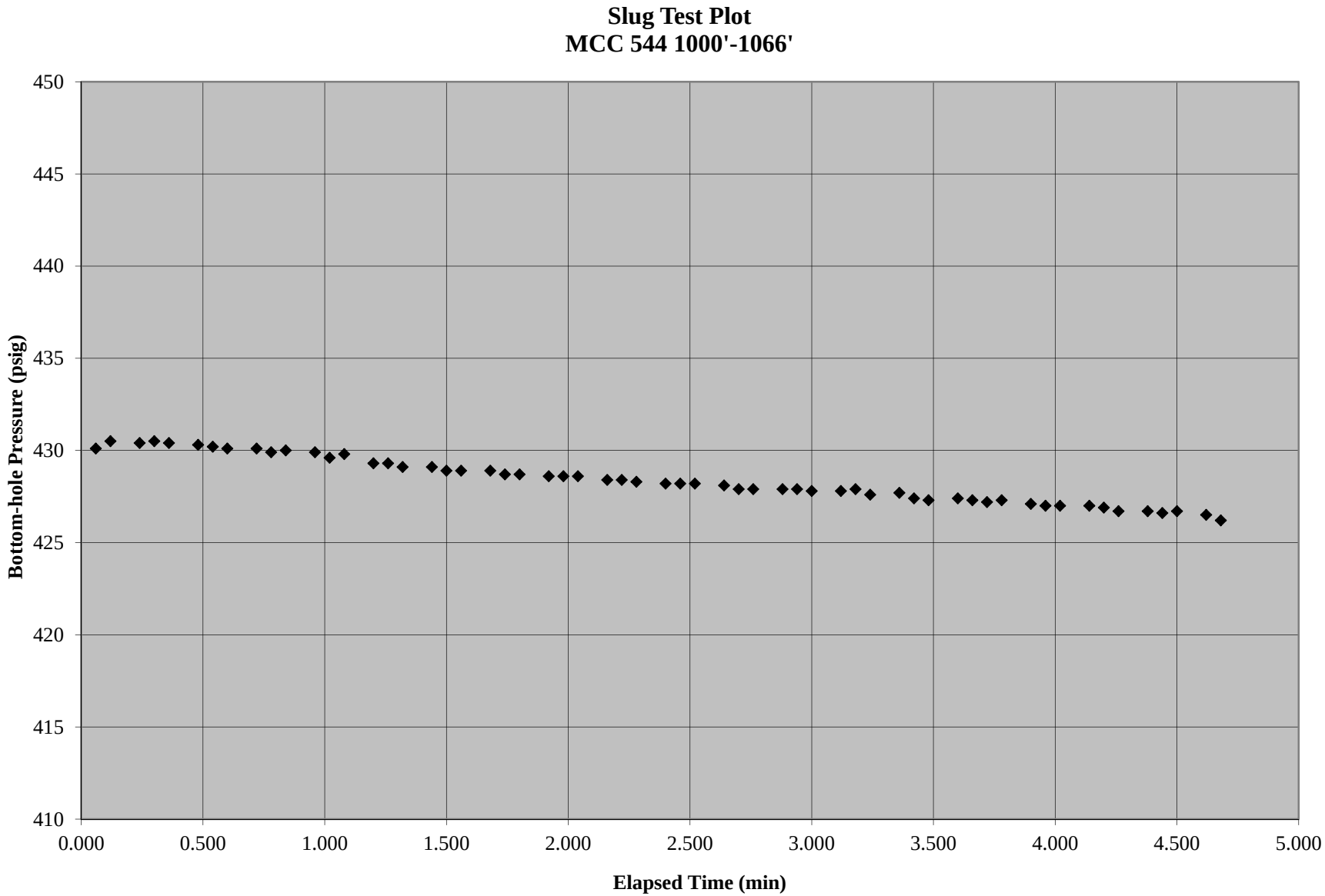
Step Rate Injection Test Data MCC 541 507'-543'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:33:38	14.56	0.392	23.520	15	344.5	
14:34:08	14.569	0.401	24.060	15	343.4	
14:34:38	14.577	0.409	24.540	15	343.8	
14:35:08	14.586	0.418	25.080	15	341.8	
14:35:39	14.594	0.426	25.560	15	340.1	
14:36:09	14.602	0.434	26.040	15	342.8	
14:36:39	14.611	0.443	26.580	RNE	371.8	Increase rate
14:37:11	14.62	0.452	27.120	RNE	373.9	Flow rate erratic
14:37:41	14.628	0.460	27.600	RNE	372.8	
14:38:12	14.637	0.469	28.140	RNE	392.7	Valve sticking
14:38:43	14.645	0.477	28.620	RNE	393.7	Pumping erratically
14:39:14	14.654	0.486	29.160	RNE	414	
14:39:45	14.663	0.495	29.700	RNE	418.2	
14:40:16	14.671	0.503	30.180	RNE	420.2	
14:40:46	14.679	0.511	30.660	RNE	417.6	
14:41:18	14.688	0.520	31.200	33	306.1	
14:41:48	14.697	0.529	31.740	33	439.4	Pumping erratically
14:42:18	14.705	0.537	32.220	33	447.7	
14:43:23	14.723	0.555	33.300	33	474.5	Flow rate erratic
14:43:54	14.732	0.564	33.840	33	477.4	
14:44:24	14.74	0.572	34.320	33	477.8	
14:44:54	14.748	0.580	34.800	33	475.5	
14:45:26	14.757	0.589	35.340	33	476.1	
14:45:56	14.766	0.598	35.880	33	469.8	
14:46:27	14.774	0.606	36.360	33	462.4	
14:46:57	14.783	0.615	36.900	33	464.5	
14:47:27	14.791	0.623	37.380	33	463.7	
14:47:58	14.799	0.631	37.860	33	465.7	End Test
14:48:28	14.808	0.640	38.400		239.8	
RNE - Rate Not Established.						

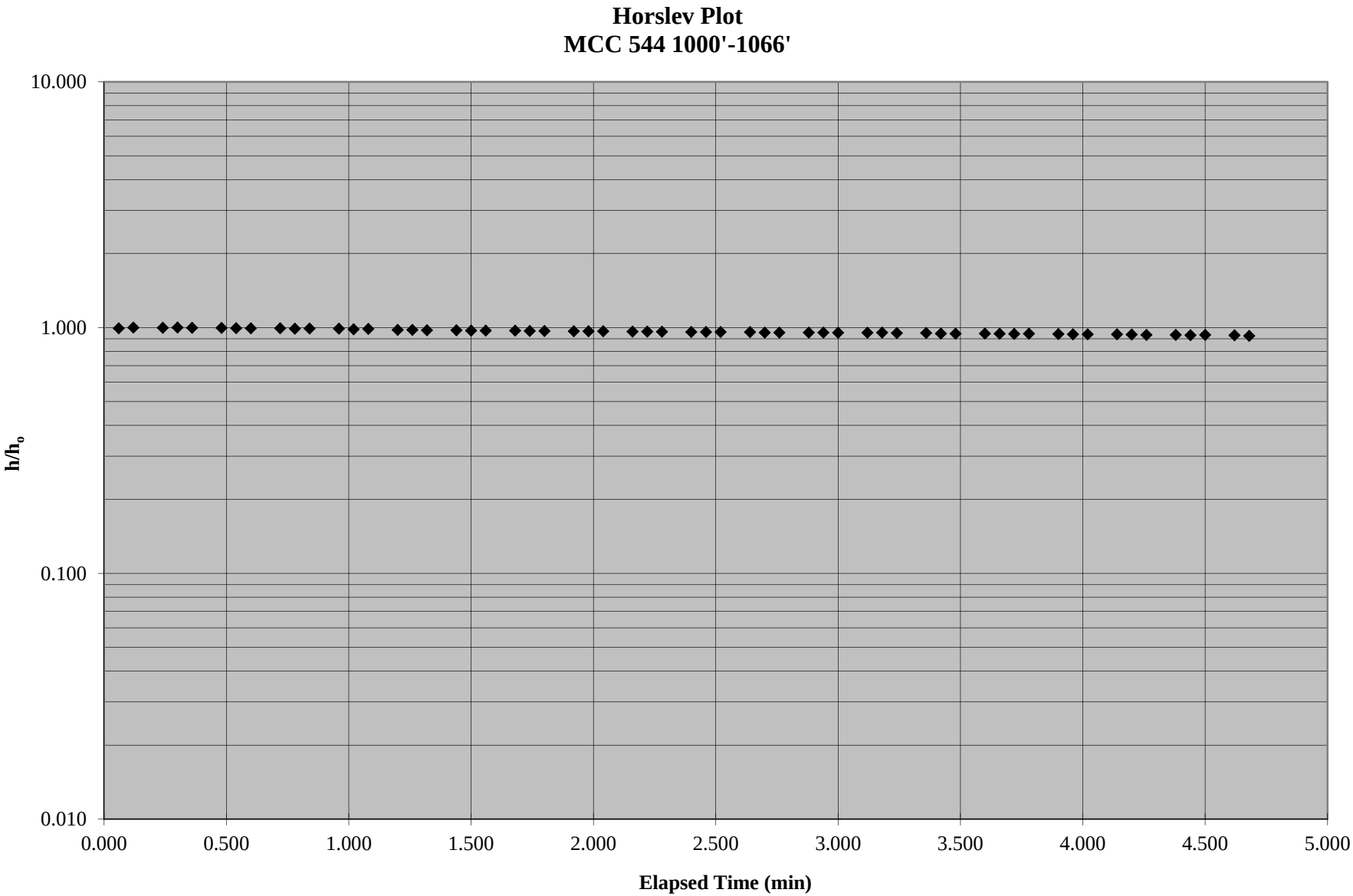

Slug Test MCC 544
1148' - 1305'
Pressure (psig)
500
495
490
485
480
475
470
465
460
455
450
0
20
40
60
80
100
120
Elapsed Time (min)


Horslev Plot MCC 544
1148' - 1305'
10
1
0.1
h/h$_o$
0
20
40
60
80
100
120
Elapsed Time (min)

Slug Test Data MCC 544 1148' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
16:16:07	16.269	-	-		438	-
16:16:11	16.27	0.001	0.06	4.17E-05	474.5	0.630397
16:16:14	16.271	0.002	0.12	8.33E-05	495.5	0.993092
16:16:19	16.272	0.003	0.18	1.25E-04	495.9	1
16:16:23	16.273	0.004	0.24	1.67E-04	495.7	0.996546
16:16:28	16.274	0.005	0.3	2.08E-04	495.7	0.996546
16:16:33	16.276	0.007	0.42	2.92E-04	495.4	0.991364
16:16:38	16.277	0.008	0.48	3.33E-04	495.4	0.991364
16:16:42	16.278	0.009	0.54	3.75E-04	495.2	0.98791
16:16:46	16.279	0.01	0.6	4.17E-04	495.2	0.98791
16:16:49	16.28	0.011	0.66	4.58E-04	495.2	0.98791
16:16:54	16.282	0.013	0.78	5.42E-04	495.2	0.98791
16:16:57	16.282	0.013	0.78	5.42E-04	495.2	0.98791
16:17:00	16.283	0.014	0.84	5.83E-04	495.2	0.98791
16:17:03	16.284	0.015	0.9	6.25E-04	495.4	0.991364
16:17:08	16.286	0.017	1.02	7.08E-04	495.2	0.98791
16:17:11	16.286	0.017	1.02	7.08E-04	495.2	0.98791
16:17:14	16.287	0.018	1.08	7.50E-04	495.1	0.986183
16:17:18	16.288	0.019	1.14	7.92E-04	495.1	0.986183
16:17:22	16.29	0.021	1.26	8.75E-04	495.1	0.986183
16:18:23	16.306	0.037	2.22	1.54E-03	495.1	0.986183
16:20:01	16.334	0.065	3.9	2.71E-03	495.2	0.98791
16:23:12	16.387	0.118	7.08	4.92E-03	493.9	0.965458
16:23:15	16.388	0.119	7.14	4.96E-03	493.8	0.963731
16:28:15	16.471	0.202	12.12	8.42E-03	492	0.932642
16:33:16	16.554	0.285	17.1	1.19E-02	490.3	0.903282
16:38:57	16.649	0.38	22.8	1.58E-02	488.5	0.872193
16:39:01	16.65	0.381	22.86	1.59E-02	488.5	0.872193
16:39:04	16.651	0.382	22.92	1.59E-02	488.5	0.872193
16:46:56	16.782	0.513	30.78	2.14E-02	486.4	0.835924
16:51:57	16.866	0.597	35.82	2.49E-02	484.8	0.80829
16:56:57	16.949	0.68	40.8	2.83E-02	483.3	0.782383
17:01:57	17.033	0.764	45.84	3.18E-02	482.1	0.761658
17:06:57	17.116	0.847	50.82	3.53E-02	480.9	0.740933
17:13:18	17.222	0.953	57.18	3.97E-02	479.5	0.716753
17:18:10	17.303	1.034	62.04	4.31E-02	478.4	0.697755
17:23:10	17.386	1.117	67.02	4.65E-02	477	0.673575
17:28:48	17.48	1.211	72.66	5.05E-02	476	0.656304
17:28:52	17.481	1.212	72.72	5.05E-02	475.9	0.654577
17:33:52	17.564	1.295	77.7	5.40E-02	475.2	0.642487
17:38:52	17.648	1.379	82.74	5.75E-02	473.6	0.614853
17:43:52	17.731	1.462	87.72	6.09E-02	472.7	0.599309
17:48:52	17.815	1.546	92.76	6.44E-02	471.6	0.580311
17:54:36	17.91	1.641	98.46	6.84E-02	470.5	0.561313

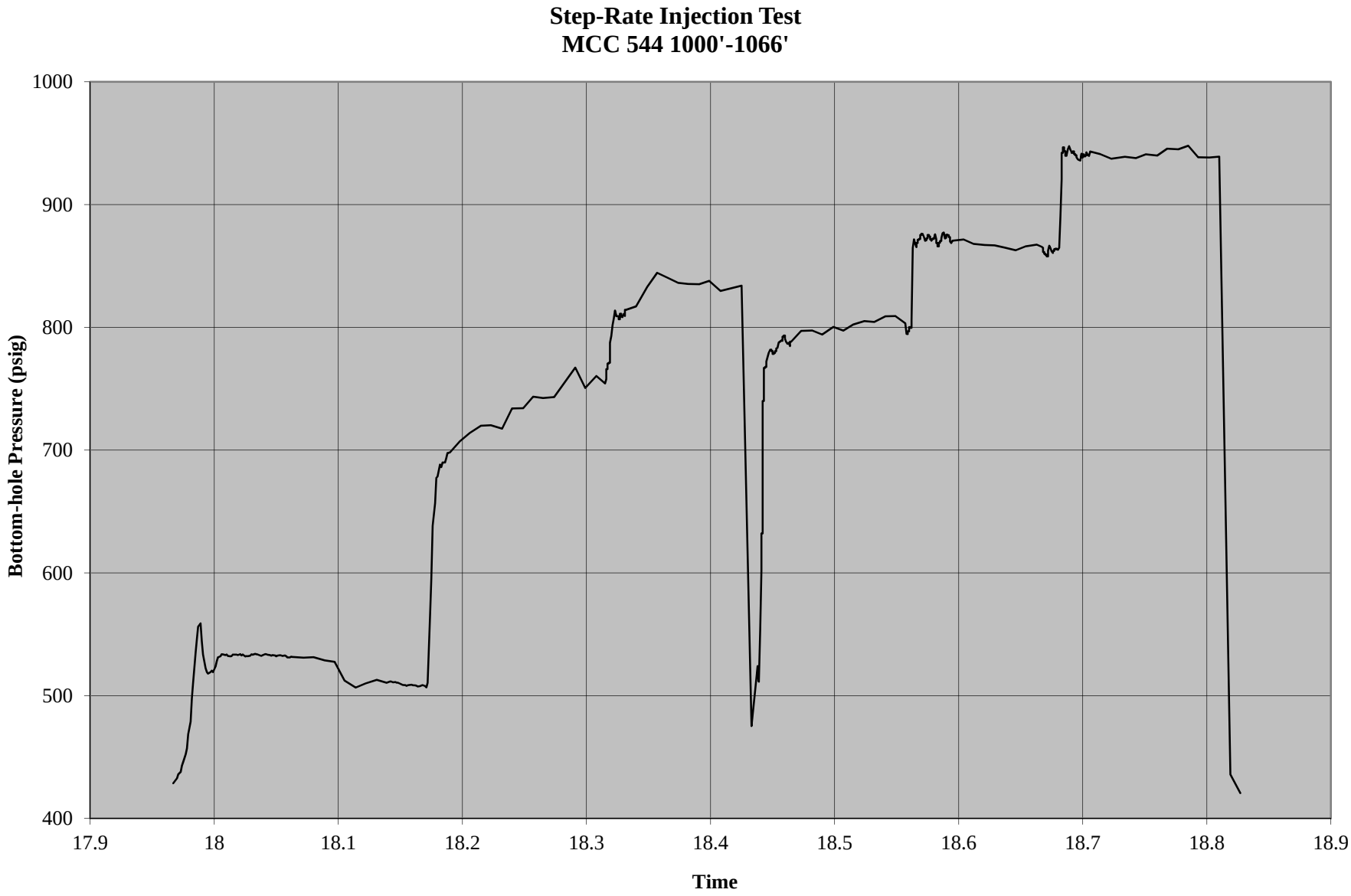
Slug Test Data MCC 544 1148' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
17:59:36	17.993	1.724	103.44	7.18E-02	470.7	0.564767

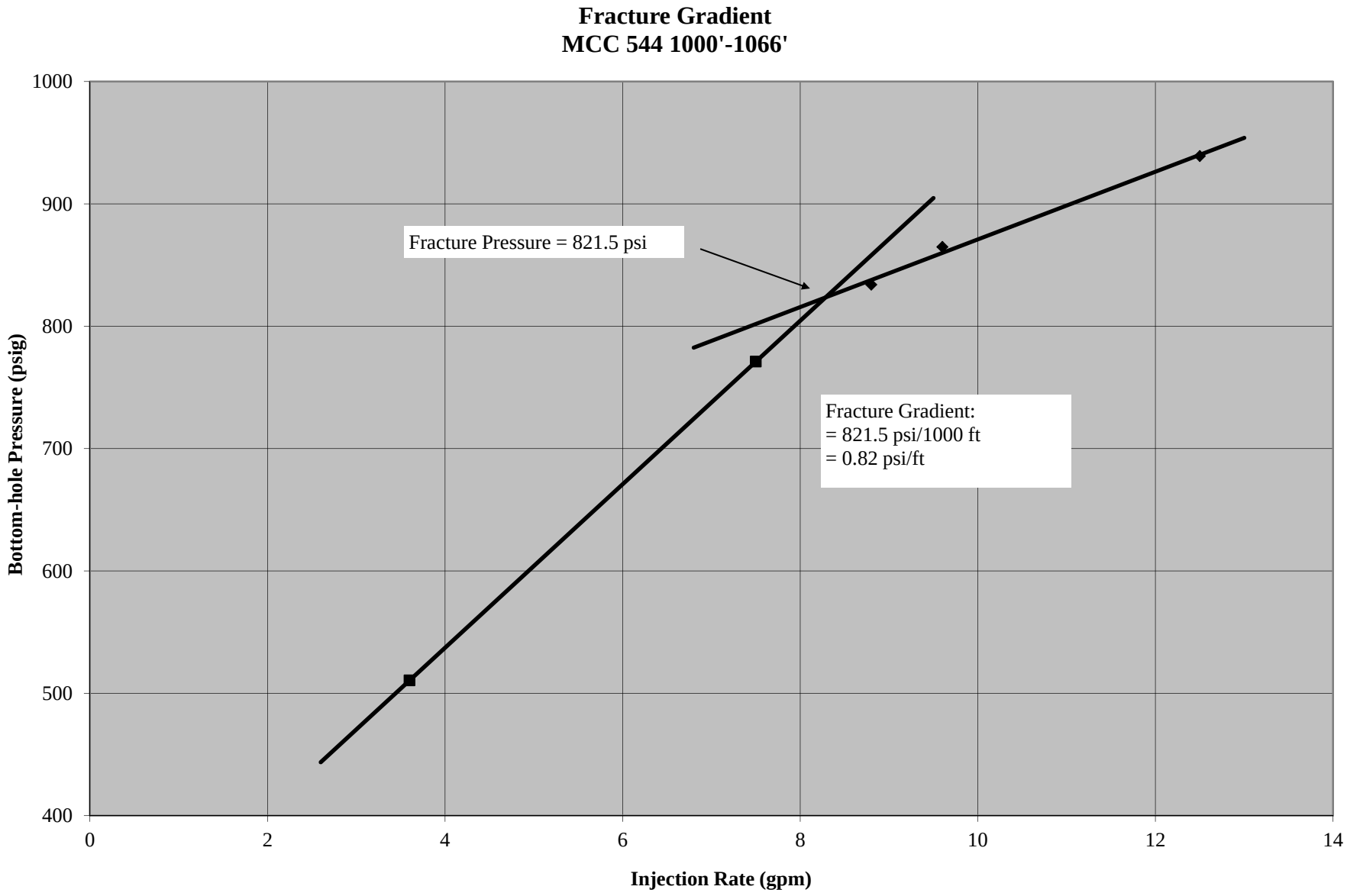

Slug Test Plot
MCC 544 1000'-1066'
Bottom-hole Pressure (psig)
450
445
440
435
430
425
420
415
410
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Elapsed Time (min)


Horslev Plot
MCC 544 1000'-1066'
10.000
1.000
0.100
0.010
h/h$_o$
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
4.500
5.000
Elapsed Time (min)

Slug Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
17:43:22	17.723	0.000	0.000	0.000	373.2	-
17:43:26	17.724	0.001	0.060	4.17E-05	430.1	0.993
17:43:31	17.725	0.002	0.120	8.33E-05	430.5	1.000
17:43:36	17.727	0.004	0.240	1.67E-04	430.4	0.998
17:43:41	17.728	0.005	0.300	2.08E-04	430.5	1.000
17:43:46	17.729	0.006	0.360	2.50E-04	430.4	0.998
17:43:50	17.731	0.008	0.480	3.33E-04	430.3	0.997
17:43:55	17.732	0.009	0.540	3.75E-04	430.2	0.995
17:44:00	17.733	0.010	0.600	4.17E-04	430.1	0.993
17:44:05	17.735	0.012	0.720	5.00E-04	430.1	0.993
17:44:09	17.736	0.013	0.780	5.42E-04	429.9	0.990
17:44:14	17.737	0.014	0.840	5.83E-04	430	0.991
17:44:19	17.739	0.016	0.960	6.67E-04	429.9	0.990
17:44:24	17.74	0.017	1.020	7.08E-04	429.6	0.984
17:44:29	17.741	0.018	1.080	7.50E-04	429.8	0.988
17:44:33	17.743	0.020	1.200	8.33E-04	429.3	0.979
17:44:38	17.744	0.021	1.260	8.75E-04	429.3	0.979
17:44:43	17.745	0.022	1.320	9.17E-04	429.1	0.976
17:44:48	17.747	0.024	1.440	1.00E-03	429.1	0.976
17:44:53	17.748	0.025	1.500	1.04E-03	428.9	0.972
17:44:57	17.749	0.026	1.560	1.08E-03	428.9	0.972
17:45:02	17.751	0.028	1.680	1.17E-03	428.9	0.972
17:45:07	17.752	0.029	1.740	1.21E-03	428.7	0.969
17:45:12	17.753	0.030	1.800	1.25E-03	428.7	0.969
17:45:16	17.755	0.032	1.920	1.33E-03	428.6	0.967
17:45:21	17.756	0.033	1.980	1.38E-03	428.6	0.967
17:45:26	17.757	0.034	2.040	1.42E-03	428.6	0.967
17:45:31	17.759	0.036	2.160	1.50E-03	428.4	0.963
17:45:36	17.76	0.037	2.220	1.54E-03	428.4	0.963
17:45:41	17.761	0.038	2.280	1.58E-03	428.3	0.962
17:45:45	17.763	0.040	2.400	1.67E-03	428.2	0.960
17:45:50	17.764	0.041	2.460	1.71E-03	428.2	0.960
17:45:55	17.765	0.042	2.520	1.75E-03	428.2	0.960
17:46:00	17.767	0.044	2.640	1.83E-03	428.1	0.958
17:46:04	17.768	0.045	2.700	1.88E-03	427.9	0.955
17:46:09	17.769	0.046	2.760	1.92E-03	427.9	0.955
17:46:14	17.771	0.048	2.880	2.00E-03	427.9	0.955
17:46:19	17.772	0.049	2.940	2.04E-03	427.9	0.955
17:46:24	17.773	0.050	3.000	2.08E-03	427.8	0.953
17:46:28	17.775	0.052	3.120	2.17E-03	427.8	0.953
17:46:33	17.776	0.053	3.180	2.21E-03	427.9	0.955
17:46:38	17.777	0.054	3.240	2.25E-03	427.6	0.949
17:46:43	17.779	0.056	3.360	2.33E-03	427.7	0.951
17:46:47	17.78	0.057	3.420	2.38E-03	427.4	0.946
17:46:52	17.781	0.058	3.480	2.42E-03	427.3	0.944

Slug Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
17:46:57	17.783	0.060	3.600	2.50E-03	427.4	0.946
17:47:02	17.784	0.061	3.660	2.54E-03	427.3	0.944
17:47:07	17.785	0.062	3.720	2.58E-03	427.2	0.942
17:47:11	17.786	0.063	3.780	2.63E-03	427.3	0.944
17:47:16	17.788	0.065	3.900	2.71E-03	427.1	0.941
17:47:21	17.789	0.066	3.960	2.75E-03	427	0.939
17:47:26	17.79	0.067	4.020	2.79E-03	427	0.939
17:47:30	17.792	0.069	4.140	2.88E-03	427	0.939
17:47:35	17.793	0.070	4.200	2.92E-03	426.9	0.937
17:47:40	17.794	0.071	4.260	2.96E-03	426.7	0.934
17:47:45	17.796	0.073	4.380	3.04E-03	426.7	0.934
17:47:50	17.797	0.074	4.440	3.08E-03	426.6	0.932
17:47:55	17.798	0.075	4.500	3.12E-03	426.7	0.934
17:47:59	17.8	0.077	4.620	3.21E-03	426.5	0.930
17:48:04	17.801	0.078	4.680	3.25E-03	426.2	0.925


Step-Rate Injection Test
MCC 544 1000'-1066'
Bottom-hole Pressure (psig)
1000
900
800
700
600
500
400
17.9
18
18.1
18.2
18.3
18.4
18.5
18.6
18.7
18.8
18.9
Time


Fracture Gradient
MCC 544 1000'-1066'
Fracture Pressure = 821.5 psi
Fracture Gradient:
= 821.5 psi/1000 ft
= 0.82 psi/ft
Bottom-hole Pressure (psig)
Injection Rate (gpm)
1000
900
800
700
600
500
400
0
2
4
6
8
10
12
14

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
17:58:03	17.967	0.000	0.000	3.6	428.6	
17:58:08	17.969	0.002	0.120	3.6	431.4	
17:58:12	17.97	0.003	0.180	3.6	432.7	
17:58:17	17.971	0.004	0.240	3.6	435.9	
17:58:22	17.973	0.006	0.360	3.6	437.9	
17:58:27	17.974	0.007	0.420	3.6	443	
17:58:31	17.975	0.008	0.480	3.6	445.9	
17:58:36	17.977	0.010	0.600	3.6	452.4	
17:58:41	17.978	0.011	0.660	3.6	457.1	
17:58:46	17.979	0.012	0.720	3.6	468.6	
17:58:51	17.981	0.014	0.840	3.6	478.8	
17:58:55	17.982	0.015	0.900	3.6	497.8	
17:59:00	17.983	0.016	0.960	3.6	510.4	
17:59:05	17.985	0.018	1.080	3.6	535.4	
17:59:10	17.986	0.019	1.140	3.6	546.1	
17:59:15	17.987	0.020	1.200	3.6	556.2	
17:59:19	17.989	0.022	1.320	3.6	558.9	
17:59:24	17.99	0.023	1.380	3.6	544.4	
17:59:29	17.991	0.024	1.440	3.6	533.5	
17:59:34	17.993	0.026	1.560	3.6	522.3	
17:59:38	17.994	0.027	1.620	3.6	519.4	
17:59:43	17.995	0.028	1.680	3.6	518	
17:59:48	17.997	0.030	1.800	3.6	519.2	
17:59:53	17.998	0.031	1.860	3.6	520.3	
17:59:58	17.999	0.032	1.920	3.6	519.2	
18:00:03	18.001	0.034	2.040	3.6	523.6	
18:00:07	18.002	0.035	2.100	3.6	527.9	
18:00:12	18.003	0.036	2.160	3.6	531.2	
18:00:17	18.005	0.038	2.280	3.6	532	
18:00:22	18.006	0.039	2.340	3.6	533.7	
18:00:26	18.007	0.040	2.400	3.6	533.6	
18:00:31	18.009	0.042	2.520	3.6	533	
18:00:36	18.01	0.043	2.580	3.6	533.5	
18:00:41	18.011	0.044	2.640	3.6	532.3	
18:00:46	18.013	0.046	2.760	3.6	532	
18:00:50	18.014	0.047	2.820	3.6	532.2	
18:00:55	18.015	0.048	2.880	3.6	533.4	
18:01:00	18.017	0.050	3.000	3.6	533.4	
18:01:05	18.018	0.051	3.060	3.6	533.4	
18:01:09	18.019	0.052	3.120	3.6	533	
18:01:14	18.021	0.054	3.240	3.6	533.8	
18:01:19	18.022	0.055	3.300	3.6	532.7	
18:01:24	18.023	0.056	3.360	3.6	533.5	
18:01:29	18.025	0.058	3.480	3.6	531.9	
18:01:33	18.026	0.059	3.540	3.6	532.2	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:01:38	18.027	0.060	3.600	3.6	532.1	
18:01:43	18.029	0.062	3.720	3.6	532.5	
18:01:48	18.03	0.063	3.780	3.6	533.6	
18:01:53	18.031	0.064	3.840	3.6	533.3	
18:01:57	18.033	0.066	3.960	3.6	534	
18:02:02	18.034	0.067	4.020	3.6	533.7	
18:02:07	18.035	0.068	4.080	3.6	533.5	
18:02:12	18.037	0.070	4.200	3.6	532.7	
18:02:16	18.038	0.071	4.260	3.6	532.4	
18:02:21	18.039	0.072	4.320	3.6	532.9	
18:02:26	18.041	0.074	4.440	3.6	533.8	
18:02:31	18.042	0.075	4.500	3.6	533.7	
18:02:36	18.043	0.076	4.560	3.6	533.3	
18:02:40	18.045	0.078	4.680	3.6	533	
18:02:45	18.046	0.079	4.740	3.6	532.5	
18:02:50	18.047	0.080	4.800	3.6	533	
18:02:55	18.049	0.082	4.920	3.6	532.7	
18:03:00	18.05	0.083	4.980	3.6	532	
18:03:04	18.051	0.084	5.040	3.6	532.6	
18:03:09	18.053	0.086	5.160	3.6	532.9	
18:03:14	18.054	0.087	5.220	3.6	532.7	
18:03:19	18.055	0.088	5.280	3.6	532.3	
18:03:24	18.057	0.090	5.400	3.6	532.7	
18:03:28	18.058	0.091	5.460	3.6	532.1	
18:03:33	18.059	0.092	5.520	3.6	531.1	
18:03:38	18.061	0.094	5.640	3.6	531.1	
18:03:43	18.062	0.095	5.700	3.6	531.7	
18:03:47	18.063	0.096	5.760	3.6	531.5	
18:04:18	18.072	0.105	6.300	3.6	530.9	
18:04:48	18.08	0.113	6.780	3.6	531.3	
18:05:19	18.089	0.122	7.320	3.6	528.7	
18:05:49	18.097	0.130	7.800	3.6	527.5	
18:06:19	18.105	0.138	8.280	3.6	512.3	
18:06:50	18.114	0.147	8.820	3.6	506.6	
18:07:20	18.122	0.155	9.300	3.6	510	
18:07:50	18.131	0.164	9.840	3.6	512.9	
18:08:20	18.139	0.172	10.320	3.6	510.5	
18:08:31	18.142	0.175	10.500	3.6	511.6	
18:08:35	18.143	0.176	10.560	3.6	511.4	
18:08:40	18.144	0.177	10.620	3.6	510.9	
18:08:44	18.146	0.179	10.740	3.6	511.1	
18:08:49	18.147	0.180	10.800	3.6	510.6	
18:08:54	18.148	0.181	10.860	3.6	510.6	
18:08:59	18.15	0.183	10.980	3.6	509.7	
18:09:04	18.151	0.184	11.040	3.6	509.2	
18:09:08	18.152	0.185	11.100	3.6	508.7	
18:09:13	18.154	0.187	11.220	3.6	508.6	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:09:18	18.155	0.188	11.280	3.6	508	
18:09:23	18.156	0.189	11.340	3.6	508.5	
18:09:28	18.158	0.191	11.460	3.6	508.8	
18:09:32	18.159	0.192	11.520	3.6	508.9	
18:09:37	18.16	0.193	11.580	3.6	508.5	
18:09:42	18.162	0.195	11.700	3.6	508.4	
18:09:47	18.163	0.196	11.760	3.6	508.1	
18:09:51	18.164	0.197	11.820	3.6	507.5	
18:09:56	18.166	0.199	11.940	3.6	507.8	
18:10:01	18.167	0.200	12.000	3.6	508.3	
18:10:06	18.168	0.201	12.060	3.6	508.6	
18:10:11	18.17	0.203	12.180	3.6	507.8	
18:10:15	18.171	0.204	12.240	3.6	506.8	
18:10:20	18.172	0.205	12.300	3.6	510.5	
18:10:25	18.174	0.207	12.420	7.5	565.8	
18:10:30	18.175	0.208	12.480	7.5	594.8	
18:10:35	18.176	0.209	12.540	7.5	638.3	
18:10:39	18.178	0.211	12.660	7.5	656.8	
18:10:44	18.179	0.212	12.720	7.5	677.3	
18:10:49	18.18	0.213	12.780	7.5	678.5	
18:10:54	18.182	0.215	12.900	7.5	688.2	
18:10:58	18.183	0.216	12.960	7.5	686.1	
18:11:03	18.184	0.217	13.020	7.5	689.9	
18:11:08	18.186	0.219	13.140	7.5	689.9	
18:11:13	18.187	0.220	13.200	7.5	693.4	
18:11:18	18.188	0.221	13.260	7.5	697.6	
18:11:23	18.19	0.223	13.380	7.5	698.1	
18:11:53	18.198	0.231	13.860	7.5	707.2	
18:12:23	18.206	0.239	14.340	7.5	713.9	
18:12:53	18.215	0.248	14.880	7.5	719.8	
18:13:24	18.223	0.256	15.360	7.5	720.2	
18:13:54	18.232	0.265	15.900	7.5	717.4	
18:14:25	18.24	0.273	16.380	7.5	733.9	
18:14:55	18.249	0.282	16.920	7.5	734.1	
18:15:25	18.257	0.290	17.400	7.5	743.5	
18:15:55	18.265	0.298	17.880	7.5	742.4	
18:16:26	18.274	0.307	18.420	7.5	743.2	
18:16:56	18.282	0.315	18.900	7.5	754.5	
18:17:26	18.291	0.324	19.440	7.5	767.1	
18:17:57	18.299	0.332	19.920	7.5	750.6	
18:18:27	18.308	0.341	20.460	7.5	760.3	
18:18:53	18.315	0.348	20.880	7.5	754.3	
18:18:54	18.315	0.348	20.880	7.5	754.3	
18:18:56	18.316	0.349	20.940	7.5	757.9	
18:18:57	18.316	0.349	20.940	7.5	757.9	
18:18:59	18.316	0.349	20.940	7.5	765.9	
18:19:01	18.317	0.350	21.000	7.5	765.9	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:19:02	18.317	0.350	21.000	7.5	770.4	
18:19:04	18.318	0.351	21.060	7.5	770.4	
18:19:05	18.318	0.351	21.060	7.5	771.1	
18:19:07	18.319	0.352	21.120	7.5	771.1	
18:19:09	18.319	0.352	21.120	8.8	787.4	
18:19:10	18.319	0.352	21.120	8.8	787.4	
18:19:12	18.32	0.353	21.180	8.8	793	
18:19:13	18.32	0.353	21.180	8.8	793	
18:19:15	18.321	0.354	21.240	8.8	801.7	
18:19:17	18.321	0.354	21.240	8.8	801.7	
18:19:18	18.322	0.355	21.300	8.8	807.1	
18:19:20	18.322	0.355	21.300	8.8	807.1	
18:19:21	18.323	0.356	21.360	8.8	813.6	
18:19:23	18.323	0.356	21.360	8.8	813.6	
18:19:25	18.324	0.357	21.420	8.8	809.7	
18:19:26	18.324	0.357	21.420	8.8	809.7	
18:19:28	18.324	0.357	21.420	8.8	809	
18:19:29	18.325	0.358	21.480	8.8	809	
18:19:31	18.325	0.358	21.480	8.8	809	
18:19:33	18.326	0.359	21.540	8.8	809	
18:19:34	18.326	0.359	21.540	8.8	806.6	
18:19:36	18.327	0.360	21.600	8.8	806.6	
18:19:37	18.327	0.360	21.600	8.8	811	
18:19:39	18.328	0.361	21.660	8.8	811	
18:19:41	18.328	0.361	21.660	8.8	808.6	
18:19:42	18.328	0.361	21.660	8.8	808.6	
18:19:44	18.329	0.362	21.720	8.8	808.2	
18:19:45	18.329	0.362	21.720	8.8	808.2	
18:19:47	18.33	0.363	21.780	8.8	810.8	
18:19:49	18.33	0.363	21.780	8.8	810.8	
18:19:50	18.331	0.364	21.840	8.8	809.2	
18:19:52	18.331	0.364	21.840	8.8	809.2	
18:19:53	18.331	0.364	21.840	8.8	814.2	
18:19:55	18.332	0.365	21.900	8.8	814.2	
18:20:25	18.34	0.373	22.380	8.8	817	
18:20:56	18.349	0.382	22.920	8.8	832.9	
18:21:26	18.357	0.390	23.400	8.8	844.4	
18:21:56	18.366	0.399	23.940	8.8	840.1	
18:22:27	18.374	0.407	24.420	8.8	836.2	
18:22:57	18.382	0.415	24.900	8.8	835.3	
18:23:27	18.391	0.424	25.440	8.8	835.1	
18:23:57	18.399	0.432	25.920	8.8	837.8	
18:24:28	18.408	0.441	26.460	8.8	829.6	
18:25:30	18.425	0.458	27.480	8.8	833.9	
18:26:00	18.433	0.466	27.960	9.6	475.2	
18:26:17	18.438	0.471	28.260	9.6	524	
18:26:18	18.438	0.471	28.260	9.6	517.3	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:26:20	18.439	0.472	28.320	9.6	511.4	
18:26:21	18.439	0.472	28.320	9.6	511.4	
18:26:23	18.44	0.473	28.380	9.6	553.6	
18:26:24	18.44	0.473	28.380	9.6	553.6	
18:26:26	18.441	0.474	28.440	9.6	602	
18:26:28	18.441	0.474	28.440	9.6	602	
18:26:29	18.441	0.474	28.440	9.6	632.1	
18:26:31	18.442	0.475	28.500	9.6	632.1	
18:26:32	18.442	0.475	28.500	9.6	740	
18:26:34	18.443	0.476	28.560	9.6	740	
18:26:36	18.443	0.476	28.560	9.6	766.9	
18:26:37	18.444	0.477	28.620	9.6	766.9	
18:26:39	18.444	0.477	28.620	9.6	767.7	
18:26:40	18.445	0.478	28.680	9.6	767.7	
18:26:42	18.445	0.478	28.680	9.6	772.1	
18:26:44	18.445	0.478	28.680	9.6	772.1	
18:26:45	18.446	0.479	28.740	9.6	775.7	
18:26:47	18.446	0.479	28.740	9.6	775.7	
18:26:48	18.447	0.480	28.800	9.6	779.3	
18:26:50	18.447	0.480	28.800	9.6	779.3	
18:26:52	18.448	0.481	28.860	9.6	781.7	
18:26:53	18.448	0.481	28.860	9.6	781.7	
18:26:55	18.449	0.482	28.920	9.6	781.8	
18:26:56	18.449	0.482	28.920	9.6	781.8	
18:26:58	18.449	0.482	28.920	9.6	780.7	
18:27:00	18.45	0.483	28.980	9.6	780.7	
18:27:01	18.45	0.483	28.980	9.6	778.3	
18:27:03	18.451	0.484	29.040	9.6	778.3	
18:27:04	18.451	0.484	29.040	9.6	779.1	
18:27:06	18.452	0.485	29.100	9.6	779.1	
18:27:08	18.452	0.485	29.100	9.6	780.6	
18:27:09	18.453	0.486	29.160	9.6	780.6	
18:27:11	18.453	0.486	29.160	9.6	782.7	
18:27:12	18.453	0.486	29.160	9.6	782.7	
18:27:14	18.454	0.487	29.220	9.6	783.3	
18:27:16	18.454	0.487	29.220	9.6	783.3	
18:27:17	18.455	0.488	29.280	9.6	787.6	
18:27:19	18.455	0.488	29.280	9.6	787.6	
18:27:20	18.456	0.489	29.340	9.6	788.3	
18:27:22	18.456	0.489	29.340	9.6	788.3	
18:27:23	18.457	0.490	29.400	9.6	789.3	
18:27:25	18.457	0.490	29.400	9.6	789.3	
18:27:27	18.457	0.490	29.400	9.6	789	
18:27:28	18.458	0.491	29.460	9.6	789	
18:27:30	18.458	0.491	29.460	9.6	792.4	
18:27:31	18.459	0.492	29.520	9.6	792.4	
18:27:33	18.459	0.492	29.520	9.6	793.3	

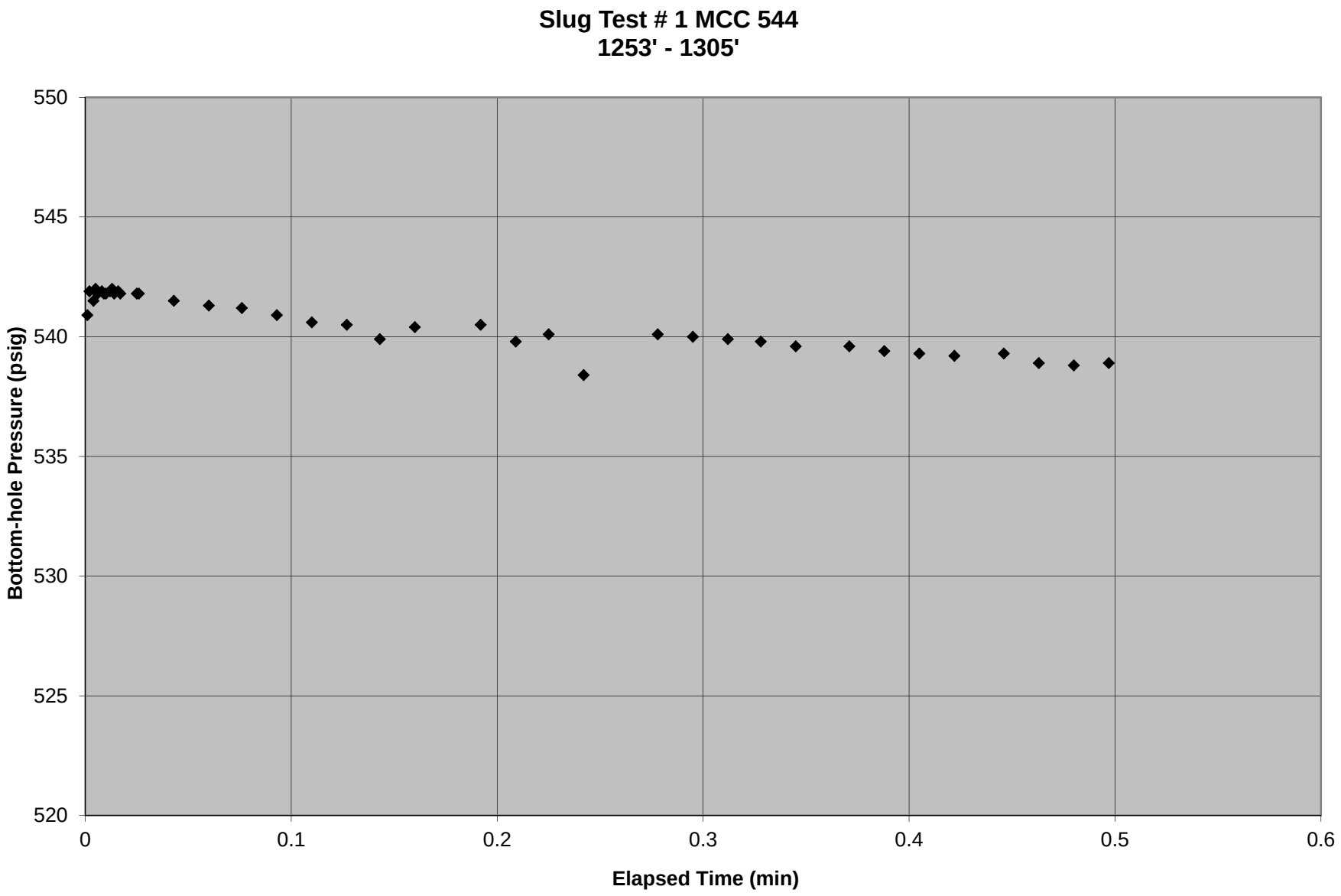
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:27:35	18.46	0.493	29.580	9.6	793.3	
18:27:36	18.46	0.493	29.580	9.6	790.8	
18:27:38	18.46	0.493	29.580	9.6	790.8	
18:27:39	18.461	0.494	29.640	9.6	788.1	
18:27:41	18.461	0.494	29.640	9.6	788.1	
18:27:43	18.462	0.495	29.700	9.6	786.6	
18:27:44	18.462	0.495	29.700	9.6	786.6	
18:27:46	18.463	0.496	29.760	9.6	787.3	
18:27:47	18.463	0.496	29.760	9.6	787.3	
18:27:49	18.464	0.497	29.820	9.6	784.7	
18:27:51	18.464	0.497	29.820	9.6	784.7	
18:27:52	18.464	0.497	29.820	9.6	788.3	
18:27:54	18.465	0.498	29.880	9.6	788.3	
18:28:24	18.473	0.506	30.360	9.6	797.1	
18:28:54	18.482	0.515	30.900	9.6	797.4	
18:29:25	18.49	0.523	31.380	9.6	794.1	
18:29:55	18.499	0.532	31.920	9.6	800.3	
18:30:25	18.507	0.540	32.400	9.6	797.3	
18:30:56	18.515	0.548	32.880	9.6	802.3	
18:31:26	18.524	0.557	33.420	9.6	805.1	
18:31:56	18.532	0.565	33.900	9.6	804.4	
18:32:27	18.541	0.574	34.440	9.6	808.9	
18:32:57	18.549	0.582	34.920	9.6	809.1	
18:33:26	18.557	0.590	35.400	9.6	803.3	
18:33:27	18.558	0.591	35.460	9.6	794.7	
18:33:29	18.558	0.591	35.460	9.6	794.7	
18:33:31	18.559	0.592	35.520	9.6	794.5	
18:33:32	18.559	0.592	35.520	9.6	794.5	
18:33:34	18.559	0.592	35.520	9.6	796.7	
18:33:35	18.56	0.593	35.580	9.6	796.7	
18:33:37	18.56	0.593	35.580	9.6	800.2	
18:33:39	18.561	0.594	35.640	9.6	800.2	
18:33:40	18.561	0.594	35.640	9.6	799.6	
18:33:42	18.562	0.595	35.700	9.6	799.6	
18:33:43	18.562	0.595	35.700	9.6	805.8	
18:33:45	18.562	0.595	35.700	9.6	805.8	
18:33:46	18.563	0.596	35.760	9.6	864.7	
18:33:48	18.563	0.596	35.760	9.6	864.7	
18:33:50	18.564	0.597	35.820	9.6	871.6	
18:33:51	18.564	0.597	35.820	9.6	871.6	
18:33:53	18.565	0.598	35.880	9.6	867.9	
18:33:54	18.565	0.598	35.880	9.6	867.9	
18:33:56	18.566	0.599	35.940	9.6	865.3	
18:33:58	18.566	0.599	35.940	9.6	865.3	
18:33:59	18.566	0.599	35.940	9.6	868.6	
18:34:01	18.567	0.600	36.000	9.6	868.6	
18:34:03	18.567	0.600	36.000	9.6	871.3	

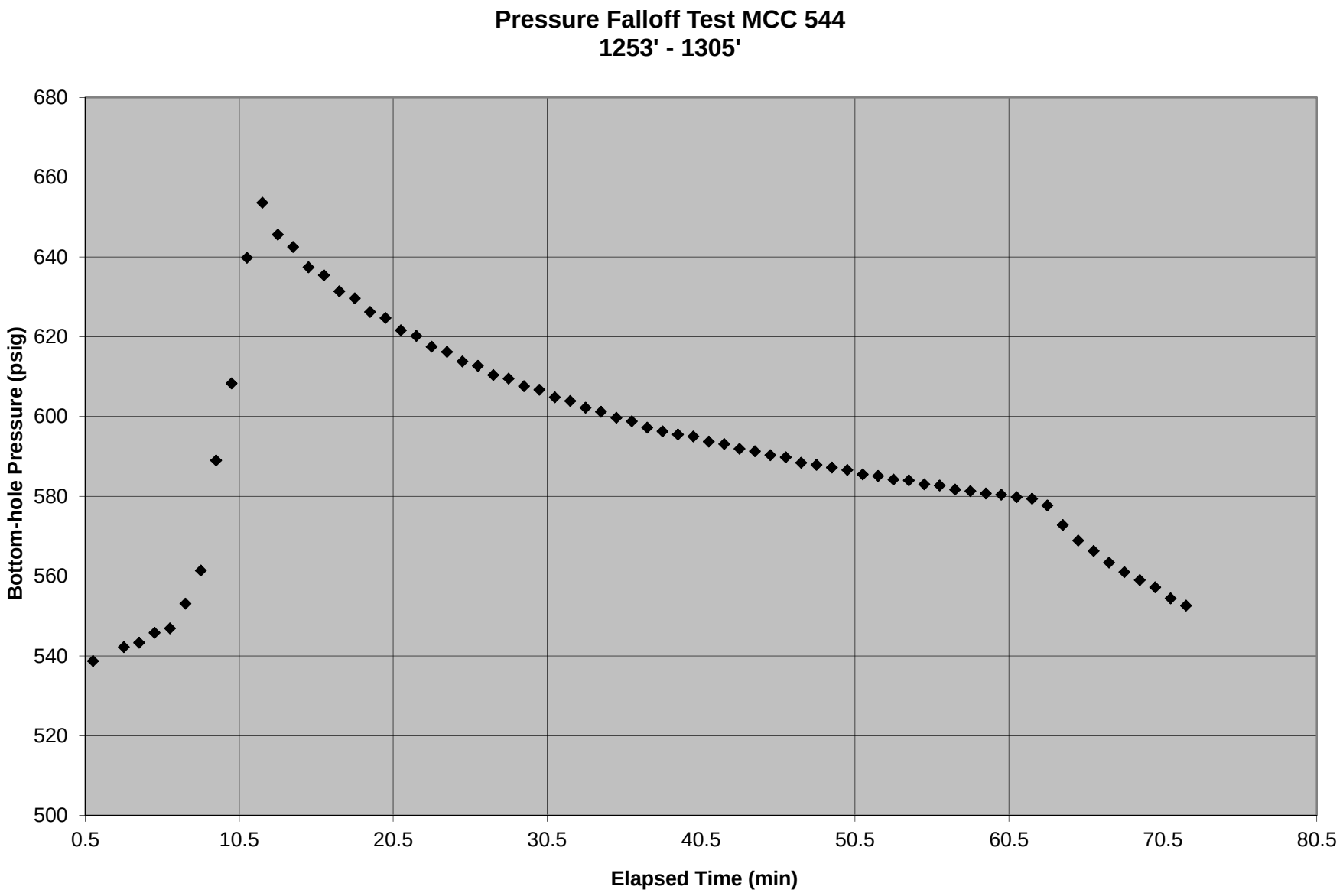
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:34:04	18.568	0.601	36.060	9.6	871.3	
18:34:06	18.568	0.601	36.060	9.6	871.9	
18:34:07	18.569	0.602	36.120	9.6	871.9	
18:34:09	18.569	0.602	36.120	9.6	875.2	
18:34:10	18.57	0.603	36.180	9.6	875.2	
18:34:12	18.57	0.603	36.180	9.6	876.2	
18:34:14	18.57	0.603	36.180	9.6	876.2	
18:34:15	18.571	0.604	36.240	9.6	876	
18:34:17	18.571	0.604	36.240	9.6	876	
18:34:18	18.572	0.605	36.300	9.6	873.6	
18:34:20	18.572	0.605	36.300	9.6	873.6	
18:34:21	18.573	0.606	36.360	9.6	870.4	
18:34:23	18.573	0.606	36.360	9.6	870.4	
18:34:25	18.574	0.607	36.420	9.6	870.8	
18:34:26	18.574	0.607	36.420	9.6	870.8	
18:34:28	18.574	0.607	36.420	9.6	872.4	
18:34:30	18.575	0.608	36.480	9.6	872.4	
18:34:31	18.575	0.608	36.480	9.6	875.2	
18:34:33	18.576	0.609	36.540	9.6	875.2	
18:34:34	18.576	0.609	36.540	9.6	873.9	
18:34:36	18.577	0.610	36.600	9.6	873.9	
18:34:38	18.577	0.610	36.600	9.6	871.5	
18:34:39	18.578	0.611	36.660	9.6	871.5	
18:34:41	18.578	0.611	36.660	9.6	870.5	
18:34:42	18.578	0.611	36.660	9.6	870.5	
18:34:44	18.579	0.612	36.720	9.6	872.2	
18:34:45	18.579	0.612	36.720	9.6	872.2	
18:34:47	18.58	0.613	36.780	9.6	871.9	
18:34:49	18.58	0.613	36.780	9.6	871.9	
18:34:50	18.581	0.614	36.840	9.6	875.7	
18:34:52	18.581	0.614	36.840	9.6	875.7	
18:34:53	18.582	0.615	36.900	9.6	871.6	
18:34:55	18.582	0.615	36.900	9.6	871.6	
18:34:57	18.582	0.615	36.900	9.6	868.6	
18:34:58	18.583	0.616	36.960	9.6	868.6	
18:35:00	18.583	0.616	36.960	9.6	865.9	
18:35:02	18.584	0.617	37.020	9.6	865.9	
18:35:03	18.584	0.617	37.020	9.6	868.9	
18:35:05	18.585	0.618	37.080	9.6	868.9	
18:35:06	18.585	0.618	37.080	9.6	870.3	
18:35:08	18.586	0.619	37.140	9.6	870.3	
18:35:10	18.586	0.619	37.140	9.6	872.4	
18:35:11	18.586	0.619	37.140	9.6	872.4	
18:35:13	18.587	0.620	37.200	9.6	876.5	
18:35:14	18.587	0.620	37.200	9.6	876.5	
18:35:16	18.588	0.621	37.260	9.6	877.2	
18:35:17	18.588	0.621	37.260	9.6	877.2	

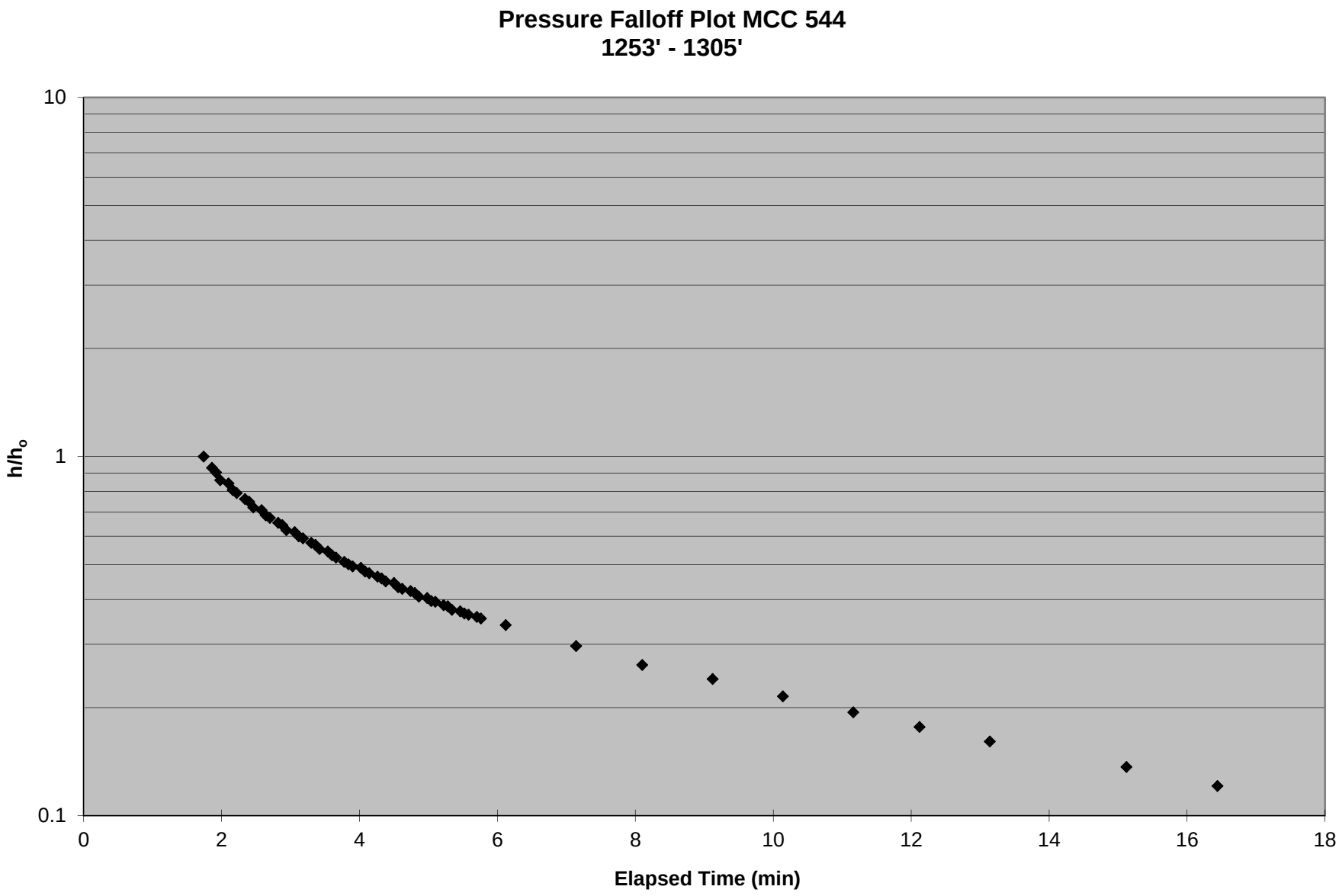
Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:35:19	18.589	0.622	37.320	9.6	872.3	
18:35:21	18.589	0.622	37.320	9.6	872.3	
18:35:22	18.59	0.623	37.380	9.6	873	
18:35:24	18.59	0.623	37.380	9.6	873	
18:35:26	18.59	0.623	37.380	9.6	875.4	
18:35:27	18.591	0.624	37.440	9.6	875.4	
18:35:29	18.591	0.624	37.440	9.6	875	
18:35:30	18.592	0.625	37.500	9.6	875	
18:35:32	18.592	0.625	37.500	9.6	873.4	
18:35:34	18.593	0.626	37.560	9.6	873.4	
18:35:35	18.593	0.626	37.560	9.6	870	
18:35:36	18.593	0.626	37.560	9.6	870	
18:35:38	18.594	0.627	37.620	9.6	868.6	
18:35:40	18.594	0.627	37.620	9.6	868.6	
18:35:41	18.595	0.628	37.680	9.6	870.5	
18:35:43	18.595	0.628	37.680	9.6	870.5	
18:36:13	18.604	0.637	38.220	9.6	871.5	
18:36:44	18.612	0.645	38.700	9.6	867.9	
18:37:14	18.621	0.654	39.240	9.6	867	
18:37:44	18.629	0.662	39.720	9.6	866.7	
18:38:15	18.637	0.670	40.200	9.6	864.9	
18:38:45	18.646	0.679	40.740	9.6	862.7	
18:39:15	18.654	0.687	41.220	9.6	865.9	
18:39:46	18.663	0.696	41.760	9.6	867.3	
18:40:02	18.667	0.700	42.000	9.6	865.5	
18:40:03	18.668	0.701	42.060	9.6	864.7	
18:40:05	18.668	0.701	42.060	9.6	864.7	
18:40:06	18.668	0.701	42.060	9.6	861.3	
18:40:08	18.669	0.702	42.120	9.6	861.3	
18:40:09	18.669	0.702	42.120	9.6	859.8	
18:40:11	18.67	0.703	42.180	9.6	859.8	
18:40:13	18.67	0.703	42.180	9.6	858.9	
18:40:14	18.671	0.704	42.240	9.6	858.9	
18:40:16	18.671	0.704	42.240	9.6	857.7	
18:40:17	18.672	0.705	42.300	9.6	857.7	
18:40:19	18.672	0.705	42.300	9.6	862.3	
18:40:21	18.672	0.705	42.300	9.6	862.3	
18:40:22	18.673	0.706	42.360	9.6	866.4	
18:40:24	18.673	0.706	42.360	9.6	866.4	
18:40:25	18.674	0.707	42.420	9.6	864.4	
18:40:27	18.674	0.707	42.420	9.6	864.4	
18:40:29	18.675	0.708	42.480	9.6	861.7	
18:40:30	18.675	0.708	42.480	9.6	861.7	
18:40:32	18.676	0.709	42.540	9.6	860.5	
18:40:33	18.676	0.709	42.540	9.6	860.5	
18:40:35	18.676	0.709	42.540	9.6	862.1	
18:40:37	18.677	0.710	42.600	9.6	862.1	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:40:38	18.677	0.710	42.600	9.6	863.6	
18:40:40	18.678	0.711	42.660	9.6	863.6	
18:40:41	18.678	0.711	42.660	9.6	864	
18:40:43	18.679	0.712	42.720	9.6	864	
18:40:45	18.679	0.712	42.720	9.6	863.4	
18:40:46	18.68	0.713	42.780	9.6	863.4	
18:40:48	18.68	0.713	42.780	9.6	863.1	
18:40:50	18.68	0.713	42.780	9.6	863.1	
18:40:51	18.681	0.714	42.840	9.6	864.8	
18:40:52	18.681	0.714	42.840	9.6	864.8	
18:40:54	18.682	0.715	42.900	12.5	890.2	
18:40:56	18.682	0.715	42.900	12.5	890.2	
18:40:57	18.683	0.716	42.960	12.5	920.5	
18:40:59	18.683	0.716	42.960	12.5	920.5	
18:41:00	18.683	0.716	42.960	12.5	942.1	
18:41:02	18.684	0.717	43.020	12.5	942.1	
18:41:04	18.684	0.717	43.020	12.5	946.6	
18:41:05	18.685	0.718	43.080	12.5	946.6	
18:41:07	18.685	0.718	43.080	12.5	943.5	
18:41:08	18.686	0.719	43.140	12.5	943.5	
18:41:10	18.686	0.719	43.140	12.5	939.7	
18:41:12	18.687	0.720	43.200	12.5	939.7	
18:41:13	18.687	0.720	43.200	12.5	940.2	
18:41:15	18.687	0.720	43.200	12.5	940.2	
18:41:16	18.688	0.721	43.260	12.5	945.2	
18:41:18	18.688	0.721	43.260	12.5	945.2	
18:41:20	18.689	0.722	43.320	12.5	947.6	
18:41:21	18.689	0.722	43.320	12.5	947.6	
18:41:23	18.69	0.723	43.380	12.5	944.9	
18:41:24	18.69	0.723	43.380	12.5	944.9	
18:41:26	18.691	0.724	43.440	12.5	942.7	
18:41:28	18.691	0.724	43.440	12.5	942.7	
18:41:29	18.691	0.724	43.440	12.5	942.1	
18:41:31	18.692	0.725	43.500	12.5	942.1	
18:41:33	18.692	0.725	43.500	12.5	943.3	
18:41:34	18.693	0.726	43.560	12.5	943.3	
18:41:36	18.693	0.726	43.560	12.5	941.1	
18:41:37	18.694	0.727	43.620	12.5	941.1	
18:41:39	18.694	0.727	43.620	12.5	940.1	
18:41:40	18.695	0.728	43.680	12.5	940.1	
18:41:42	18.695	0.728	43.680	12.5	938.5	
18:41:44	18.695	0.728	43.680	12.5	938.5	
18:41:45	18.696	0.729	43.740	12.5	936.8	
18:41:47	18.696	0.729	43.740	12.5	936.8	
18:41:48	18.697	0.730	43.800	12.5	936.2	
18:41:50	18.697	0.730	43.800	12.5	936.2	
18:41:51	18.698	0.731	43.860	12.5	935.8	

Step Rate Injection Test Data MCC 544 1000'-1066'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
18:41:53	18.698	0.731	43.860	12.5	935.8	
18:41:55	18.699	0.732	43.920	12.5	941.4	
18:41:56	18.699	0.732	43.920	12.5	941.4	
18:41:58	18.699	0.732	43.920	12.5	938.3	
18:42:00	18.7	0.733	43.980	12.5	938.3	
18:42:01	18.7	0.733	43.980	12.5	940.9	
18:42:03	18.701	0.734	44.040	12.5	940.9	
18:42:04	18.701	0.734	44.040	12.5	939.2	
18:42:06	18.702	0.735	44.100	12.5	939.2	
18:42:08	18.702	0.735	44.100	12.5	940	
18:42:09	18.703	0.736	44.160	12.5	940	
18:42:11	18.703	0.736	44.160	12.5	942.5	
18:42:12	18.703	0.736	44.160	12.5	942.5	
18:42:14	18.704	0.737	44.220	12.5	940.4	
18:42:15	18.704	0.737	44.220	12.5	940.4	
18:42:17	18.705	0.738	44.280	12.5	939.6	
18:42:19	18.705	0.738	44.280	12.5	939.6	
18:42:20	18.706	0.739	44.340	12.5	943.2	
18:42:22	18.706	0.739	44.340	12.5	943.2	
18:42:52	18.714	0.747	44.820	12.5	941.1	
18:43:22	18.723	0.756	45.360	12.5	937.3	
18:44:04	18.734	0.767	46.020	12.5	938.9	
18:44:34	18.743	0.776	46.560	12.5	937.8	
18:45:05	18.751	0.784	47.040	12.5	940.9	
18:45:35	18.76	0.793	47.580	12.5	939.9	
18:46:05	18.768	0.801	48.060	12.5	945.5	
18:46:36	18.777	0.810	48.600	12.5	945	
18:47:06	18.785	0.818	49.080	12.5	947.9	
18:47:36	18.793	0.826	49.560	12.5	938.5	
18:48:07	18.802	0.835	50.100	12.5	938.3	
18:48:37	18.81	0.843	50.580	12.5	939	End Test
18:49:07	18.819	0.852	51.120	-	435.8	
18:49:37	18.827	0.860	51.600	-	420.7	


Slug Test # 1 MCC 544
1253' - 1305'
550
545
540
535
530
525
520
Bottom-hole Pressure (psig)
0
0.1
0.2
0.3
0.4
0.5
0.6
Elapsed Time (min)


Pressure Falloff Test MCC 544
1253' - 1305'
Bottom-hole Pressure (psig)
680
660
640
620
600
580
560
540
520
500
0.5
10.5
20.5
30.5
40.5
50.5
60.5
70.5
80.5
Elapsed Time (min)


Pressure Falloff Plot MCC 544
1253' - 1305'
10
1
0.1
h/h$_o$
0
2
4
6
8
10
12
14
16
18
Elapsed Time (min)

Pressure Falloff Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
13:00:23	13.006	-	-	-	538.7	-
13:01:24	13.023	0.017	1.02	0.0007083	542.2	0.0304613
13:01:29	13.025	0.019	1.14	0.0007917	543.3	0.0400348
13:01:34	13.026	0.02	1.2	0.0008333	545.8	0.0617929
13:01:39	13.027	0.021	1.26	0.000875	546.9	0.0713664
13:01:43	13.029	0.023	1.38	0.0009583	553.1	0.1253264
13:01:48	13.03	0.024	1.44	0.001	561.4	0.1975631
13:01:53	13.031	0.025	1.5	0.0010417	589	0.437772
13:01:58	13.033	0.027	1.62	0.001125	608.3	0.6057441
13:02:02	13.034	0.028	1.68	0.0011667	639.8	0.8798956
13:02:07	13.035	0.029	1.74	0.0012083	653.6	1
13:02:12	13.037	0.031	1.86	0.0012917	645.6	0.9303742
13:02:17	13.038	0.032	1.92	0.0013333	642.5	0.9033943
13:02:22	13.039	0.033	1.98	0.001375	637.4	0.8590078
13:02:26	13.041	0.035	2.1	0.0014583	635.4	0.8416014
13:02:31	13.042	0.036	2.16	0.0015	631.4	0.8067885
13:02:36	13.043	0.037	2.22	0.0015417	629.6	0.7911227
13:02:41	13.045	0.039	2.34	0.001625	626.2	0.7615318
13:02:46	13.046	0.04	2.4	0.0016667	624.7	0.7484769
13:02:50	13.047	0.041	2.46	0.0017083	621.6	0.721497
13:02:55	13.049	0.043	2.58	0.0017917	620.2	0.7093124
13:03:00	13.05	0.044	2.64	0.0018333	617.5	0.6858138
13:03:05	13.051	0.045	2.7	0.001875	616.2	0.6744996
13:03:09	13.053	0.047	2.82	0.0019583	613.8	0.6536118
13:03:14	13.054	0.048	2.88	0.002	612.7	0.6440383
13:03:19	13.055	0.049	2.94	0.0020417	610.4	0.6240209
13:03:24	13.057	0.051	3.06	0.002125	609.5	0.616188
13:03:29	13.058	0.052	3.12	0.0021667	607.6	0.5996519
13:03:34	13.059	0.053	3.18	0.0022083	606.7	0.591819
13:03:38	13.061	0.055	3.3	0.0022917	604.8	0.5752829
13:03:43	13.062	0.056	3.36	0.0023333	603.9	0.56745
13:03:48	13.063	0.057	3.42	0.002375	602.2	0.5526545
13:03:53	13.065	0.059	3.54	0.0024583	601.2	0.5439513
13:03:57	13.066	0.06	3.6	0.0025	599.7	0.5308964
13:04:02	13.067	0.061	3.66	0.0025417	598.8	0.5230635
13:04:07	13.069	0.063	3.78	0.002625	597.2	0.5091384
13:04:12	13.07	0.064	3.84	0.0026667	596.3	0.5013055
13:04:17	13.071	0.065	3.9	0.0027083	595.5	0.4943429
13:04:21	13.073	0.067	4.02	0.0027917	595	0.4899913
13:04:26	13.074	0.068	4.08	0.0028333	593.7	0.4786771
13:04:31	13.075	0.069	4.14	0.002875	593.1	0.4734552
13:04:36	13.077	0.071	4.26	0.0029583	591.9	0.4630113
13:04:41	13.078	0.072	4.32	0.003	591.3	0.4577894
13:04:45	13.079	0.073	4.38	0.0030417	590.3	0.4490862
13:04:50	13.081	0.075	4.5	0.003125	589.8	0.4447346

Pressure Falloff Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
13:04:55	13.082	0.076	4.56	0.0031667	588.4	0.43255
13:05:00	13.083	0.077	4.62	0.0032083	587.9	0.4281984
13:05:05	13.085	0.079	4.74	0.0032917	587.2	0.4221062
13:05:09	13.086	0.08	4.8	0.0033333	586.6	0.4168842
13:05:14	13.087	0.081	4.86	0.003375	585.5	0.4073107
13:05:19	13.089	0.083	4.98	0.0034583	585.1	0.4038294
13:05:24	13.09	0.084	5.04	0.0035	584.2	0.3959965
13:05:28	13.091	0.085	5.1	0.0035417	584	0.3942559
13:05:33	13.093	0.087	5.22	0.003625	583	0.3855527
13:05:38	13.094	0.088	5.28	0.0036667	582.7	0.3829417
13:05:43	13.095	0.089	5.34	0.0037083	581.7	0.3742385
13:05:48	13.097	0.091	5.46	0.0037917	581.3	0.3707572
13:05:52	13.098	0.092	5.52	0.0038333	580.7	0.3655352
13:05:57	13.099	0.093	5.58	0.003875	580.4	0.3629243
13:06:02	13.101	0.095	5.7	0.0039583	579.8	0.3577023
13:06:07	13.102	0.096	5.76	0.004	579.4	0.3542211
13:06:28	13.108	0.102	6.12	0.00425	577.7	0.3394256
13:07:28	13.125	0.119	7.14	0.0049583	572.8	0.2967798
13:08:28	13.141	0.135	8.1	0.005625	568.9	0.2628372
13:09:28	13.158	0.152	9.12	0.0063333	566.3	0.2402089
13:10:29	13.175	0.169	10.14	0.0070417	563.4	0.2149695
13:11:30	13.192	0.186	11.16	0.00775	561	0.1940818
13:12:29	13.208	0.202	12.12	0.0084167	559	0.1766754
13:13:29	13.225	0.219	13.14	0.009125	557.2	0.1610096
13:15:29	13.258	0.252	15.12	0.0105	554.4	0.1366406
13:16:49	13.28	0.274	16.44	0.0114167	552.6	0.1209748

13:27:01	13.45	#REF!	#REF!	#REF!	486.8
13:28:01	13.467	#REF!	#REF!	#REF!	487.3
13:29:02	13.484	#REF!	#REF!	#REF!	487.4
13:30:03	13.501	#REF!	#REF!	#REF!	486.8
13:31:03	13.518	#REF!	#REF!	#REF!	486.8
13:32:04	13.534	#REF!	#REF!	#REF!	486.3
13:34:01	13.567	#REF!	#REF!	#REF!	532.3
13:35:02	13.584	#REF!	#REF!	#REF!	533.3
13:36:02	13.601	#REF!	#REF!	#REF!	533.4
13:36:44	13.612	#REF!	#REF!	#REF!	533.4
13:36:49	13.614	#REF!	#REF!	#REF!	533.4
13:36:54	13.615	#REF!	#REF!	#REF!	533.3
13:36:58	13.616	#REF!	#REF!	#REF!	533.4
13:37:03	13.618	#REF!	#REF!	#REF!	533.4
13:37:08	13.619	#REF!	#REF!	#REF!	533.4
13:37:13	13.62	#REF!	#REF!	#REF!	533.3
13:37:17	13.622	#REF!	#REF!	#REF!	533.5
13:37:22	13.623	#REF!	#REF!	#REF!	533.8
13:37:27	13.624	#REF!	#REF!	#REF!	534.4
13:37:32	13.625	#REF!	#REF!	#REF!	534.9
13:37:36	13.627	#REF!	#REF!	#REF!	535.1
13:37:41	13.628	#REF!	#REF!	#REF!	535.7
13:37:46	13.63	#REF!	#REF!	#REF!	536.3
13:37:51	13.631	#REF!	#REF!	#REF!	537.1
13:37:56	13.632	#REF!	#REF!	#REF!	537.7
13:38:01	13.634	#REF!	#REF!	#REF!	538.8
13:38:05	13.635	#REF!	#REF!	#REF!	539.7
13:38:10	13.636	#REF!	#REF!	#REF!	541.5
13:38:15	13.637	#REF!	#REF!	#REF!	542.4
13:38:20	13.639	#REF!	#REF!	#REF!	544.6
13:38:25	13.64	#REF!	#REF!	#REF!	545.6
13:38:29	13.641	#REF!	#REF!	#REF!	548.2
13:38:34	13.643	#REF!	#REF!	#REF!	549.6
13:38:39	13.644	#REF!	#REF!	#REF!	551.7
13:38:44	13.645	#REF!	#REF!	#REF!	553.2
13:38:48	13.647	#REF!	#REF!	#REF!	556.2
13:38:53	13.648	#REF!	#REF!	#REF!	558.6
13:38:58	13.649	#REF!	#REF!	#REF!	563.2
13:39:03	13.651	#REF!	#REF!	#REF!	565.1
13:39:08	13.652	#REF!	#REF!	#REF!	572.6
13:39:12	13.653	#REF!	#REF!	#REF!	576.5
13:39:17	13.655	#REF!	#REF!	#REF!	596.1
13:39:22	13.656	#REF!	#REF!	#REF!	603.1
13:39:27	13.657	#REF!	#REF!	#REF!	609.9
13:39:32	13.659	#REF!	#REF!	#REF!	620.2
13:39:36	13.66	#REF!	#REF!	#REF!	640.2
13:39:41	13.661	#REF!	#REF!	#REF!	645
13:39:46	13.663	#REF!	#REF!	#REF!	605.1
13:39:51	13.664	#REF!	#REF!	#REF!	588.7
13:39:56	13.665	#REF!	#REF!	#REF!	584.1
13:40:00	13.667	#REF!	#REF!	#REF!	588.4

13:40:05	13.668	#REF!	#REF!	#REF!	599.8
13:40:10	13.669	#REF!	#REF!	#REF!	610.5
13:40:15	13.671	#REF!	#REF!	#REF!	633.3
13:40:20	13.672	#REF!	#REF!	#REF!	637.1
13:40:24	13.673	#REF!	#REF!	#REF!	641.4
13:40:29	13.675	#REF!	#REF!	#REF!	642.3
13:40:34	13.676	#REF!	#REF!	#REF!	625.4
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13:41:31	13.692	#REF!	#REF!	#REF!	640.9
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13:41:51	13.697	#REF!	#REF!	#REF!	632.7
13:41:55	13.699	#REF!	#REF!	#REF!	622.6
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13:42:14	13.704	#REF!	#REF!	#REF!	618
13:42:19	13.705	#REF!	#REF!	#REF!	627.3
13:42:24	13.707	#REF!	#REF!	#REF!	641.1
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13:42:46	13.713	#REF!	#REF!	#REF!	658.5
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13:45:09	13.752	#REF!	#REF!	#REF!	660.4
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13:46:57	13.783	#REF!	#REF!	#REF!	659.2
13:47:28	13.791	#REF!	#REF!	#REF!	658.7
13:47:58	13.799	#REF!	#REF!	#REF!	657.8
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13:52:52	13.881	#REF!	#REF!	#REF!	864.6
13:52:57	13.882	#REF!	#REF!	#REF!	855.5
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13:54:56	13.916	#REF!	#REF!	#REF!	874.1
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13:56:52	13.948	#REF!	#REF!	#REF!	854.8
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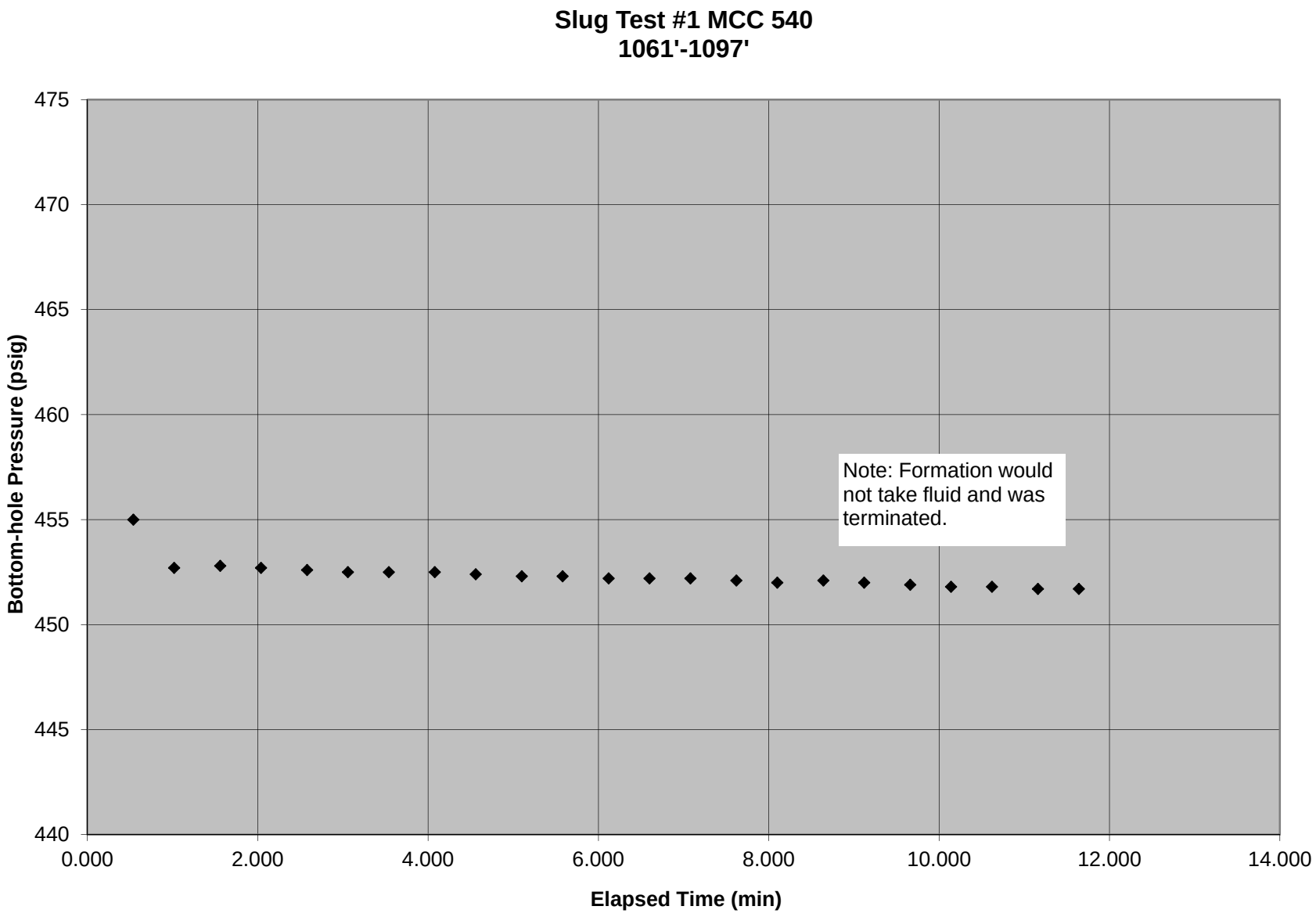
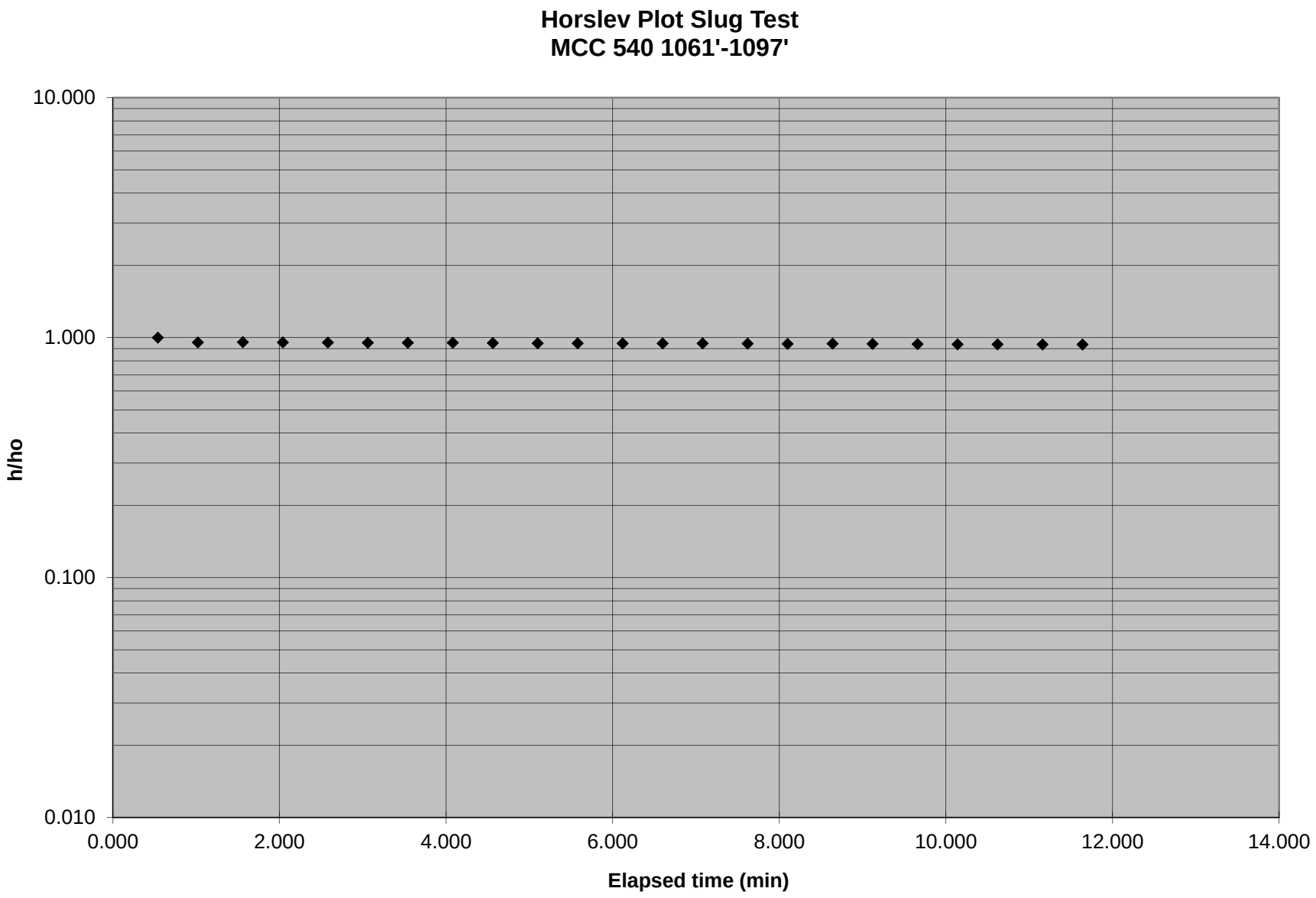
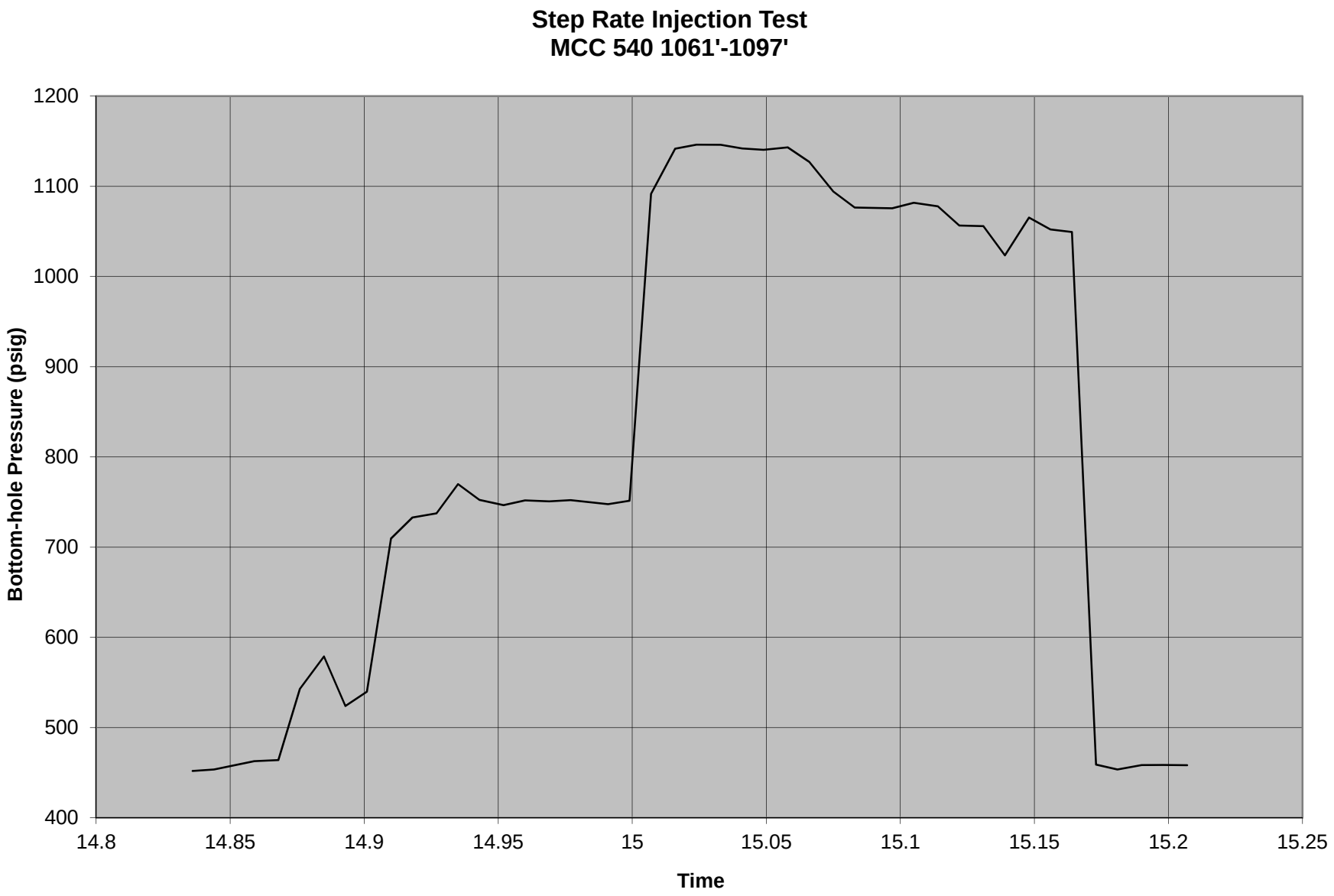
13:58:23	13.973	#REF!	#REF!	#REF!	839.8
13:58:53	13.981	#REF!	#REF!	#REF!	840.2
13:59:23	13.99	#REF!	#REF!	#REF!	548.3
13:59:54	13.998	#REF!	#REF!	#REF!	539.9
14:00:24	14.007	#REF!	#REF!	#REF!	539.7
14:00:54	14.015	#REF!	#REF!	#REF!	539.6
14:01:25	14.024	#REF!	#REF!	#REF!	539.6
14:01:55	14.032	#REF!	#REF!	#REF!	539.3
17:21:18	17.355	#REF!	#REF!	#REF!	-7.8

Slug Test Data MCC 544 1253' - 1305'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
12:29:33	12.493	-	-	-	486.4	-
12:29:38	12.494	0.001	0.06	4.167E-05	540.9	
12:29:43	12.495	0.002	0.12	8.333E-05	541.9	
12:29:48	12.497	0.004	0.24	0.0001667	541.5	
12:29:53	12.498	0.005	0.3	0.0002083	542	
12:29:57	12.499	0.006	0.36	0.00025	541.8	
12:30:02	12.501	0.008	0.48	0.0003333	541.9	
12:30:07	12.502	0.009	0.54	0.000375	541.8	
12:30:12	12.503	0.01	0.6	0.0004167	541.8	
12:30:17	12.505	0.012	0.72	0.0005	541.9	
12:30:21	12.506	0.013	0.78	0.0005417	542	
12:30:26	12.507	0.014	0.84	0.0005833	541.8	
12:30:31	12.509	0.016	0.96	0.0006667	541.9	
12:30:36	12.51	0.017	1.02	0.0007083	541.8	
12:31:04	12.518	0.025	1.5	0.0010417	541.8	
12:31:09	12.519	0.026	1.56	0.0010833	541.8	
12:32:10	12.536	0.043	2.58	0.0017917	541.5	
12:33:09	12.553	0.06	3.6	0.0025	541.3	
12:34:10	12.569	0.076	4.56	0.0031667	541.2	
12:35:10	12.586	0.093	5.58	0.003875	540.9	
12:36:10	12.603	0.11	6.6	0.0045833	540.6	
12:37:10	12.62	0.127	7.62	0.0052917	540.5	
12:38:11	12.636	0.143	8.58	0.0059583	539.9	
12:39:10	12.653	0.16	9.6	0.0066667	540.4	
12:41:05	12.685	0.192	11.52	0.008	540.5	
12:42:06	12.702	0.209	12.54	0.0087083	539.8	
12:43:06	12.718	0.225	13.5	0.009375	540.1	
12:44:07	12.735	0.242	14.52	0.0100833	538.4	
12:46:15	12.771	0.278	16.68	0.0115833	540.1	
12:47:16	12.788	0.295	17.7	0.0122917	540	
12:48:16	12.805	0.312	18.72	0.013	539.9	
12:49:17	12.821	0.328	19.68	0.0136667	539.8	
12:50:18	12.838	0.345	20.7	0.014375	539.6	
12:51:52	12.864	0.371	22.26	0.0154583	539.6	
12:52:53	12.881	0.388	23.28	0.0161667	539.4	
12:53:53	12.898	0.405	24.3	0.016875	539.3	
12:54:54	12.915	0.422	25.32	0.0175833	539.2	
12:56:20	12.939	0.446	26.76	0.0185833	539.3	
12:57:21	12.956	0.463	27.78	0.0192917	538.9	
12:58:22	12.973	0.48	28.8	0.02	538.8	
12:59:23	12.99	0.497	29.82	0.0207083	538.9	


Slug Test #1 MCC 540
1061'-1097'
Bottom-hole Pressure (psig)
475
470
465
460
455
450
445
440
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed Time (min)
Note: Formation would not take fluid and was terminated.


Horslev Plot Slug Test
MCC 540 1061'-1097'
10.000
1.000
0.100
0.010
h/ho
0.000
2.000
4.000
6.000
8.000
10.000
12.000
14.000
Elapsed time (min)

Slug Test Data MCC 540 1061'-1097'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Elapsed Time (days)	Pressure (psig)	h/h_o
Static Pressure						
14:38:00	14.633	0.000	0.000	0.000	403.8	-
14:38:31	14.642	0.009	0.540	0.00038	455	1.000
14:39:01	14.65	0.017	1.020	0.00071	452.7	0.955
14:39:31	14.659	0.026	1.560	0.00108	452.8	0.957
14:40:02	14.667	0.034	2.040	0.00142	452.7	0.955
14:40:32	14.676	0.043	2.580	0.00179	452.6	0.953
14:41:02	14.684	0.051	3.060	0.00213	452.5	0.951
14:41:33	14.692	0.059	3.540	0.00246	452.5	0.951
14:42:03	14.701	0.068	4.080	0.00283	452.5	0.951
14:42:33	14.709	0.076	4.560	0.00317	452.4	0.949
14:43:04	14.718	0.085	5.100	0.00354	452.3	0.947
14:43:34	14.726	0.093	5.580	0.00388	452.3	0.947
14:44:04	14.735	0.102	6.120	0.00425	452.2	0.945
14:44:35	14.743	0.11	6.600	0.00458	452.2	0.945
14:45:05	14.751	0.118	7.080	0.00492	452.2	0.945
14:45:35	14.76	0.127	7.620	0.00529	452.1	0.943
14:46:06	14.768	0.135	8.100	0.00563	452	0.941
14:46:36	14.777	0.144	8.640	0.00600	452.1	0.943
14:47:06	14.785	0.152	9.120	0.00633	452	0.941
14:47:37	14.794	0.161	9.660	0.00671	451.9	0.939
14:48:07	14.802	0.169	10.140	0.00704	451.8	0.938
14:48:37	14.81	0.177	10.620	0.00738	451.8	0.938
14:49:08	14.819	0.186	11.160	0.00775	451.7	0.936
14:49:38	14.827	0.194	11.640	0.00808	451.7	0.936
Note: Formation did not take fluid and test was terminated.						


Step Rate Injection Test
MCC 540 1061'-1097'
Bottom-hole Pressure (psig)
1200
1100
1000
900
800
700
600
500
400
14.8
14.85
14.9
14.95
15
15.05
15.1
15.15
15.2
15.25
Time

Step Rate Injection Test MCC 540 1061'-1097'						
Time	Time	Elapsed Time (hrs)	Elapsed Time (min)	Injection Rate (gpm)	Pressure (psig)	
14:50:09	14.836	0.000	0.000	3.5	451.9	
14:50:39	14.844	0.008	0.480	3.5	453.6	
14:51:33	14.859	0.023	1.380	3.5	462.8	
14:52:04	14.868	0.032	1.920	3.5	464	
14:52:34	14.876	0.040	2.400	3.5	542.9	
14:53:04	14.885	0.049	2.940	3.5	578.8	
14:53:35	14.893	0.057	3.420	3.5	523.9	
14:54:05	14.901	0.065	3.900	3.5	539.8	
14:54:35	14.91	0.074	4.440	3.5	709.5	
14:55:05	14.918	0.082	4.920	3.5	732.9	
14:55:36	14.927	0.091	5.460	3.5	737.5	
14:56:06	14.935	0.099	5.940	3.5	769.9	
14:56:37	14.943	0.107	6.420	3.5	752.4	
14:57:07	14.952	0.116	6.960	3.5	746.6	
14:57:37	14.96	0.124	7.440	3.5	751.9	
14:58:08	14.969	0.133	7.980	3.5	750.8	
14:58:38	14.977	0.141	8.460	3.5	752.1	
14:59:26	14.991	0.155	9.300	3.5	747.6	
14:59:56	14.999	0.163	9.780	3.5	751.4	
15:00:26	15.007	0.171	10.260	5.5	1091.6	
15:00:57	15.016	0.180	10.800	5.5	1141.7	
15:01:27	15.024	0.188	11.280	5.5	1146.2	
15:01:57	15.033	0.197	11.820	5.5	1146	
15:02:28	15.041	0.205	12.300	5.5	1142	
15:02:58	15.049	0.213	12.780	5.5	1140.5	
15:03:29	15.058	0.222	13.320	5.5	1143.2	Fm Fractured
15:03:59	15.066	0.230	13.800	5.5	1127.2	
15:04:29	15.075	0.239	14.340	5.5	1094.3	
15:05:00	15.083	0.247	14.820	5.5	1076.5	
15:05:49	15.097	0.261	15.660	5.5	1075.7	
15:06:19	15.105	0.269	16.140	5.5	1081.7	
15:06:50	15.114	0.278	16.680	5.5	1077.8	
15:07:20	15.122	0.286	17.160	6	1056.6	
15:07:50	15.131	0.295	17.700	6	1055.9	
15:08:21	15.139	0.303	18.180	6	1023.4	
15:08:51	15.148	0.312	18.720	6	1065.4	
15:09:21	15.156	0.320	19.200	6	1052.2	
15:09:52	15.164	0.328	19.680	6	1049.3	End Test
15:10:22	15.173	0.337	20.220	-	459	
15:10:52	15.181	0.345	20.700	-	453.6	
15:11:23	15.19	0.354	21.240	-	458.4	
15:11:53	15.198	0.362	21.720	-	458.6	
15:12:23	15.207	0.371	22.260	-	458.3	

EXHIBIT B-8

Pilot Test Facility Mine Block Ambient Groundwater Concentrations and Initial Discharge Characterization of the Underground Workings

Pilot Test Facility (PTF) Mine Block Ambient Groundwater Concentrations and Initial Discharge Characterization of the Underground Workings

Florence Copper Project
Florence, Arizona

September 11, 2018

Brown AND Caldwell
2 North Central Avenue, Suite 1600
Phoenix, Arizona 85004

INTRODUCTION

Temporary Aquifer Protection Permit (APP) No. P-106360 requires an initial sample to be collected from each well of the pilot test facility mine block in order to establish ambient mine block groundwater concentrations. An initial sample of the underground workings to characterize ambient discharge concentrations is also required.

SAMPLING AND ANALYSIS

Groundwater sampling and analysis was conducted in general accordance with the requirements of APP Section 2.5.3 (Groundwater Monitoring and Sampling Protocols). Sampling, preservation, and holding times were in accordance with accepted industry standards. Three wells, I-01, WB-01, and WB-04, were purged for less than three borehole volumes. The reduced purge did not appear to affect sampling results. Sampling records will be stored at the project site per permit requirements.

RESULTS

Results are summarized in the following tables, which include the maximum result for each parameter.

- Table 1 – Sampling Analyses;
- Table 2 – Primary Four Indicator Parameters (Level 1);
- Table 3 – Field Parameters;
- Table 4 – Trace Metal Parameters;
- Table 5 – Organic Parameters; and
- Table 6 – Radiochemical Parameters.

Five total radium results exceeded the Aquifer Water Quality Standard (AWQS) during this ambient-baseline event. No other results exceeded an AWQS.

Table 1. Summary of Sampling Analyses		
Analysis	Method	Preservative
Common Ions		
pH (lab)	SM 4500H+	None
Electroconductivity (EC) (lab)	SM 2510B	None
Alkalinity – Bicarbonate, Carbonate, Hydroxide, and Total	SM 2320B	None
Ammonia (Underground Workings Only)	SM 4500-NH3	H2SO4
Chloride	EPA 300.0	None
Cyanide (PTF Samples Only)	EPA 335.4	NaOH
Fluoride (Level I Indicator)	EPA 300.0	None
Nitrate as N	EPA 300.0	None
Nitrite as N (PTF Samples Only)	EPA 300.0	None
Sulfate (Level I Indicator)	EPA 300.0	None
Total Dissolved Solids (Level I Indicator)	SM 2540C	None
Formation-Related Radiochemicals		
Gross Alpha	600/00-02	None
Radium 226	903/GammaRay HPGE	None
Radium 228	904/GammaRay HPGE	None
Total Uranium Isotopes (Activity) (if G. Alpha >12.0)	ASTM 6239	None
Total Uranium (unfiltered total as mg/L)	EPA 200.8	HNO3
Process-Related Organics		
Extractable Fuel Hydrocarbons (Diesel-Range Organics)	EPA 8015D	None
Benzene	EPA 8260B	HCl
Carbon Disulfide	EPA 8260B	HCl
Ethylbenzene	EPA 8260B	HCl
Toluene	EPA 8260B	HCl
Total Xylene	EPA 8260B	HCl
Trace Metals (Dissolved)		
Aluminum	EPA 200.8	HNO3
Antimony	EPA 200.8	HNO3
Arsenic	EPA 200.8	HNO3
Barium	EPA 200.8	HNO3
Beryllium	EPA 200.8	HNO3
Cadmium	EPA 200.8	HNO3
Calcium	EPA 200.7	HNO3
Chromium	EPA 200.8	HNO3
Cobalt	EPA 200.8	HNO3
Copper	EPA 200.8	HNO3
Iron	EPA 200.8	HNO3
Lead	EPA 200.8	HNO3

Table 1. Summary of Sampling Analyses		
Analysis	Method	Preservative
Magnesium (Level I Indicator)	EPA 200.7	HNO3
Manganese	EPA 200.8	HNO3
Mercury	EPA 245.1	HNO3
Nickel	EPA 200.8	HNO3
Potassium	EPA 200.7	HNO3
Selenium	EPA 200.8	HNO3
Sodium	EPA 200.7	HNO3
Thallium	EPA 200.8	HNO3
Uranium (*Total)	EPA 200.8	HNO3
Zinc	EPA 200.8	HNO3

Table 2. Summary of Indicator Parameters, PTF Wells

Well ID	Sample Date	Magnesium	Sulfate	Fluoride	Total Dissolved Solids	Field Temp	Field pH	Field EC
Injection/Pumping Wells								
I-01	Apr 11 2018	25	200	<0.5	1000	25.67	7.65	1531
I-02	Jul 18 2018	24	170	<0.5	1000	27.8	7.42	1539
I-03	May 02 2018	26	180	<0.5	990	25	7.48	1916
I-04	Apr 19 2018	24	150	<0.5	990	25.54	7.57	1606
Recovery Wells								
R-01	Aug 08 2018	24	200	<0.5	1000	32.4	7.61	1672
R-02	Aug 08 2018	22	150	<0.5	950	28.4	7.42	1564
R-03	Aug 08 2018	15	120	<0.5	720	27.3	7.51	1252
R-04	Aug 08 2018	19	130	<0.5	920	27.9	7.59	1458
R-05	Aug 08 2018	24	160	<0.5	980	27.6	7.52	1569
R-06	Jul 16 2018	20	140	<0.5	1100	28.9	6.61	1487
R-06 (Dup)	Jul 16 2018	20	140	<0.5	1200	28.9	6.61	1487
R-07	Aug 08 2018	20	130	<0.5	800	27.6	7.54	1356
R-08	Aug 08 2018	22	180	<0.5	1000	31.2	7.49	1670
R-09	Apr 23 2018	27	190	<0.5	1000	25.64	7.52	1446
Observation Wells								
O-01	Jun 28 2018	12	150	0.63	720	24	9.1	1246
O-02	Jun 28 2018	7.7	200	0.89	660	25.3	7.52	1075
O-03	Jun 28 2018	11	100	0.58	640	24.1	7.69	1137
O-04	Jun 28 2018	23	180	<0.5	910	25.6	7.17	1515
O-05	Jun 28 2018	15	110	<0.5	680	24.5	7.57	1201
O-06	Jul 05 2018	13	120	0.53	710	24	7.29	1186
O-07	Jul 05 2018	30	230	<0.5	1000	24.2	7.43	1593
O-07 (Dup)	Jul 05 2018	30	210	<0.5	1000	24.2	7.43	1593
Westbay								
WB-01	Apr 11 2018	27	200	<0.5	990	25.5	7.72	1512
WB-02	Apr 18 2018	25	180	<0.5	950	24.84	7.64	1491
WB-03	Mar 30 2018	27	180	<0.4	1000	25.5	7.64	1889
WB-04	Apr 05 2018	27	170	<0.5	950	25.7	7.49	1606
Shaft								
Shaft	Jun 05 2018	20	<5	0.63	730	29.07	6.83	1293
Maximum		30	230	0.89	1200	32.4	9.1	1916
Arizona Aquifer Water Quality Standard		-	-	4	-	-	-	-

All Results in Milligrams per Liter (mg/l)
< = Less than the Laboratory Practical Quantitation Limit
NA = Not Analyzed

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Table 3. Summary of Common Inorganic Analytical Results, PTF Wells

Well ID	Sample Date	Bicarbonate Alkalinity	Carbonate Alkalinity	Hydroxide Alkalinity	Total Alkalinity	Cyanide (Free)	Calcium	Chloride	Nitrate as N	Nitrite as N	Potassium	Sodium	pH (Lab)	EC (Lab)
Injection/Pumping Wells														
I-01	Apr 11 2018	160	<2.	<2.	160	<0.1	130	320	8.5	<0.1	6.4	180	7.6	1700
I-02	Jul 18 2018	140	<2.	<2.	140	<0.1	120	320	7.97	<0.1	6.5	140	7.4	1600
I-03	May 02 2018	140	<2.	<2.	140	<0.1	130	340	7.9	<0.1	6.6	180	7.6	1700
I-04	Apr 19 2018	130	<2.	<2.	130	<0.1	120	310	8.4	<0.1	5.6	140	7.9	1700
Recovery Wells														
R-01	Aug 08 2018	170	<2.	<2.	170	<0.1	120	280	8.9	<0.1	6.	160	7.6	1700
R-02	Aug 08 2018	140	<2.	<2.	140	<0.1	110	290	6.4	<0.1	6.2	160	7.6	1500
R-03	Aug 08 2018	120	<2.	<2.	120	<0.1	81	240	5.2	<0.1	5.5	130	7.6	1200
R-04	Aug 08 2018	120	<2.	<2.	120	<0.1	100	270	6.4	<0.1	6.8	140	7.7	1600
R-05	Aug 08 2018	140	<2.	<2.	140	<0.1	120	300	8.3	<0.1	6.2	140	7.4	1700
R-06	Jul 16 2018	100	<2.	<2.	100	<0.1	110	340	7.1	<0.1	6.4	150	6.7	1600
R-06 (Dup)	Jul 16 2018	100	<2.	<2.	100	<0.1	110	340	7.07	<0.1	6.4	150	6.7	1500
R-07	Aug 08 2018	120	<2.	<2.	120	<0.1	95	280	6.8	<0.1	5.2	120	7.5	1300
R-08	Aug 08 2018	150	<2.	<2.	150	<0.1	120	330	9.1	<0.1	6.1	170	7.5	1800
R-09	Apr 23 2018	150	<2.	<2.	150	<0.1	140	310	8.8	<0.1	6.8	170	7.8	1700
Observation Wells														
O-01	Jun 28 2018	98	20.	<2.	120	<0.1	63	230	4.2	<0.1	11.	160	8.7	1200
O-02	Jun 28 2018	130	<2.	<2.	130	<0.1	47	130	0.73	<0.1	<5.	160	7.7	1100
O-03	Jun 28 2018	110	<2.	<2.	110	<0.1	65	220	3.9	<0.1	<5.	140	7.7	1100
O-04	Jun 28 2018	150	<2.	<2.	150	<0.1	110	270	7.6	<0.1	5.6	160	7.4	1600
O-05	Jun 28 2018	120	<2.	<2.	120	<0.1	75	230	4.4	<0.1	5.5	130	7.7	1200
O-06	Jul 05 2018	130	<2.	<2.	130	<0.1	66	210	3.2	<0.1	5.1	150	7.4	1200
O-07	Jul 05 2018	200	<2.	<2.	200	<0.1	130	240	8.8	<0.1	5.8	150	7.4	1600
O-07 (Dup)	Jul 05 2018	200	<2.	<2.	200	<0.1	130	220	8.	<0.1	5.8	150	7.5	1600
Westbay														
WB-01	Apr 11 2018	150	<2.	<2.	150	<0.1	140	310	8.1	<0.1	6.3	170	7.6	1700
WB-02	Apr 18 2018	130	<2.	<2.	130	<0.1	120	330	8.1	<0.1	6.1	150	7.7	1700
WB-03	Mar 30 2018	150	<2.	<2.	150	<0.1	140	320	8.8	<0.1	6.7	170	7.7	1600
WB-04	Apr 05 2018	150	<2.	<2.	150	<0.1	130	300	8.	<0.1	7.	170	7.9	1700

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Table 3. Summary of Common Inorganic Analytical Results, PTF Wells

Well ID	Sample Date	Bicarbonate Alkalinity	Carbonate Alkalinity	Hydroxide Alkalinity	Total Alkalinity	Cyanide (Free)	Calcium	Chloride	Nitrate as N	Nitrite as N	Potassium	Sodium	pH (Lab)	EC (Lab)
Shaft														
Shaft	Jun 05 2018	370	<2.	<2.	370	NR	89	190	<0.5	NR	6.9	150	6.8	1300
Maximum		370	20.0	<2.0	370	<0.1	140	340	9.1	<0.1	11.0	180	8.7	1800
AWQS		-	-	-	-	0.2	-	-	10	1	-	-	-	-

All results in milligrams per liter (mg/L), except pH in pH units.
< = less than detection limit
NR = Not required
AWQS = Arizona Aquifer Water Quality Standard
Shaft Ammonia - <0.5 mg/L. Ammonia not required for PTF wells.

Table 4. Summary of Radiochemical Analytical Results, PTF Wells

Well ID	Sample Date	Gross Alpha	Uranium Activity	Adjusted Gross Alpha	Total Radium	Radium 226	Radium 228	Uranium (mg/L)
Injection/Pumping Wells								
I-01	Apr 11 2018	15.3 ± 3.6	10.6 ± 1.1	4.7 ± 3.8	2.7 ± 0.4	1.2 ± 0.2	1.5 ± 0.3	0.016
I-02	Jul 18 2018	6.4 ± 0.5	-	-	3.7 ± 0.5	1.4 ± 0.3	2.3 ± 0.4	0.014
I-03	May 02 2018	16.2 ± 0.9	10.6 ± 1.1	5.6 ± 1.4	4.6 ± 0.5	1.3 ± 0.2	3.3 ± 0.5	0.013
I-04	Apr 19 2018	14.2 ± 1.2	12.8 ± 1.2	1.4 ± 1.7	5 ± 0.5	2.8 ± 0.3	2.2 ± 0.4	0.01
Recovery Wells								
R-01	Aug 08 2018	32.4 ± 1.7	18.2 ± 1.5	14.2 ± 2.3	4.5 ± 0.5	2.8 ± 0.3	1.7 ± 0.4	0.029
R-02	Aug 08 2018	21.1 ± 1.4	7.9 ± 1	13.2 ± 1.7	3.9 ± 0.5	2.1 ± 0.3	1.8 ± 0.4	0.013
R-03	Aug 08 2018	5.5 ± 0.7	-	-	1.6 ± 0.4	0.5 ± 0.2	1.1 ± 0.3	0.0053
R-04	Aug 08 2018	9.4 ± 0.9	-	-	1.9 ± 0.4	0.8 ± 0.2	1.1 ± 0.3	0.0065
R-05	Aug 08 2018	15.4 ± 1.2	7.3 ± 0.9	8.1 ± 1.5	5.1 ± 0.5	2.6 ± 0.3	2.5 ± 0.4	0.011
R-06	Jul 16 2018	10.9 ± 1	-	-	3.5 ± 0.4	2.3 ± 0.3	1.2 ± 0.3	0.0085
R-06 (Dup)	Jul 16 2018	11.6 ± 1	-	-	3.1 ± 0.4	1.6 ± 0.2	1.5 ± 0.3	0.0089
R-07	Aug 08 2018	12.5 ± 1	5 ± 0.8	7.5 ± 1.3	3.6 ± 0.4	1.4 ± 0.2	2.2 ± 0.4	0.0073
R-08	Aug 08 2018	12.9 ± 1.1	6.5 ± 0.9	6.4 ± 1.4	1.4 ± 0.2	1.4 ± 0.2	<0.7	0.013
R-09	Apr 23 2018	17.7 ± 0.9	12.9 ± 1.2	4.8 ± 1.5	6.2 ± 0.5	3.1 ± 0.3	3.1 ± 0.4	0.016
Observation Wells								
O-01	Jun 28 2018	7.8 ± 0.6	-	-	2.8 ± 0.4	0.8 ± 0.2	2 ± 0.3	0.0044
O-02	Jun 28 2018	4 ± 0.8	-	-	<0.6	<0.4	<0.6	0.0037
O-03	Jun 28 2018	8.1 ± 0.6	-	-	2.6 ± 0.4	0.9 ± 0.2	1.7 ± 0.3	0.0025
O-04	Jun 28 2018	7.9 ± 0.6	-	-	1.5 ± 0.4	0.8 ± 0.2	0.7 ± 0.3	0.012
O-05	Jun 28 2018	7 ± 6	-	-	1.2 ± 0.4	0.6 ± 0.2	0.6 ± 0.3	0.0047
O-06	Jul 05 2018	3.6 ± 0.4	-	-	<0.7	<0.5	<0.7	0.0048
O-07	Jul 05 2018	44.5 ± 1.6	29.1 ± 1.9	15.4 ± 2.5	5.6 ± 0.5	3.6 ± 0.3	2 ± 0.4	0.046
O-07 (Dup)	Jul 05 2018	42.3 ± 1.5	28.5 ± 1.9	13.8 ± 2.4	5.2 ± 0.5	3.4 ± 0.3	1.8 ± 0.4	0.048
Westbay								
WB-01	Apr 11 2018	17.3 ± 1.9	12.5 ± 1.2	4.8 ± 2.2	4.3 ± 0.5	2 ± 0.3	2.3 ± 0.4	0.018
WB-02	Apr 18 2018	12.1 ± 1	6.6 ± 1.8	5.5 ± 2.1	5.5 ± 0.4	2.7 ± 0.2	2.8 ± 0.4	0.0098
WB-03	Mar 30 2018	11.1 ± 1.7	-	-	3.7 ± 0.4	1.6 ± 0.3	2.1 ± 0.3	0.013
WB-04	Apr 05 2018	13.9 ± 0.8	9.2 ± 1	4.7 ± 1.3	4.2 ± 0.4	1.3 ± 0.2	2.9 ± 0.4	0.015
Shaft								
Shaft	Jun 05 2018	3.6 ± 0.7	-	-	0.7 ± 0.2	0.7 ± 0.2	<0.6	<0.0005

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Table 4. Summary of Radiochemical Analytical Results, PTF Wells

Well ID	Sample Date	Gross Alpha	Uranium Activity	Adjusted Gross Alpha	Total Radium	Radium 226	Radium 228	Uranium (mg/L)
Maximum		9.4 ± 0.9	9.2 ± 1	8.1 ± 1.5	6.2 ± 0.5	3.6 ± 0.3	3.3 ± 0.5	
Arizona Aquifer Water Quality Standard		15 *	-	15*	5	-	-	-

All results in pico-curies per liter (unless noted) ± a standard deviation of two (pCi/L ± 2σ)
< = less than detection limit
Total Radium = Radium 226 + Radium 228
Uranium activity is measured when Gross Alpha exceeds 12 pCi/L
Adjusted gross alpha is calculated when Gross Alpha exceeds 12 pCi/L

Table 5. Summary of Organic Analytical Results, PTF Wells

Well ID	Sample Date	Benzene	Ethylbenzene	Toluene	Total Xylene	Carbon Disulfide	Total Petroleum Hydrocarbons - Diesel
Injection/Pumping Wells							
I-01	Apr 11 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
I-02	Jul 18 2018	<0.0005	<0.0005	0.0016	<0.0015	<0.002	<0.1
I-03	May 02 2018	<0.0005	<0.0005	0.0008	<0.0015	<0.002	<0.1
I-04	Apr 19 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
Recovery Wells							
R-01	Aug 08 2018	<0.0005	<0.0005	0.0011	<0.0015	<0.002	<0.1
R-02	Aug 08 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	0.17
R-03	Aug 08 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-04	Aug 08 2018	<0.0005	<0.0005	0.0009	<0.0015	<0.002	<0.1
R-05	Aug 08 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-06	Jul 16 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-06 (Dup)	Jul 16 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-07	Aug 08 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-08	Aug 08 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
R-09	Apr 23 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
Observation Wells							
O-01	Jun 28 2018	<0.0005	<0.0005	0.0021	<0.0015	<0.002	<0.1
O-02	Jun 28 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-03	Jun 28 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-04	Jun 28 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-05	Jun 28 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-06	Jul 05 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-07	Jul 05 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
O-07 (Dup)	Jul 05 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
Westbay							
WB-01	Apr 11 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
WB-02	Apr 18 2018	<0.0005	<0.0005	0.0011	<0.0015	<0.002	<0.1
WB-03	Mar 30 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	<0.1
WB-04	Apr 05 2018	<0.0005	<0.0005	0.001	<0.0015	<0.002	<0.1
Shaft							
Shaft	Jun 05 2018	<0.0005	<0.0005	<0.0005	<0.0015	<0.002	0.3
Maximum		<0.0005	<0.0005	0.0021	<0.0015	<0.002	0.3
AWQS		0.005	0.7	1	10	-	-

All results are in milligrams per liter (mg/L)
< = less than detection limit
AWQS = Arizona Aquifer Water Quality Standard

Table 6. Summary of Trace Metal Analytical Results,PTF Wells

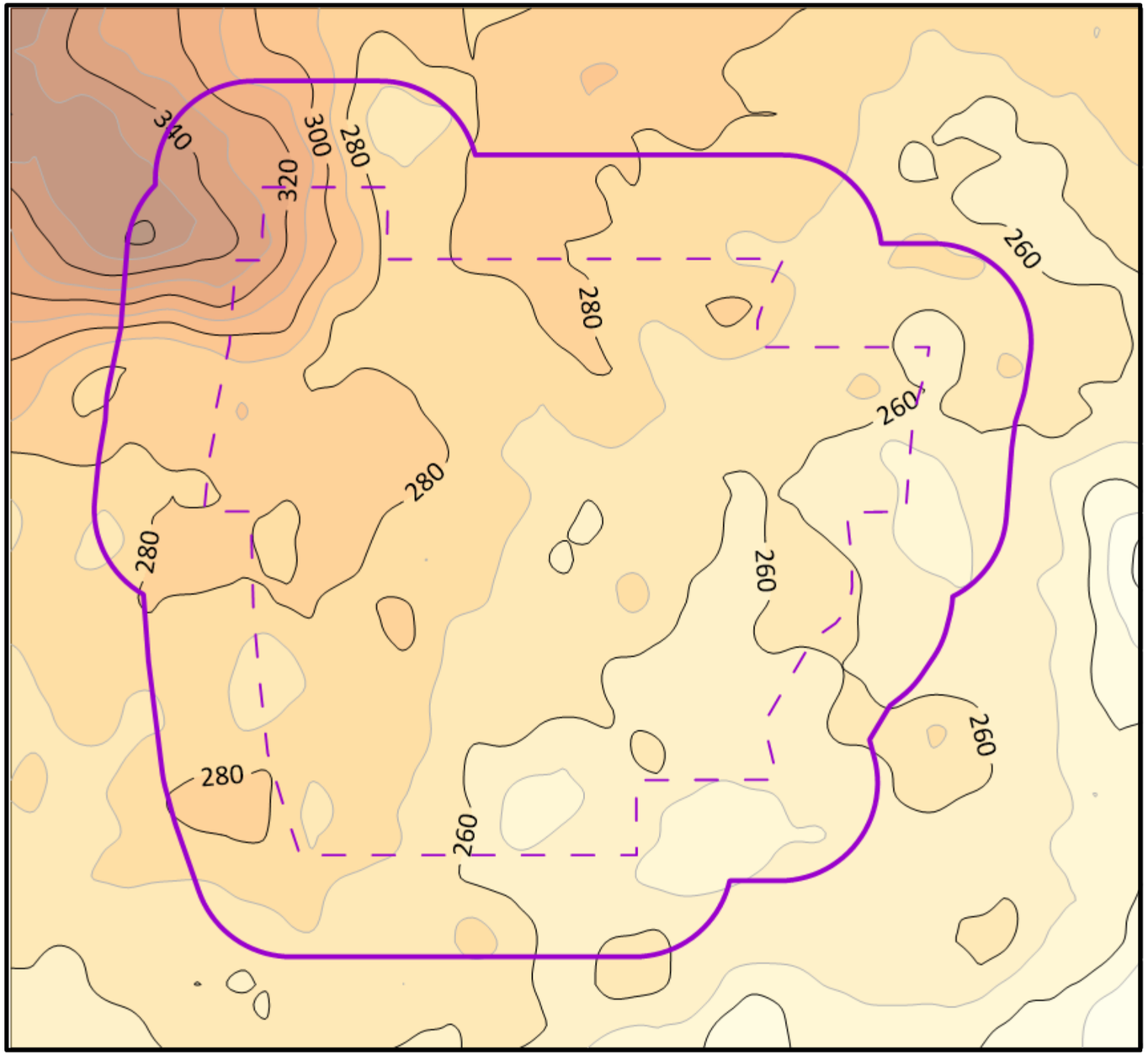
Well ID	Sample Date	Aluminium	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Thallium	Zinc
Injection/Pumping Wells																		
I-01	Apr 11 2018	<0.04	<0.0005	0.0017	0.097	<0.0003	<0.0003	0.01	0.0003	0.0079	<0.3	<0.0005	0.0055	<0.001	0.0071	0.0034	<0.0005	<0.04
I-02	Jul 18 2018	<0.04	<0.0005	0.0012	0.087	<0.0003	<0.0003	0.0011	0.0003	0.055	<0.3	<0.0005	0.0052	<0.001	0.0051	0.0031	<0.0005	0.043
I-03	May 02 2018	<0.04	<0.0005	0.0018	0.091	<0.0003	<0.0003	0.0036	0.0005	0.016	<0.3	<0.0005	0.027	<0.001	0.0045	0.0027	<0.0005	<0.04
I-04	Apr 19 2018	<0.04	<0.0005	0.0014	0.061	<0.0003	<0.0003	0.0062	0.0003	0.0072	<0.3	<0.0005	0.0098	<0.001	<0.0005	<0.0025	<0.0005	<0.04
Recovery Wells																		
R-01	Aug 08 2018	<0.04	<0.0005	0.0011	0.054	<0.0003	<0.0003	0.0014	0.0003	<0.02	<0.3	<0.0005	0.0012	<0.001	0.0059	0.0027	<0.0005	<0.04
R-02	Aug 08 2018	<0.04	<0.0005	0.0019	0.09	<0.0003	0.0004	0.0024	0.0004	<0.02	<0.3	<0.0005	0.037	<0.001	0.0052	0.0025	<0.0005	<0.04
R-03	Aug 08 2018	<0.04	<0.0005	0.0014	0.083	<0.0003	<0.0003	0.0016	0.0003	<0.02	<0.3	<0.0005	0.015	<0.001	0.0039	0.0026	<0.0005	<0.04
R-04	Aug 08 2018	<0.08	<0.0005	0.0015	0.074	<0.0005	<0.0003	0.0018	0.0003	<0.02	<0.3	<0.0005	0.0079	<0.001	0.0045	0.0028	<0.0005	<0.04
R-05	Aug 08 2018	<0.08	<0.0005	0.0018	0.087	<0.0005	<0.0003	0.0017	0.0003	<0.02	<0.3	<0.0005	0.0048	<0.001	0.0053	0.0029	<0.0005	<0.04
R-06	Jul 16 2018	<0.04	<0.0005	0.0029	0.047	<0.0003	0.0014	0.0025	0.0081	1.9	<0.3	<0.0005	0.11	<0.001	0.0093	0.0039	<0.0005	0.16
R-06 (Dup)	Jul 16 2018	<0.04	<0.0005	0.0027	0.045	<0.0003	0.0013	0.0023	0.0078	1.9	<0.3	<0.0005	0.11	<0.001	0.009	0.0038	<0.0005	0.16
R-07	Aug 08 2018	<0.08	<0.0005	0.0018	0.068	<0.0005	<0.0003	0.0036	<0.0005	<0.02	<0.3	<0.0005	0.0014	<0.001	0.0033	0.0026	<0.0005	<0.04
R-08	Aug 08 2018	<0.08	<0.0005	0.0013	0.087	<0.0005	<0.0003	0.0027	<0.0005	<0.02	<0.3	<0.0005	0.014	<0.001	0.0045	0.0029	<0.0005	<0.04
R-09	Apr 23 2018	<0.08	<0.0005	0.0016	0.071	<0.0005	<0.0003	0.0051	<0.0003	0.011	<0.3	<0.0005	0.002	<0.001	0.0033	<0.0025	<0.0005	<0.04
Observation Wells																		
O-01	Jun 28 2018	<0.04	<0.0005	0.0011	0.036	<0.0003	<0.0003	0.0025	<0.0003	0.0012	<0.3	<0.0005	0.0021	<0.001	0.0017	0.0035	<0.0005	<0.04
O-02	Jun 28 2018	<0.04	<0.0005	0.0025	0.062	<0.0003	<0.0003	0.0007	0.0003	0.0052	<0.3	<0.0005	0.12	<0.001	0.0015	0.0032	<0.0005	<0.04
O-03	Jun 28 2018	<0.04	<0.0005	0.0014	0.031	<0.0003	0.0006	0.0022	<0.0003	0.0071	<0.3	<0.0005	0.0011	<0.001	0.0018	0.0031	<0.0005	<0.04
O-04	Jun 28 2018	<0.04	<0.0005	0.0017	0.11	<0.0003	<0.0003	0.0006	0.0003	0.0057	<0.3	<0.0005	0.022	<0.001	0.0059	<0.0025	<0.0005	<0.04
O-05	Jun 28 2018	<0.04	<0.0005	0.0015	0.036	<0.0003	<0.0003	0.0021	<0.0003	0.0021	<0.3	<0.0005	0.0003	<0.001	0.0023	<0.0025	<0.0005	<0.04
O-06	Jul 05 2018	0.0427	<0.0005	0.0023	0.099	<0.0003	<0.0003	0.0018	<0.0003	0.0061	<0.3	<0.0005	0.039	<0.001	0.0012	<0.0025	<0.0005	<0.04
O-07	Jul 05 2018	<0.04	<0.0005	0.0013	0.052	<0.0003	<0.0003	0.0028	<0.0003	0.012	<0.3	<0.0005	0.0003	<0.001	0.0021	<0.0025	<0.0005	<0.04
O-07 (Dup)	Jul 05 2018	<0.04	<0.0005	0.0013	0.05	<0.0003	<0.0003	0.0026	<0.0003	0.012	<0.3	<0.0005	0.0003	<0.001	0.0021	<0.0025	<0.0005	<0.04
Westbay																		
WB-01	Apr 11 2018	<0.04	<0.0005	0.0019	0.1	<0.0003	<0.0003	0.0051	0.0003	0.0063	<0.3	<0.0005	0.0046	<0.001	0.0077	0.0035	<0.0005	0.65
WB-02	Apr 18 2018	<0.04	<0.0005	0.0014	0.083	<0.0003	<0.0003	0.003	0.0006	0.046	<0.3	<0.0005	0.03	<0.001	<0.0005	<0.0025	<0.0005	1.4
WB-03	Mar 30 2018	<0.04	<0.0005	0.0018	0.092	<0.0003	<0.0003	0.0029	0.0005	0.011	<0.3	<0.001	0.056	<0.001	0.0045	0.0031	<0.001	1.9
WB-04	Apr 05 2018	<0.04	<0.0005	0.0016	0.072	<0.0003	<0.0003	0.0037	0.0004	0.016	<0.3	<0.0005	0.026	<0.001	0.0043	0.0032	<0.0005	0.85
Shaft																		
Shaft	Jun 05 2018	<0.04	<0.0005	<0.0005	0.047	<0.0003	<0.0003	0.003	0.0033	0.0021	9.6	<0.0005	1.1	<0.001	0.0061	<0.0025	<0.0005	<0.04
Maximum		0.0427	<0.0005	0.0029	0.11	<0.0003	0.0014	0.01	0.0081	1.9	9.6	<0.0005	1.1	<0.001	0.0093	0.0039	<0.0005	1.9
Arizona Aquifer Water Quality Standard		-	0.006	0.05	2	0.004	0.005	0.1	-	-	-	0.05	-	0.002	0.1	0.05	0.002	-

All results in milligrams per liter (mg/L)
< = less than detection limit

Brown AND Caldwell

EXHIBIT B-9

Isopach Maps



LEGEND

AQUIFER EXEMPTION BOUNDARY

PROPOSED ISCR AREA

DATA SOURCE: FLORENCE COPPER CORE HOLE RECORDS
CONTOUR INTERVAL: 10 FEET

HALEY ALDRICH

NOTES: ISOPACHS ARE CALCULATED AS UNIT THICKNESS BETWEEN LOGGED FORMATION BOTTOMS. NO STRUCTURAL DIP CORRECTION.

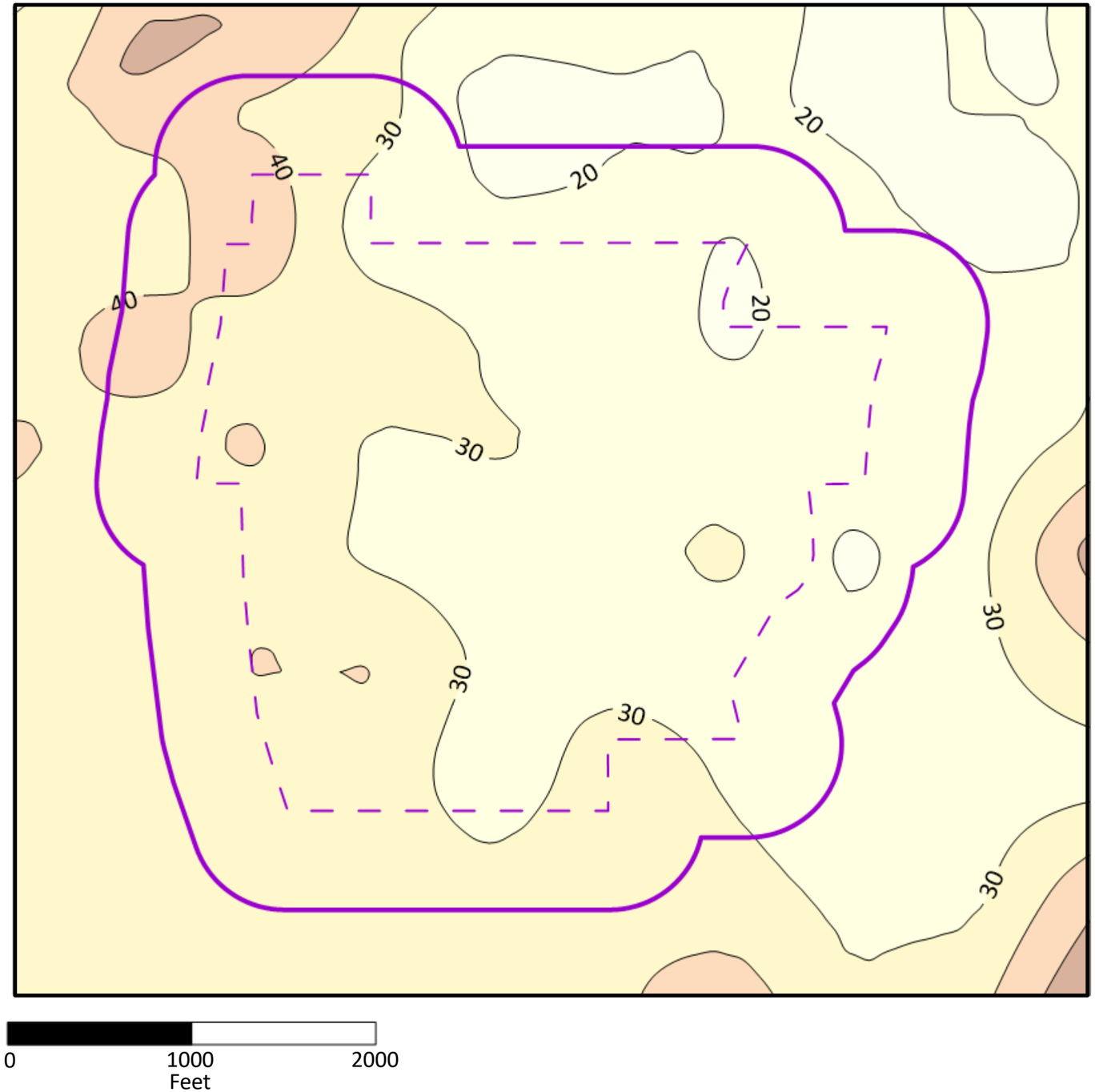
FLORENCE COPPER, INC.
FLORENCE, ARIZONA

FLORENCE COPPER

UPPER BASIN FILL UNIT (UBFU)

MARCH 2022

FIGURE 1



LEGEND

AQUIFER EXEMPTION BOUNDARY

PROPOSED ISCR AREA

DATA SOURCE: FLORENCE COPPER CORE HOLE RECORDS
CONTOUR INTERVAL: 10 FEET

N

HALEY ALDRICH

NOTES: ISOPACHS ARE CALCULATED AS UNIT THICKNESS BETWEEN LOGGED FORMATION BOTTOMS. NO STRUCTURAL DIP CORRECTION.

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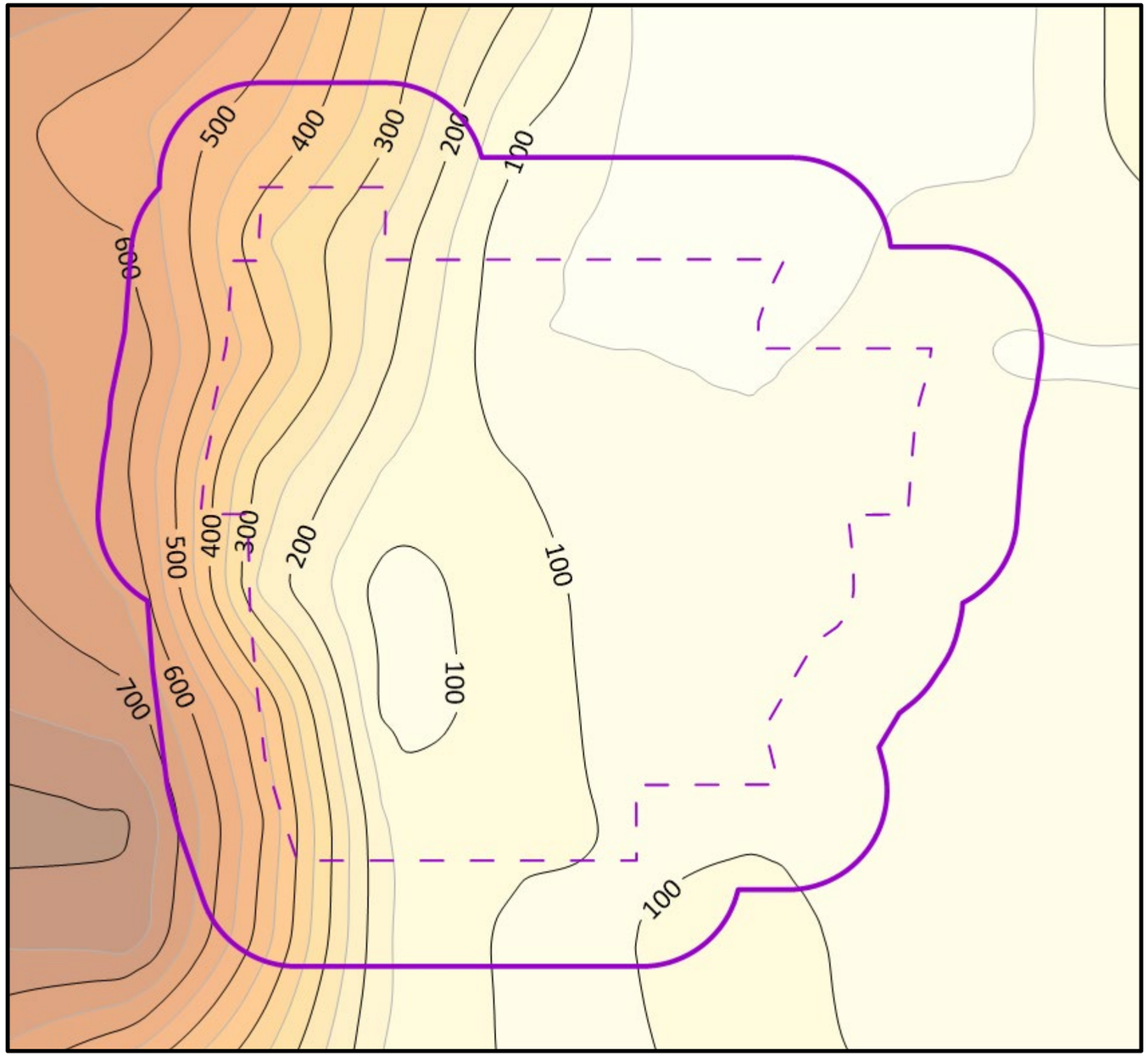
FLORENCE COPPER

MIDDLE FINE GRAINED UNIT (MFGU)

MARCH 2022

FIGURE 2



0 1000 2000
Feet

LEGEND

AQUIFER EXEMPTION BOUNDARY

PROPOSED ISCR AREA

DATA SOURCE: FLORENCE COPPER CORE HOLE RECORDS
CONTOUR INTERVAL: 50 FEET

N

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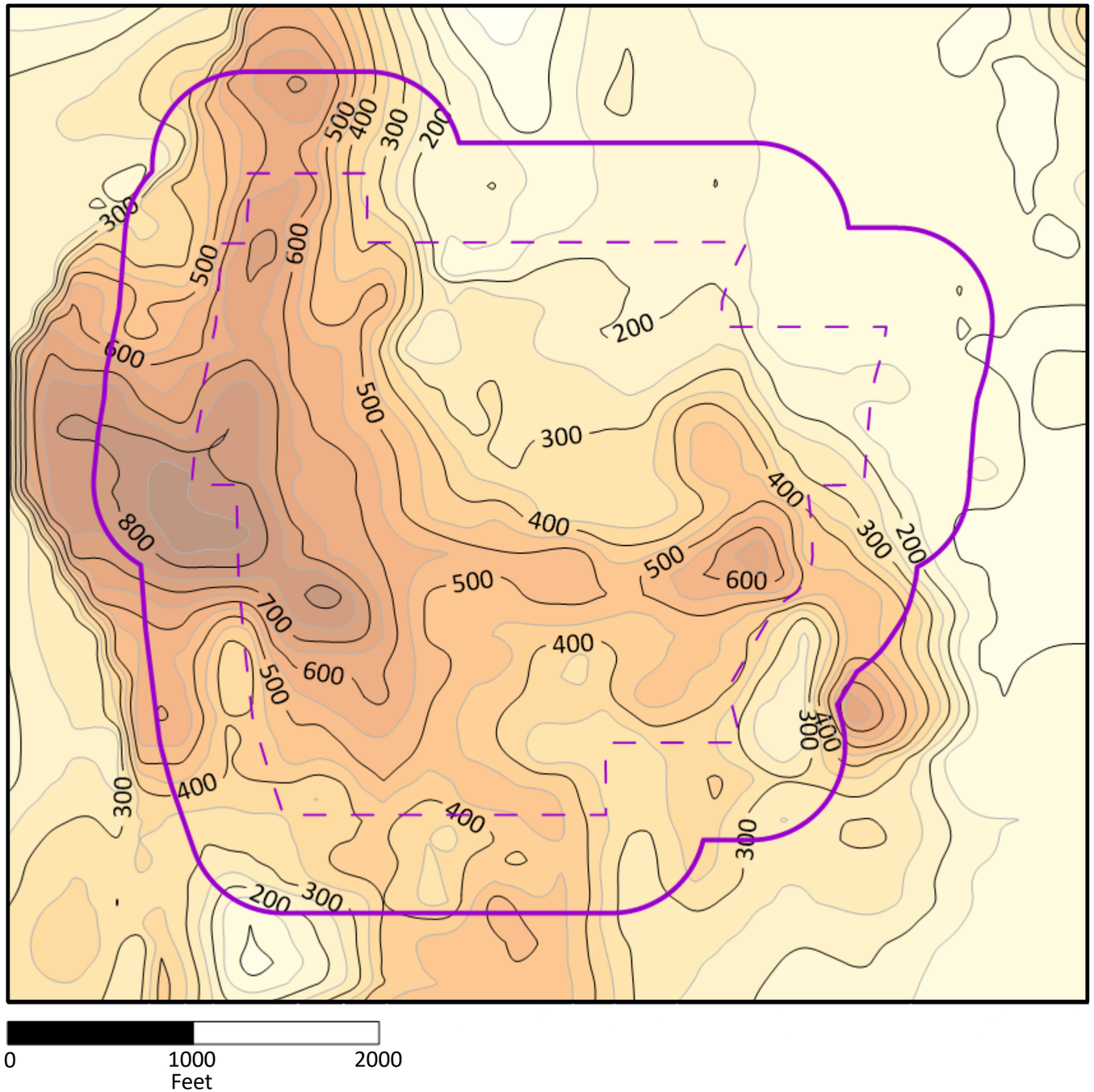
FLORENCE COPPER

LOWER BASIN FILL UNIT (LBFU)

MARCH 2022

FIGURE 3



LEGEND

AQUIFER EXEMPTION BOUNDARY

PROPOSED ISCR AREA

DATA SOURCE: FLORENCE COPPER CORE HOLE RECORDS
CONTOUR INTERVAL: 50 FEET

HALEY ALDRICH

NOTES: ISOPACHS ARE CALCULATED AS UNIT THICKNESS BETWEEN LOGGED FORMATION BOTTOMS. NO STRUCTURAL DIP CORRECTION.

FLORENCE COPPER, INC.
FLORENCE, ARIZONA

OXIDE UNIT (OU)

FLORENCE COPPER

MARCH 2022

FIGURE 4

EXHIBIT B-10

Brown and Caldwell 1996 Site Characterization Report
Table 4.3-2

Table 4.3-2 Summary of Existing In-Situ Mine Area Aquifer Test Data

Source	Investigative Method/Test Location	Aquifer Characteristics				Lithologic Unit Tested	Interval Tested Measured From Top of Lithologic Unit
		Transmissivity (gpd/ft)	Hydraulic Conductivity[a]		Storage Coefficient (dimensionless)		
			ft/day	cm/sec			
Golder (1976a)	NR/NR	NR	0.08	$3.0X10^{-5}$	$1.0X10^{-6}$	Oxide Bedrock	NR
	NR/NR	NR	0.26	$8.0X10^{-4}$	NR	Diorite dikes	NR
	NR/NR	NR	0.01	$2.0X10^{-6}$	NR	Clayey zones	NR
Golder (1976b)	In-situ corehole permeability/P-1	NR	0.1	$3.5X10^{-5}$	NR	Oxide Bedrock	NR
	In-situ corehole permeability/P-2	NR	0.1	$3.4X10^{-5}$	NR	Sulfide Bedrock	NR
	In-situ corehole permeability/P-3	NR	0.02	$0.8X10^{-5}$	NR	Sulfide Bedrock	NR
Anderson (1968); Halpenny and Greene (1973); Beck and Associates (1975)	Aquifer Test/NR	20,000	2.7	$9.4x10^{-4}$	$7.5x10^{-3}$	Bedrock	0 to 1,000 feet
	Aquifer Test/NR	2,000	0.27	$9.4x10^{-5}$	$7.5x10^{-3}$	Bedrock	1,000 to 2,000 feet
	Aquifer Test/NR	520,000	188	$6.6x10^{-2}$	$1.0x10^{-4}$	Conglomerate	0 to 370 feet
	Aquifer Test/NR	125,000	45	$1.6x10^{-2}$	NR	Conglomerate	0 to 370 feet
	Aquifer Test/NR	50,000	25	$8.7x10^{-3}$	NR	Conglomerate	0 to 270 feet
Dames and Moore (1974)	Air Lifting/DM-A	1,500	0.64	$2.3x10^{-4}$	NR	Bedrock	382 to 700 feet
	Air Lifting/DM-B	200	0.29	1.0x10-4	NR	Bedrock	611 to 700 feet
	Air Lifting/DM-C	1,700	0.91	$3.2x10^{-4}$	NR	Bedrock	358 to 610 feet
	Air Lifting/DM-D	320	0.16	$5.6x10^{-5}$	NR	Bedrock	364 to 635 feet
	Air Lifting/DM-E	2,000	0.87	$3.1x10^{-4}$	NR	Bedrock	392 to 700 feet
Halpenny and Greene (1976)	Measured Specific Capacity/Conoco 1	6,800	1.3	$4.6x10^{-4}$	NR	Conglomerate and Bedrock	NR
	Adjusted Specific Capacity[b]/Conoco 1	15,600	3.0	$1.1x10^{-3}$	NR		
	Measured Specific Capacity/Conoco 2	23,200	4.2	$1.5x10^{-3}$	NR	Conglomerate and Bedrock	NR
	Adjusted Specific Capacity[b]/Conoco 2	29,000	5.2	$1.8x10^{-3}$	NR		
	Aquifer Test/Conoco 3	15,800	3.0	$1.1x10^{-3}$	NR	Conglomerate and Bedrock	NR
	Measured Specific Capacity/Conoco 3	17,400	3.4	$1.2x10^{-3}$	NR		
	Adjusted Specific Capacity[b]/Conoco 3	38,800	7.5	$2.6x10^{-3}$	NR		
	Aquifer Test/Conoco 4	14,100	2.5	$8.8x10^{-4}$	NR	Conglomerate and Bedrock (including sulfide)	NR
	Measured Specific Capacity\Conoco 4	20,200	3.6	$1.3x10^{-3}$	NR		NR
	Adjusted Specific Capacity[b]/Conoco 4	24,600	4.4	$1.6x10^{-3}$	NR		
	Aquifer Test/Conoco 20	19,400	2.7	$9.5x10^{-4}$	NR	Conglomerate and Bedrock	NR
	Measured Specific Capacity/Conoco 20	17,800	2.5	$8.8x10^{-4}$	NR		
	Adjusted Specific Capacity[b]/Conoco 20	20,600	2.9	$1.0x10^{-3}$	NR		

Table 4.3-2 Summary of Existing In-Situ Mine Area Aquifer Test Data

Source	Investigative Method/Test Location	Aquifer Characteristics				Lithologic Unit Tested	Interval Tested Measured From Top of Lithologic Unit
		Transmissivity (gpd/ft)	Hydraulic Conductivity[a]		Storage Coefficient (dimensionless)		
			ft/day	cm/sec			
Halpenny and Greene (1976) - Continued	Aquifer Test Canal Well (Observation)	113,850	NR	NR	$2.7x10^{-4}$	Conglomerate	NR
	Aquifer Test Recorder Well (Observation)	209,700	NR	NR	$2.1x10^{-2}$	Conglomerate	NR
	Aquifer Test BIA-9 (Observation)	161,800	52	$1.8x10^{-2}$	$1.2xX10^{-2}$	Conglomerate and Bedrock	NR
	Aquifer Test OB-1 (Observation)	11,400	2.7	$9.5x10^{-4}$	$1.2x10^{-3}$	Bedrock	NR
	Aquifer Test DM-C (Observation)	12,000	6.4	$3.0x10^{-4}$	NR	Bedrock	NR
Magma Copper (1994)	Aquifer Test PW1-1 (Pumping)	227	0.08	$2.8x10^{-5}$	$6.9x10^{-6}$	Oxide Bedrock	NR
	Aquifer Test OB1-1 (Observation)	1,301	0.46	$1.6x10^{-4}$	$1.7x10^{-4}$	Oxide Bedrock	NR
	Aquifer Test MCC-523 (Observation)	905	NR	NR	$6.7x10^{-5}$	Oxide Bedrock	NR
	Aquifer Test PW2-1 (Pumping)	987	0.6	$2.1x10^{-4}$	$2.1x10^{-3}$	Oxide Bedrock	NR
	Aquifer Test OB2-1 (Observation)	3,441	2.1	$7.4x10^{-4}$	$7.4x10^{-5}$	Oxide Bedrock	NR
	Aquifer Test PW3-1 (Pumping)	5,019	2.4	$8.4x10^{-4}$	$5.5x10^{-2}$	Oxide Bedrock	NR
	Aquifer Test OB3-1 (Observation)	5,655	2.7	$9.5x10^{-4}$	$7.3x10^{-4}$	Oxide Bedrock	NR

[a]Estimated, where appropriate, based on saturated screen interval information from source.
[b]Adjusted specific capacity; values adjusted for decreasing saturated interval thickness during test.
NR - Not reported
gpd/ft - gallons per day per foot
ft/day - feet per day
cm/sec - centimeters per second

Attachment C
Well Construction/Conversion Information
Application for Class III Underground Injection Control Permit

Florence Copper Project
Florence Copper Inc.

Revised February 2022

HALEY ALDRICH

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C-1	PTF Annular Conductivity Data

Application for Class III Underground Injection Control Permit
Florence Copper Project

Attachment C: Well Construction/Conversion Information

Part I. Well Schematic Diagram (40 CFR § 146.34)

C.1 INTRODUCTION

This Attachment describes proposed well design attributes and well construction procedures.

This Attachment has been prepared in support of an application (Application) by Florence Copper Inc. (Florence Copper) to the United States Environmental Protection Agency (USEPA) for an Underground Injection Control (UIC) Class III (Area) Permit for the planned In-Situ Copper Recovery (ISCR) facility at the Florence Copper Project (FCP) in Pinal County, Arizona. With this Application, Florence Copper seeks authorization to construct and operate a commercial-scale ISCR facility at the FCP site. Florence Copper proposes to incorporate the pilot-scale Production Test Facility (PTF), which is currently operating under UIC Permit R9UIC-AZ3-FY11-1, into the planned commercial-scale ISCR facility at the FCP site.

C.2 WELL DESIGN

Injection, recovery, observation, and perimeter wells will be of a single design, with minor variations in the screen configuration to accommodate formation characteristics. Injection and recovery wells may have continuous well screen or segmented well screen through the injection zone. Perimeter wells and observation wells constructed outside of the ISCR area but within the area of review (AOR) will have a single well screen segment that spans the entire interval. Selected injection and recovery wells constructed in the ISCR area, but outside of the active ISCR operations, will be used as observation and perimeter wells. As the wellfield expands, these wells will be converted for use as injection and recovery wells. Similarly, injection and recovery wells constructed within the ISCR area will alternate roles between injection and recovery during the course of operations.

Well design details are shown on Figures C-1 through C-4. Figure C-1 shows details of a typical injection/recovery well. Figure C-2 shows construction details of a typical injection/recovery well head. Figure C-3 shows construction details of a typical observation/perimeter well. Figure C-4 shows construction details for the annular conductivity device (ACD) that will be installed on all injection, recovery, observation, and perimeter wells. These wells will be constructed with fiberglass reinforced plastic (FRP), polyvinyl chloride (PVC), or other corrosion-resistant well casing.

C.2.1 Well Casing

The surface casing will be low carbon steel manufactured in accordance with ASTM International (ASTM) Specification 153-89A (1989) Grade A (or better) steel. This casing will be of a diameter sufficient to allow a minimum 2½-inch annular space between the casing wall and borehole wall to ensure that an adequate seal can be installed.

The surface casing diameter will vary based on the diameter of the planned well casing to be installed. Because of the chemical environment in which the casing will be installed, FRP, PVC, or other corrosion-resistant threaded casing will be used to complete the injection, recovery, observation, and perimeter wells. These casing materials will be of sufficient grade so that they will not fail in tension and will not collapse or burst, and will be chemically resistant to the process solutions.

Well screen made of PVC or other suitable material may be used in the lower portion of each injection, recovery, observation, and perimeter well as necessary to keep the hole open and to provide the operational flexibility to isolate segments of the full length of the injection and recovery zone.

C.2.2 Casing Centralizers

Casing centralizers will be installed on the well casing every 40 feet along the entire well casing, including screens, where applicable. The centralizers will be made of grade 316 stainless steel or PVC and will be suitable for contact with process solutions. Grade 316 stainless steel is resistant to corrosion by the planned ISCR process solutions.

C.2.3 Screened Interval

The screened interval will vary in length at each well and may include one or more screened segments within the full length of the injection zone. Florence Copper maintains the option to complete injection, recovery, observation, and perimeter wells without well screen and filter pack (open hole) where feasible. If open hole completions are selected in the injection zone, all other aspects of the proposed design will remain in effect. No screened interval will be installed higher than 40 feet below the Lower Basin Fill Unit (LBFU)/bedrock contact.

C.2.4 Annular Seal

The annular seal will be installed from 40 feet below the LBFU/bedrock contact to the surface. The annular seal material will be Type V cement and will be installed by the tremie method as described below in Section C.3.6.

C.2.5 Annular Conductivity Device

Florence Copper will install two ACDs on each injection, recovery, observation, and perimeter well at the limits of the exempted aquifer. One ACD will be installed at a point 10 feet below the middle fine grain unit (MFGU), and a second ACD will be installed no more than 10 feet above the MFGU. In areas where the MFGU lies more than 200 feet above the LBFU/bedrock contact, an ACD will be installed no more than 190 feet above the LBFU/bedrock contact, and a second ACD will be installed no more than 210 feet above the LBFU/bedrock contact.

This placement of the ACDs will provide an indication of solution migration prior to reaching the vertical limit of the Aquifer Exemption before a hypothetical solution excursion would reach the underground source of drinking water (USDW), and after a hypothetical excursion into the USDW. The ACDs will be installed at this level on every ISCR well within the commercial wellfield.

During wellfield development, ISCR wells installed in the interior of the wellfield will serve as perimeter and observation wells until such time as the wellfield expands to include those wells for injection and recovery uses. Consequently, the only perimeter and observation wells that will not be used later for injection and recovery of fluids are those located at the edge of the maximum wellfield footprint. Although these perimeter wells and observation wells will not be used for injection and recovery of solutions, each of these wells will have ACDs installed at the limits of the exempted aquifer as described above. Figures C-1 and C-3 show typical ACD installation above and below the MFGU.

Each ACD will consist of a pair of stainless steel (grade 316) casing centralizers spaced 3 feet apart and connected to electrical wires which extend to the surface. The ACD will be constructed of materials suitable for contact with the annular seal materials and process solutions. The ACD will be constructed to detect fluid movement through any micro-annulus that might form between the well casing and the cement seal, and will also be in contact with the formation to detect migration of injected solution through the formation, outside of the cement seal, should any occur. Details of the ACD are presented on Figure C-4.

Six early warning ACDs will be installed within each 500-foot by 500-foot resource block at a depth of 20 feet above the LBFU/bedrock contact to serve as an early warning of vertical migration of injected fluid. This number of ACDs represents 10 percent of the injection wells to be installed within each resource block. The early warning ACDs will be installed on wells designated for injection use when the wells are commissioned. As wellfield development progresses, the injection wells will transition to use as recovery wells, and recovery wells will transition to use for injection. Partial resource blocks located at the edge of the ISCR wellfield contain fewer wells than the full resource blocks and will have early warning ACDs installed on 10 percent of the injection wells.

The early warning ACD installation will be prioritized in each resource block as follows:

1. Where mapped faults transect a resource block, two ACDs will be installed on wells that are projected to penetrate the fault plane. The additional four ACDs will be installed at locations distributed across the resource at approximate even spacing.
2. Where mapped faults transect a corner or small portion of a resource block, a minimum of one ACD will be installed on a well that is projected to penetrate the fault plane. The remaining ACDs will be installed at locations distributed across the resource at approximate even spacing.
3. In partial resource blocks located at the edge of the PTF wellfield, an early warning ACD will be installed on at least one well if fewer than 10 wells are planned for the resource block, or will be installed on 10 percent of the wells in the block if more than 10 wells are planned for the resource block. ACDs installed in partial resource blocks at the edge of the wellfield will be installed in areas where mapped faults are projected or will be approximately evenly distributed across the resource block if no mapped faults transect the resource block.

Installation of early warning ACDs on 10 percent of the injection wells will provide a dataset that will support statistical analysis of monitoring results to demonstrate baseline conditions and assess changes in baseline conditions. Prioritizing installation of the ACDs at mapped faults will provide early warning of potential vertical migration of injected fluid along those faults. The typical placement of early warning ACDs at wells that penetrate mapped fault planes is shown on Figure C-4a.

For the commercial ISCR wellfield, Florence Copper will conduct statistical analysis of baseline ACD resistivity data to calculate an alert level (AL) for future ACD monitoring. The well bore conductivity AL value for each resource block will reflect the range of variability observed in background well conductivity measurements. The AL value will be established as a Background Threshold Value (BTV) calculated using baseline well bore conductivity values measured at the wells within the resource block. The number of wells contained in each resource block varies from 3 wells in the smallest blocks to approximately 60 wells in the largest blocks. The BTV will be calculated using data from all of the wells planned for each resource block. Resource blocks that have fewer than 4 wells will use the BTV from the nearest adjacent resource block. The BTV for each resource block will be calculated using ProUCL, a software package prepared and promulgated by the USEPA.

Two background well bore conductivity measurements will be taken weekly at each Class III well over a period of one month after the cement well seal has been emplaced. A minimum of three measurements are recommended to ensure that equipment and procedural variability do not produce an undue impact on the conductivity values measured. Because the background data collection period is relatively short, the magnitude of potential temporal natural variation in conductivity values may not be fully characterized. To account for potential long-term temporal variations in measured conductivity values, the historical conductivity data collected from the existing monitoring wells in the previously developed resource blocks will be assessed to quantify the degree of variation from a mean conductivity value over the observation period. In the case of the first resource block to be developed, the PTF observation wells will be used to assess potential long-term variability.

Florence Copper reports the annular conductivity data for the PTF wells to the Arizona Department of Environmental Quality and USEPA quarterly. The most recent quarterly report (2019 Q4) was transmitted to the USEPA in January 2020. The 2019 Q4 quarterly report states that annular electrical conductivity readings have remained approximately constant or increased slightly in 8 of the 11 monitored wells since monitoring began in Q3 2018. Annual electrical conductivity has decreased in wells O-04, O-06, and WB-01 during that same time. The results of the monitoring indicate the absence of injected fluid at ACD locations. These monitoring results indicate that no migration of injected fluid has occurred at the well casing/cement seal interface. The PTF ACD data are provided in Exhibit C-1.

C.2.5.1 Contingency Actions for ACDs Installed Above and Below the Limit of the Exempted Aquifer

Florence Copper will take the following actions in response to an above-background signal from an ACD detected during quarterly monitoring during ISCR operations.

1. Collect a verification ACD reading within 5 days after becoming aware of the above-background signal.
2. Within 5 days of the verification reading, notify USEPA if the verification results indicate a confirmed above-background signal.
3. If the results of the verification reading indicate that an above-background signal does not exist, notify USEPA of the verification results and assume that no exceedance has occurred. No further action is required until the next scheduled monitoring round.

4. Within 10 days of receiving verification results indicating an above-background ACD signal, do the following:
    a. Submit a written report to USEPA providing an evaluation of the cause, impacts, or mitigation of the discharge responsible for the above-background ACD signal, or
    b. Submit a written report to USEPA which definitively demonstrates that the above-background ACD signal resulted from an error(s) in sampling, analysis, or statistical evaluation.
5. Upon review of the report documenting the above-background ACD signal, USEPA may require additional monitoring and/or action beyond those specified in this Permit.

In response to a confirmed above-background signal from an ACD installed on a single well, which indicates possible loss of mechanical integrity, complete the following contingency actions. These contingency actions apply to ACDs installed at the limits of the USDW and the early warning ACDs.

1. Remove well from service.
2. Perform standard annular pressure test (SAPT) to evaluate mechanical integrity.
3. Complete temperature log, nuclear magnetic resonance log, and dual induction logs to evaluate potential fluid movement outside of the well casing.
4. Repair the well.

In response to a confirmed above-background signal from individual ACDs installed on two or more adjacent wells, indicating possible mounding and upward migration of injected fluid, complete the following contingency actions. These contingency actions apply to ACDs installed at the limits of the USDW and the early warning ACDs.

1. Remove the wells from service.
2. Reduce the injection rate at adjacent injection wells by 50 percent or more.
3. Increase recovery of injected fluid at adjacent recovery wells.
4. Increase the frequency of ACD monitoring to weekly.
5. Perform SAPTs on the subject wells to evaluate mechanical integrity.

Complete temperature log, nuclear magnetic resonance log, and dual induction logs on the subject wells to evaluate potential fluid movement outside of the well casing.

C.2.5.2 Annular Conductivity Device Demonstration

Florence Copper has planned the following ACD demonstration and contingency actions in addition to those described above. The demonstration will begin with the commencement of ISCR operations and conclude with a comparison of ACD signals recorded 6 months after injection begins in the first resource block to be activated. This period of time will allow the flow field to fully develop and allow the injected solution to mature. Florence Copper may conduct this demonstration prior to 6 months' time if the flow field and solution chemistry have achieved steady state conditions.

The demonstration outlined below includes monthly data collection and analyses that will be conducted once injection begins and throughout the period of the demonstration. The demonstration includes:

1. Prior to the commencement of injection, Florence Copper will collect baseline water quality samples from each of the ACD demonstration monitoring wells (M72-UBF and M73-LBF) and down gradient observation wells to be used in the ACD demonstration.
2. Monthly, Florence Copper will collect water quality samples from each of the ACD demonstration monitoring wells (M72-UBF and M73-LBF) and down gradient observation wells from the time that injection begins until the demonstration is completed at month six. Samples will be analyzed for the constituents listed in the quarterly monitoring table of the Aquifer Protection Permit and UIC permit.
3. During construction of the first resource block to be activated, Florence Copper will install one ACD each, on two injection wells, at a depth below the 40-foot exclusion zone. Florence Copper will extend the cement seal on the selected injection wells to a depth of 50 feet below the top of bedrock (10 feet below the exclusion zone). The ACDs will be installed below the exclusion zone within the 10-foot well extension. At the commencement of ISCR operations, injected fluid is anticipated to advance to the location of the sacrificial ACDs within the authorized injection zone.
4. Monthly, Florence Copper will collect resistivity data from each of the sacrificial ACDs installed on the injection wells selected for ACD demonstration.
5. Six months after injection begins at the first resource block to be activated, Florence Copper will conduct a statistical comparison of the average readings from the sacrificial ACDs to the early warning ACDs within the same resource block. The statistical analyses will include:
    a. Outlier test of each ACD dataset.
    b. Analysis of the group population distribution to determine if an assumption of normal distribution can be applied.
    c. Evaluation of trends occurring in the dataset for each ACD and each ACD group (e.g., upper basin fill unit (UBFU), LBFU, up gradient, and down gradient).
    d. Comparison of group means to determine if the sacrificial ACDs and early warning ACDs are derived from similar data populations.
    e. Comparison of the group trends defined above to the sacrificial ACD data population average readings and trends observed during injection.

    The comparison will identify statistically significant decreases in resistivity in the sacrificial ACD dataset relative to the early warning ACD values in the same resource block. Statistical analyses will be conducted in accordance with USEPA Unified Guidance titled *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, dated 2009.
6. Six months after injection begins at the first resource block to be activated, perform statistical analysis of the sacrificial ACD readings to identify statistically significant changes from baseline values.

Prior to conducting the ACD demonstration, Florence Copper will install two monitoring wells in the first resource block to be developed and brought online. The wells (M72-UBF and M73-LBF) will be sited based on the location of known faults and/or areas of known higher fracture intensity, to the extent possible. Well M72-UBF will be completed in the UBFU, with a 10-foot well screen installed within 20 feet of the top of the MFGU. Well M73-LBF will be completed in the LBFU, with a 10-foot well screen installed within 20 feet of the bottom of the MFGU. The approximate locations of monitoring wells M72-UBF and M73LBF are shown on Figure A-19 of Attachment A.

C.2.5.3 Contingency Actions for ACD Demonstration

If the demonstration does not show a statistically significant change from baseline values, Florence Copper will implement the following contingency actions:

1. Conduct trend analysis for each of the early warning ACDs to identify the greatest decrease in resistivity under baseline conditions. Use the trend analysis to identify naturally occurring extremes and data migration trends under baseline conditions. Compare the baseline data trends to trend(s) observed at the sacrificial ACD(s) installed in the injection zone to identify the magnitude of signal departure within the injection zone.
2. Install and begin monitoring ACD test contingency wells within the UBFU (the USDW overlying the ISCR wellfield) and LBFU.

   A total of 51 new monitoring wells will be installed throughout the wellfield area. The wells will be evenly spaced, with a minimum of one well placed in each full resource block. Additional monitoring wells have been located in resource blocks intersecting the Sidewinder Fault as illustrated in Figure C-4c. Twenty-four of the wells will be screened in the UBFU and 27 of the wells will be screened in the LBFU.

   The upper boundary of the exempted aquifer is defined as the base of the MFGU or a point 200 feet above the LBFU/bedrock contact, whichever is less. The UBFU ACD contingency monitoring wells will be screened not more than 20 feet above the MFGU where the boundary of the exempted aquifer is the base of the MFGU. Where the upper boundary of the exempted aquifer is below the base of the MFGU, the UBFU ACD contingency monitoring wells will be screened not more than 20 feet above the upper boundary of the exempted aquifer.

   The LBFU ACD contingency monitoring wells will be screened not more than 20 feet below the base of the MFGU where the boundary of the exempted aquifer is the base of the MFGU. Where the upper boundary of the exempted aquifer is below the base of the MFGU, the LBFU ACD contingency monitoring wells will be screened not more than 20 feet below the upper boundary of the exempted aquifer.

   In the resource blocks where faults are projected to intersect the top of bedrock, the ACD contingency monitoring wells will be placed directly above locations where the faults are projected to intersect the top of bedrock.

   The ACD contingency wells will be installed in the following sequence: one well will be installed in each resource block with active ISCR wells, and one in each of the pre-development resource blocks adjacent to the active ISCR wellfield. The ACD contingency well installations will be alternated between the UBFU and the LBFU in adjacent resource blocks. Additional ACD

contingency wells will be installed outward in this pattern as the ISCR wellfield is expanded. Electronic specific conductance monitoring equipment will be installed in each of the ACD contingency wells to monitor changes in water chemistry that may indicate an excursion of injected fluid. A minimum of eight specific conductance measurements will be made at each ACD contingency well prior to the commencement of ISCR operations. An example of the ACD contingency monitoring well installations is shown on Figure C-4b.

3. Incorporate the newly installed ACD contingency monitoring wells and ACD test wells (M72-UBF and M73-LBF) into the established monitoring program for the fault and USDW monitoring wells. Monitoring of the ACD contingency monitoring wells in each resource block will cease when the ISCR wells within the resource block are plugged and abandoned.

A total of 51 ACD contingency monitoring wells will be installed within the ISCR wellfield area. The ACD contingency monitoring wells will be added to the planned 16 supplemental wells which include USDW monitoring wells, fault monitoring wells, and ACD test wells and to the 29 point of compliance wells located at the edge of the ISCR wellfield. The ACD contingency monitoring well locations are shown on the accompanying on Figure C-4c.

The proposed number of ACD contingency monitoring wells is appropriate to detect and characterize the nature and extent of fluid excursions into the USDW, based on standards published in *Unified Guidance Document: Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities March 2009, EPA 530/R-09-007.* This guidance document establishes the sample population size necessary to achieve goodness-of-fit criteria necessary to establish characteristics of sample population distribution. This guidance is routinely applied to characterize hazardous waste sites under the Resource Conservation and Recovery Act (RCRA) using the combined number of wells and samples to support detailed statistical analyses.

Locating the contingency wells both within the active ISCR wellfield and in the adjacent undeveloped resource blocks will allow for statistical comparison of sample populations in both the leached and un-leached areas of the wellfield and provides for a pre-leaching baseline for comparison. The combined number of wells and background specific-conductance measurements will facilitate statistical analyses sufficient to detect changes in baseline water quality conditions both within the LBFU and within the USDW resulting from injection activities, should any occur.

With the addition of the ACD contingency wells, the Florence Copper ISCR wellfield will feature a total of 96 monitoring wells at build-out, which are positioned to monitor the USDW above and at the edge of the ISCR wellfield, and include monitoring directly above locations where faults are projected to intersect the top of bedrock.

All of the UBFU fault monitoring and ACD contingency monitoring wells will be constructed using a similar well design. ACDs will be installed on the UBFU fault monitoring wells only. No ACDs will be installed on ACD test wells M72-UBF, M73-LBF, or the ACD contingency UBFU monitoring wells. The UBFU monitoring well design is shown on Figure C-5.

The LBFU USDW monitoring will be constructed using the well design shown on Figure C-6. The LBFU fault monitoring will be constructed using the well design shown on Figure C-7. ACDs will be installed on the LBFU USDW and fault monitoring wells only. No ACDs will be installed on ACD test wells M72-UBF, M73-LBF, or the ACD contingency LBFU monitoring wells. The LBFU ACD contingency monitoring well design is shown on Figure C-8.

Construction details for ACD test wells M72-UBF and M73-LBF are shown on Figures C-5 and C-8, respectively.

C.2.6 Pressure Transducers

Each of the injection, recovery, observation, perimeter, and point of compliance wells will be fitted with dedicated pressure transducers for fluid level measurement. Injection and recovery wells will include one transducer installed within the well casing above the packer. Observation and perimeter wells will include a single transducer installed within the well casing to measure fluid levels at the edge of the ISCR wellfield. Transducer installation locations and cable configuration are shown on Figure C-9.

Fluid electrical conductivity will be monitored at the observation wells using an electronic sensor. The electrical conductivity sensor may be combined with a pressure transducer as a single instrument, or it may be a separate instrument, depending on the model of instrument selected. In the event that the fluid conductivity sensor malfunctions, Florence Copper will collect fluid samples for conductivity analysis on a contingency basis.

C.2.7 Tubing and Packer Configuration

Injection, recovery, observation, and perimeter wells will be of a single design, with minor variations in the screen configuration to accommodate formation characteristics. Injection and recovery wells may have continuous well screen or segmented well screen through the injection zone. Injection tubing will be used in all injection wells to covey injected fluid to a point below the fluid level in each injection well. Packers may be used in the injection wells, or the injection wells may be operated without packers. Recovery wells will use tubing to convey recovered fluid from the pump to piping at ground surface. Recovery wells may be operated with or without packers depending on operational considerations. Typical tubing and packer (when used) configurations are shown on Figure C-9.

Part II. Well Construction or Conversion Procedures (40 CFR §§ 144.52, 146.32 & 146.34)

C.3 WELL CONSTRUCTION

The well construction description provided below includes details for drilling, open-hole geophysics, installation of casing and ACDs, screen and filter pack installation, cementing, and cased-hole geophysics.

C.3.1 Injection Interval

Fluids will only be injected at depths greater than 40 feet below the top of the oxide zone. To ensure that the injection interval is at least 40 feet below the top of the oxide zone, Florence Copper will case and cement all injection wells from ground surface to at least 40 feet below the top of the oxide zone. Florence Copper may develop the injection interval for each well by installing well screen and short blank casing sections through the oxide interval below the bedrock exclusion zone or may inject into the open borehole below the bedrock exclusion zone.

C.3.2 Borehole Drilling

Borehole drilling consists of drilling a large diameter borehole to accommodate installation of surface casing to a depth of 20 feet, then drilling a narrower borehole from the bottom of the surface casing to the planned total depth of the well. The surface casing boring will be drilled by the auger or rotary method and its diameter will be of sufficient size to allow installation of the surface casing and an annular seal between the surface casing and the formation. The surface casing will be installed at or above ground surface to accommodate mud-rotary drilling equipment. The annular seal will consist of cement grout installed in the annulus between the surface casing and the borehole, using the tremie method. The surface annular seal will extend from the land surface to the total depth of the surface casing, a depth of 20 feet. The purpose of the surface casing is to provide ground support during the subsequent stages of drilling, and to prevent the migration of surface water into the boring and well annulus.

The borehole in which the well will be constructed will be drilled from the bottom of the surface casing borehole to approximately 20 feet below the bottom of the oxide zone using the direct mud rotary, reverse circulation mud rotary, or a casing advance drilling method as conditions require. The well boring's diameter will be of sufficient size to allow installation of the well casing and annular materials described above in Section C.2, Well Design.

C.3.3 Open-Hole Geophysics

Open-hole geophysical logs will be run in each well boring for the purpose of formation evaluation, depth control, and detection of borehole anomalies.

Geophysical tools will include caliper, gamma-ray, temperature, directional survey, and electrical logs. In addition, compensated neutron-density logs will be run in selected borings within the ISCR wellfield at a rate of one per resource block, a total of approximately 48 neutron-density logs. By comparison, one neutron log was run in each of the PTF injection wells, resulting in a total of four neutron logs within a 2-acre area. The neutron logs generated from the PTF wellfield did not indicate a porosity differential between the wells because there was not sufficient porosity differential to be detected within the 2-acre area. Based on these PTF wellfield observations, a broader neutron-porosity spacing is warranted in the larger ISCR wellfield. The planned frequency of one neutron-density log per resource block places the logging locations approximately 500 feet apart, resulting in a distribution of neutron-density data that will identify significant changes in porosity across the wellfield if such were to occur. The resulting porosity dataset will be of sufficient size to support statistical analyses, and evaluation of porosity effects on the groundwater flow field within and surrounding the ISCR wellfield. The planned neutron-density logging locations are shown on Figure C-4d.

Porosity values determined from the neutron-density logs will be compared to porosities applied to the groundwater flow model in the ISCR wellfield area. If significant differences are found in the comparison of model porosities and log porosities, porosity values in the model will be revised accordingly.

C.3.4 Well Casing and Installation

Each well will be constructed of blank casing material in the upper part of the well from land surface to a depth of 40 feet below the top of bedrock (which corresponds to a depth of 40 feet below the top of the oxide zone). Well casing installed in the injection zone starting 40 feet below the top of bedrock will consist of one or more screened intervals separated by blank casing segments, to the bottom of the well. Casing materials for injection and recovery wells will be designed to resist corrosion, not fail in tension, and not collapse or burst. Proposed casing materials are described above in Section C.2, Well Design.

During installation of the well casing and screen, the borehole will be kept full of drilling fluid and free of any obstructions detrimental to completing casing installation. The well casing and screen will be centered in the hole so as not to interfere in any way with the complete well installation. Casing centralizers will be secured to the well casing and screened at 40-foot intervals. The casing and screen will be hung in tension and centered in the borehole until the filter pack and cement grout seal have been installed. Casing installation will continue on a 24-hour per day, 7-day per week basis until completed.

Each of the injection, recovery, observation, and perimeter wells constructed with PVC or FRP well casings will have ACD devices installed. One ACD will be attached to the exterior of the well casing at a point as close as possible to the top of the MFGU, and no more than 10 feet above the MFGU where the aquifer exemption extends to the MFGU. On the western side of the ISCR area, and at localized areas within the ISCR area, the aquifer exemption extends 200 feet above the bedrock contact; in these areas, the ACD will be installed at a point 200 feet above bedrock. The ACD will consist of a pair of metal bands spaced one meter apart and connected to electrical wires which extend to the surface. A schematic diagram of the ACD is included in Figure C-4.

During casing installation, a 2-inch diameter metal tremie pipe will be installed into the annular space between the well casing and the borehole wall. The tremie pipe will be used to place formation stabilizer materials (filter pack), such as silica sand, adjacent to screened casing intervals and to install sand and cement adjacent to blank casing intervals to form the filter pack and hydraulic seals within the annular space between the blank casing intervals and the borehole wall. The tremie pipe will be removed from the well as construction and sealing operations are completed.

C.3.5 Filter Pack and Intermediate Seal Installation

Drilling fluid will be maintained throughout the full depth of the well to land surface, and the well casing and screen will be hung in tension until the filter material placement has been completed to the specified level, while the filter pack and intermediate seal materials are installed. During placement, a swab block will be located inside the well screen below the fill depth of the annular material. The swab block will be reciprocated to remove fine-grained material, prevent bridging, and aid in settling the filter pack in the borehole after filter pack has been installed above the top of the screened interval.

Filter pack (i.e., silica sand) will be placed to continuously fill the annulus to the specified level. Filter pack will be installed by use of the tremie pipe. The tremie pipe will be located at a distance of approximately 40 feet above the interval being filled during placement. As required by formation conditions, intermediate seals may be installed at selected intervals within the injection zone as shown on Figure C-1. Seal material will be installed using the same tremie pipe used for installing the filter pack material.

The tremie pipe will be moved upward during installation of the sand and seal intervals, until the filter pack is installed above the uppermost well screen interval. The level of the filter pack will be measured periodically during placement with a wireline sounder. Placement of the materials will be continuous, except when additional precautions are necessary to prevent bridging or when measurements of the level are being conducted. The quantity of materials placed in the annulus will not be less than that of the computed volume.

The same tremie pipe will then be utilized for cementing the upper portion of the well casing as described below.

C.3.6 Cementing Characteristics for All Class III Wells

Injection, recovery, observation, and perimeter wells will be of a single design and will each use the same cementing procedure. The well borings will be of a constant diameter, drilled in a single stage. Once the well casing, screen, and filter pack have been installed in the boring, cementing of the upper portion of the well casing, from the bottom of the bedrock exclusion zone to ground surface, will be accomplished by pumping a cement slurry down a tremie pipe positioned with the lower end near the bottom of the exclusion zone, forcing the cement to fill the annular space between the borehole and casing from the bottom up to the surface. Cement grout will be placed to completely fill the well annulus within the specified interval. Prior to pumping, the cement grout will be passed through a ½-inch slotted bar strainer in order to remove any unmixed lumps.

Florence Copper does not plan to use a grouting shoe at the bottom of the casing to circulate cement in the annulus behind the casing because the planned ISCR well will be drilled and constructed in a single

pass and will use a conventional well screen to achieve maximum open area to optimize flow into the well.

Use of a grouting shoe is not conducive to the use of conventional well screen and single pass well construction. Use of a grouting shoe requires that a solid well casing be emplaced to the full depth of the borehole if the well is to be constructed in a single pass. The grouting shoe would then be used to circulate cement in the annulus behind the well casing. After the cement has cured, the casing is then perforated using a perforating tool. Use of the grouting shoe and perforating method in a single-pass construction well results in the following adverse conditions in the perforated area:

1. The perforations constitute less open area than the conventional well screen and filter pack system, limiting exposure to the targeted injection zone.
2. Cement is circulated through the target injection zone, sealing fractures that are necessary to allow solution access to the copper-bearing mineralization. The minerals targeted for ISCR production are fracture lining copper-oxide minerals. If the fractures receive circulated cement, they will not receive ISCR solution, and no well stimulation is permitted to reopen sealed fractures.
3. The cement circulated through the injection zone is an acid consuming material. Cement in the injection zone will adversely impact the planned ISCR operations by consuming the acid intended to dissolve the targeted copper mineralization.

Use of a grouting shoe at the Florence Copper site would require wells to be drilled and constructed using a two-pass drilling system. The two-pass system would require that a large 20-inch diameter borehole be drilled from ground surface to a point 50 feet below the top of bedrock. The grouting shoe would then be used to circulate cement in the annulus behind the well casing. After the cement has cured, a smaller 12-inch borehole would be drilled through the cement plug at the bottom of the casing to the full depth of the well. Conventional well casing, well screen, and filter pack would then be emplaced. Use of the grouting shoe and perforating method in a two-pass construction well results in the following adverse impacts:

1. This construction method prevents the use of ACDs to detect migration of injected fluid at the well casing/cement interface.
2. The cost, complexity, and time required to complete each well is nearly doubled compared to the single-pass well construction.
3. Borehole diameter is increased to the point that the utility of certain conventional logging tools such as neutron, neutron-density, nuclear magnetic resonance, and cement bond are diminished.

At the PTF, Florence Copper constructed wells that met UIC Class III requirements using three different well construction methods and materials combinations. The injection and recovery wells were constructed using a two-pass construction method, with a large diameter steel outer casing with welded joints and fiberglass inner casing with threaded joints. The PTF observation wells were constructed using a single-pass drilling and construction method with threaded fiberglass well casing. The supplemental monitoring wells constructed within the AOR were drilled and constructed using the single-pass method with threaded steel well casing. Both the injection/recovery wells and the observation wells passed mechanical integrity testing using the SAPT, demonstrating that both the

two-pass and single-pass drilling construction methods can be used to meet UIC Class III well performance criteria. Each of the single-pass PTF observation wells was grouted using the tremie pipe method.

By contrast, the threaded steel well casing used at the supplemental monitoring wells relied on O-rings at the joints to maintain pressure during the SAPT. Consequently, additional measures were required to demonstrate mechanical integrity at several of the supplemental monitoring wells. Florence Copper does not plan to use threaded steel casing for any of the Class III wells proposed for the commercial ISCR facility.

The discharge end of the tremie pipe will be continuously submerged in the cement until the zone to be filled is completely filled. An acid-resistant, sulfate-resistant, Portland Type V cement or USEPA-approved substitute will be placed in the well annuli of all wells from the bottom of the casing to land surface. The well casing will be hung in tension until the cement has cured. The well casing will be filled with a fluid of sufficient density to maintain pressure equalization with the cement slurry in the annulus to prevent collapse of the well casing during the cementing operation.

Water and/or appropriate mud-breaker chemicals will be circulated through the casing or tremie pipe prior to cement placement to reduce mud viscosity and assist in removal of mud from the borehole/casing annulus. An excess quantity of cement will be pumped into the annular space in order to verify “clean” slurry returns from the well prior to terminating the cementing operation. Following placement of the cement slurry, the cement will be allowed to cure for a minimum of 24 hours before performing additional operations on the well.

The cement will be Type V unless the Permittee submits the following information to the Director regarding a Type V substitute:

i. The results of an immersion test for resistance to pregnant leach solution of equivalent mass samples of Type V cement and any proposed substitute cement;

ii. A comparison of the percentage weight change between samples; and

iii. A demonstration that the substitute experiences little visual change, a weight increase or decrease within 5 to 8 percent, and no significant change in compressive strength.

Upon completion of this demonstration, and subject to USEPA approval, a substitute cement that meets these criteria may be substituted for Type V cement for well construction.

C.3.7 Cased Hole Geophysics

Cased-hole geophysical logs will be run in all injection, recovery, observation, and perimeter wells after casing has been installed and cemented to the surface. Cased hole logs will include:

- Sonic (for cement bond with FRP);
- Four pi density (for cement bond with FRP);
- Dual density (for cement bond with FRP);
- Natural gamma;

- Fluid conductivity;
- Temperature;
- Nuclear magnetic resonance;
- Dual induction; and
- Gyroscopic deviation.

The pre-injection temperature logs will serve as a baseline for later casing integrity analyses. Temperature logs will be run on newly constructed injection wells at 30 days and 60 days after injection has begun. Additional geophysical surveys will be conducted as required by USEPA.

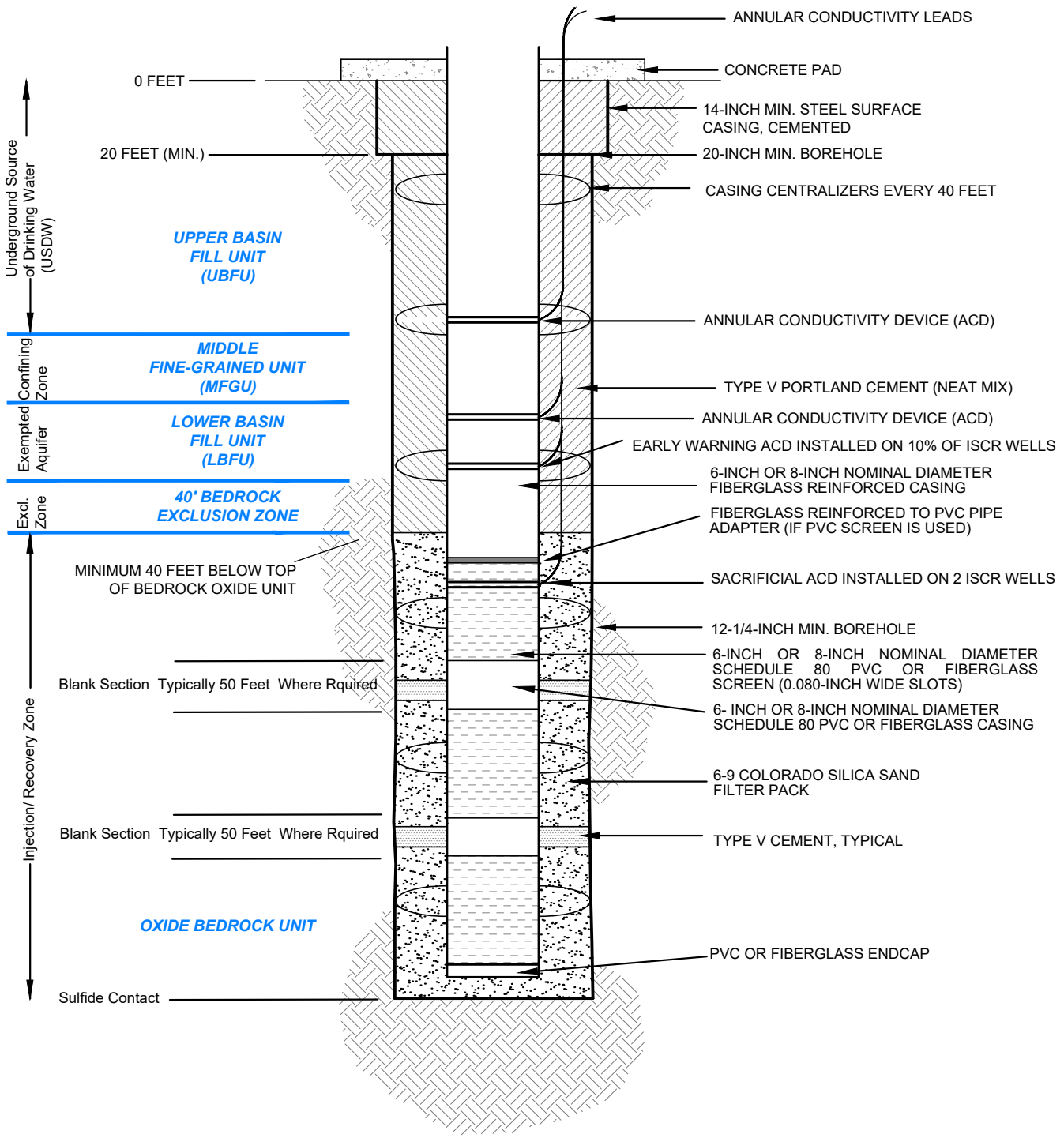
C.3.8 Formation Stimulation Plan

Florence Copper does not propose to use any formation stimulation during the development of the FCP ISCR wellfield.

C.3.9 Alarms and Shutdown Systems

The planned alarm and shutdown systems that will be implemented at the ISCR wellfield are described in the Operations Plan included in Attachment D of this Application.

FIGURES



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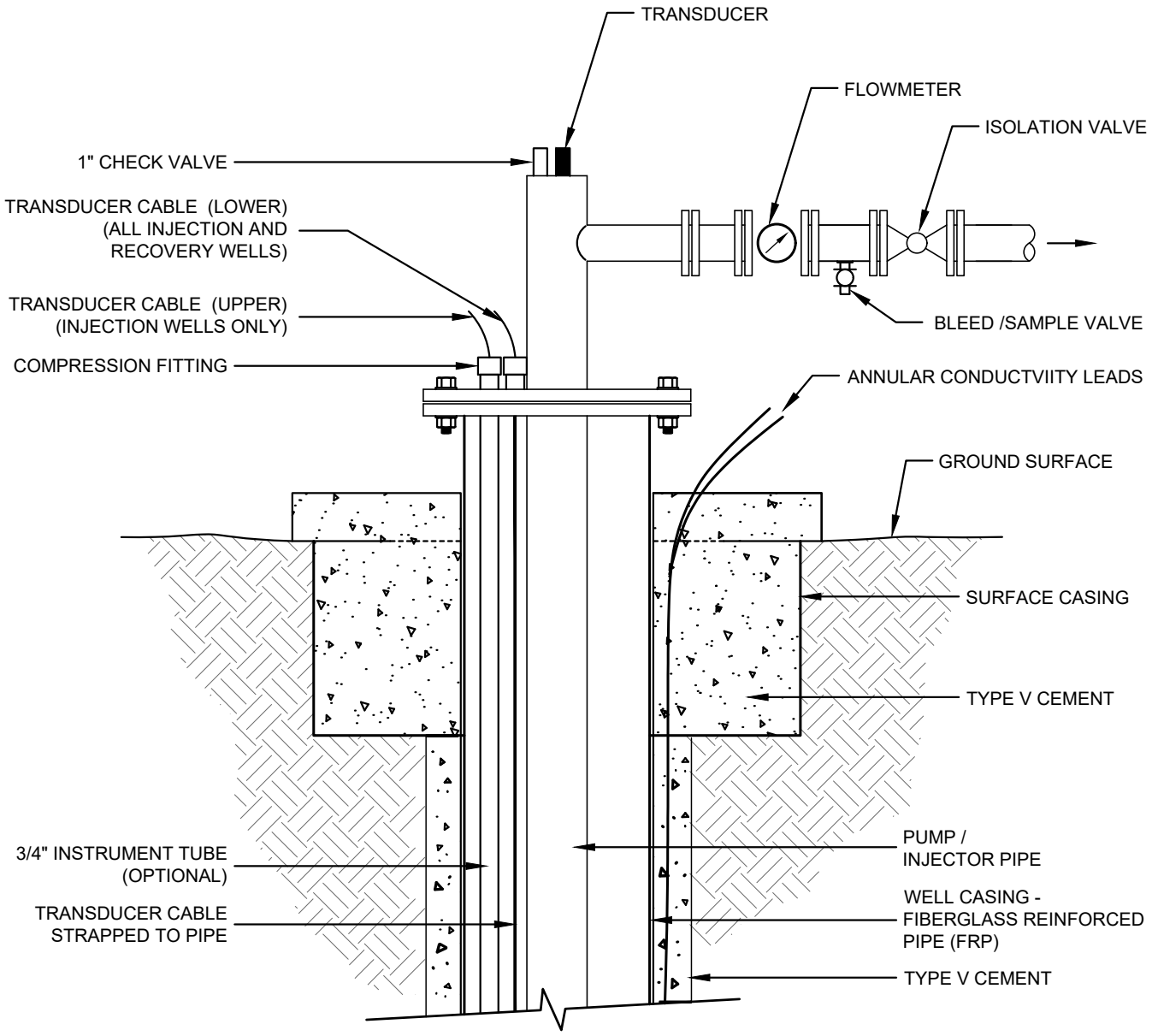
FLORENCE, ARIZONA

INJECTION / RECOVERY
WELL CONSTRUCTION DIAGRAM

FLORENCE COPPER

SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-1



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INJECTION / RECOVERY
WELL HEAD DETAIL

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SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-2

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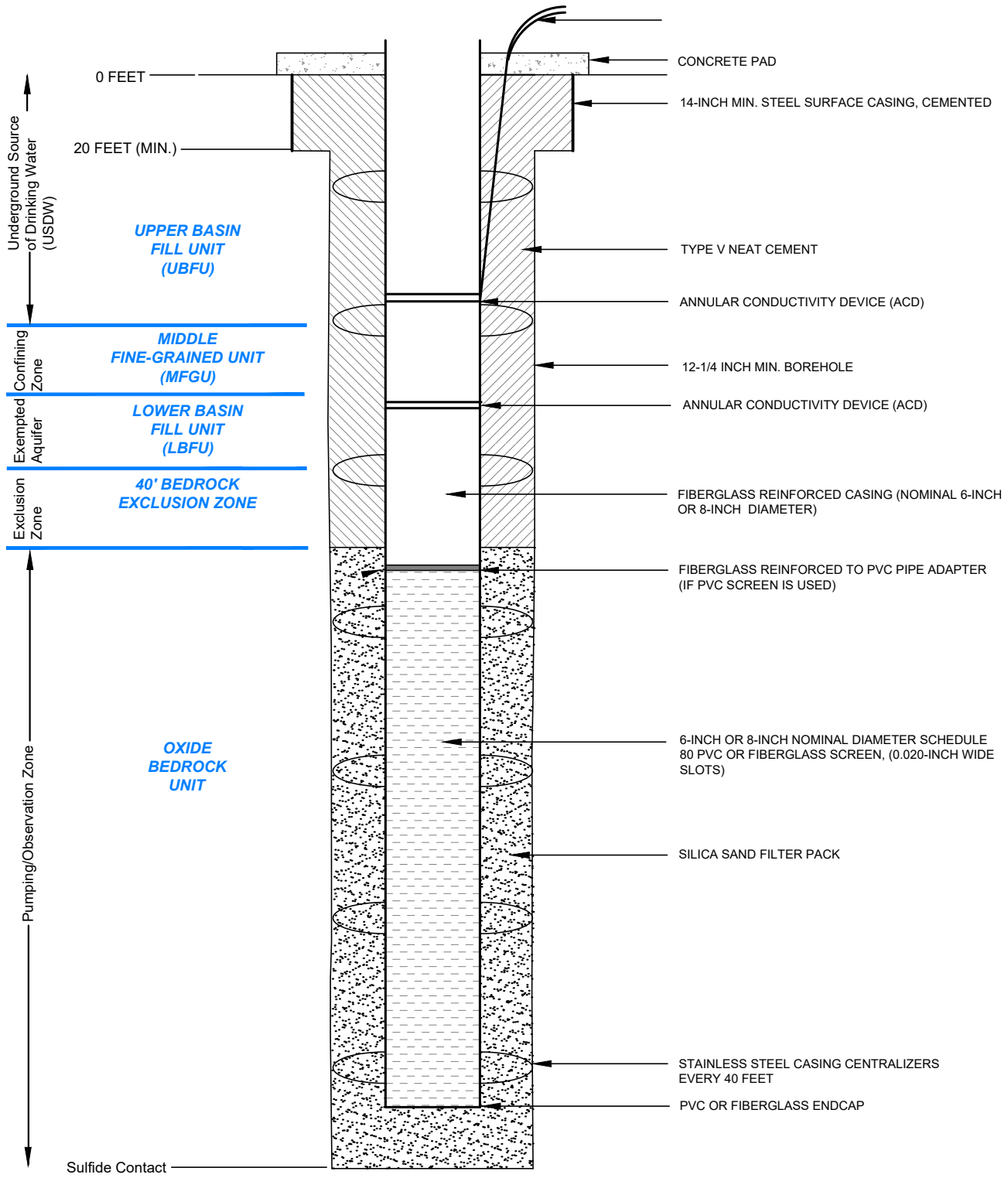
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\WORKING\101704 SIGNIFICANT AMENDMENT\CAD\WELL DIAGRAMS\132473-002_0002-9-2.DWG



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PERIMETER / OBSERVATION WELL CONSTRUCTION DIAGRAM

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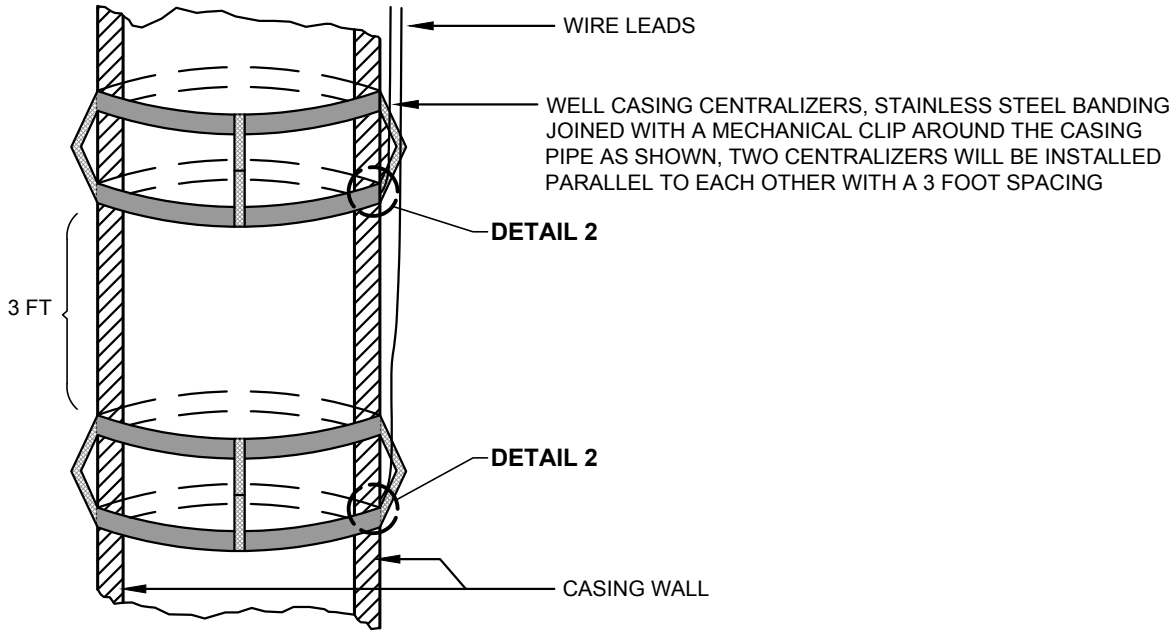
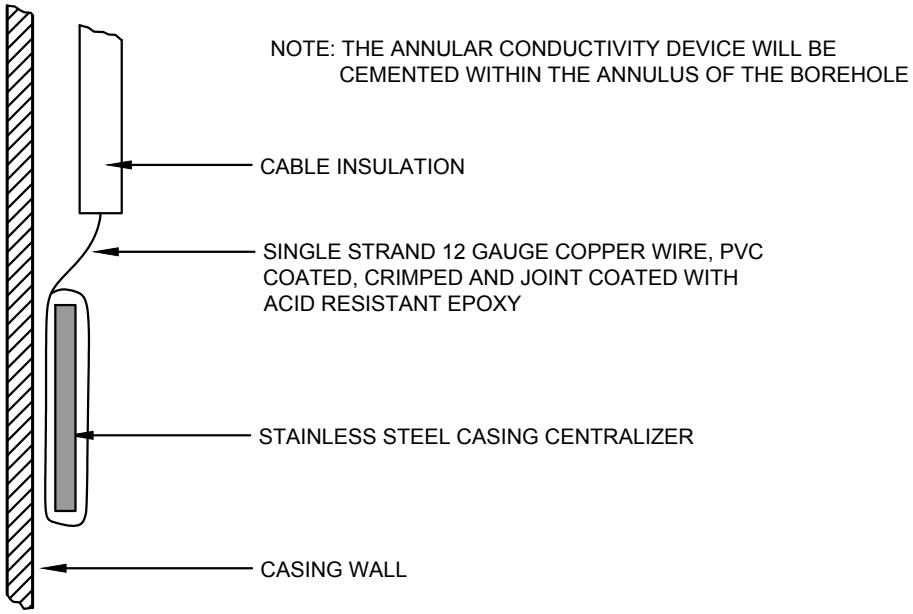
OCTOBER 2021

FIGURE C-3



ANNULAR CONDUCTIVITY DEVICE DETAIL 1

NOT TO SCALE



ANNULAR CONDUCTIVITY DEVICE DETAIL 2

NOT TO SCALE

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ANNULAR CONDUCTIVITY DEVICE DETAILS

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OCTOBER 2021

FIGURE C-4

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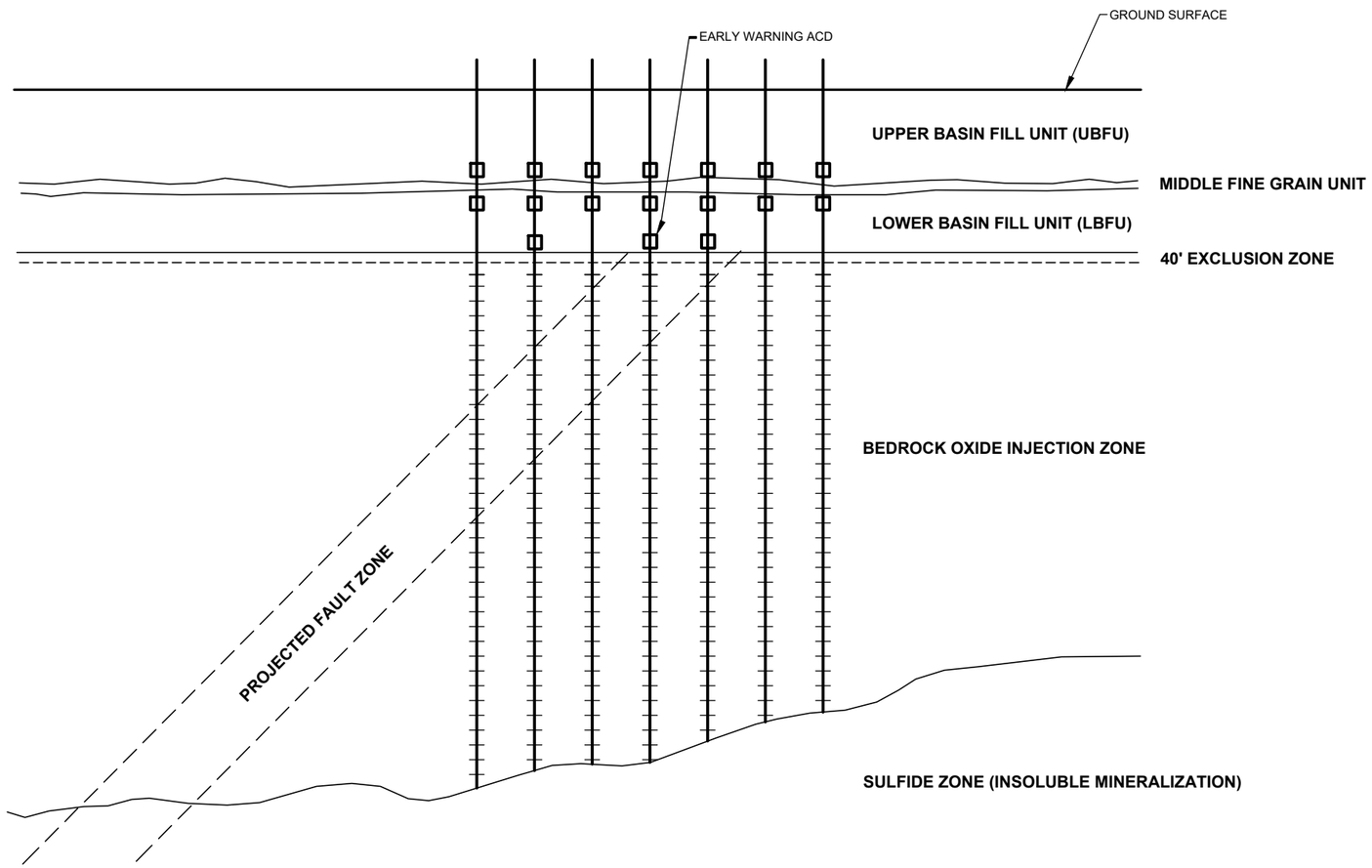
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\DELIVERABLES\2019 APP SIGNIFICANT AMENDMENT\CAD\WELL DIAGRAMS\132473-002_0002-9-4.DWG



LEGEND

ISCR WELL

ANNULAR CONDUCTIVITY DEVICE

PROJECTED FAULT ZONE

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UIC PERMIT APPLICATION

TYPICAL PLACEMENT OF ANNULAR CONDUCTIVITY DEVICES (ACDs) AT ISCR WELLS INTERSECTING FAULTS

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SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-4a

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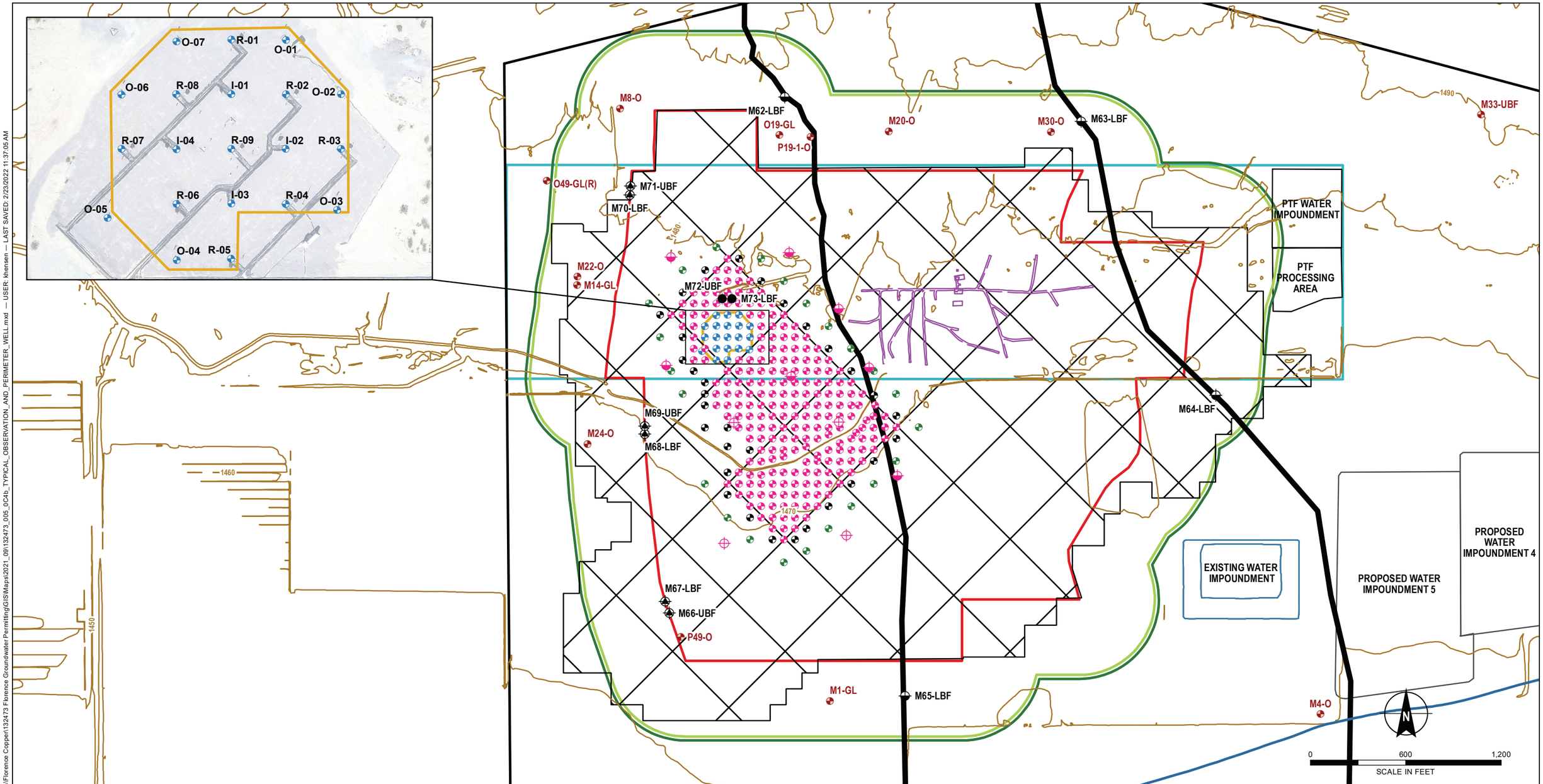
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\CAD\FIGURES\132473-005_FIG 1_ACDS.DWG



LEGEND

- PROPOSED INJECTION / RECOVERY WELL
- OBSERVATION WELL
- POINT OF COMPLIANCE WELL
- PERIMETER WELL
- PTF CLASS III WELL
- PROPOSED LOWER BASIN FILL UNIT (LBFU) CONTINGENCY WELL
- PROPOSED UPPER BASIN FILL UNIT (UBFU) CONTINGENCY WELL
- USDW MONITORING WELL
- ACD DEMONSTRATION WELL
- FAULT MONITORING WELL
- UNDERGROUND WORKING
- TOPOGRAPHIC CONTOUR, 10-FT INTERVAL
- 100 YEAR FLOOD PLAIN
- FAULT
- RESOURCE BLOCK
- PRODUCTION TEST FACILITY (PTF) WELLFIELD
- IN-SITU COPPER RECOVERY (ISCR) WELLFIELD
- AQUIFER EXEMPTION BOUNDARY
- PROPOSED AREA OF RECOVERY (AOR)/FORMER BHP AOR
- STATE MINERAL LEASE BOUNDARY
- FLORENCE COPPER PROPERTY BOUNDARY

NOTE

ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

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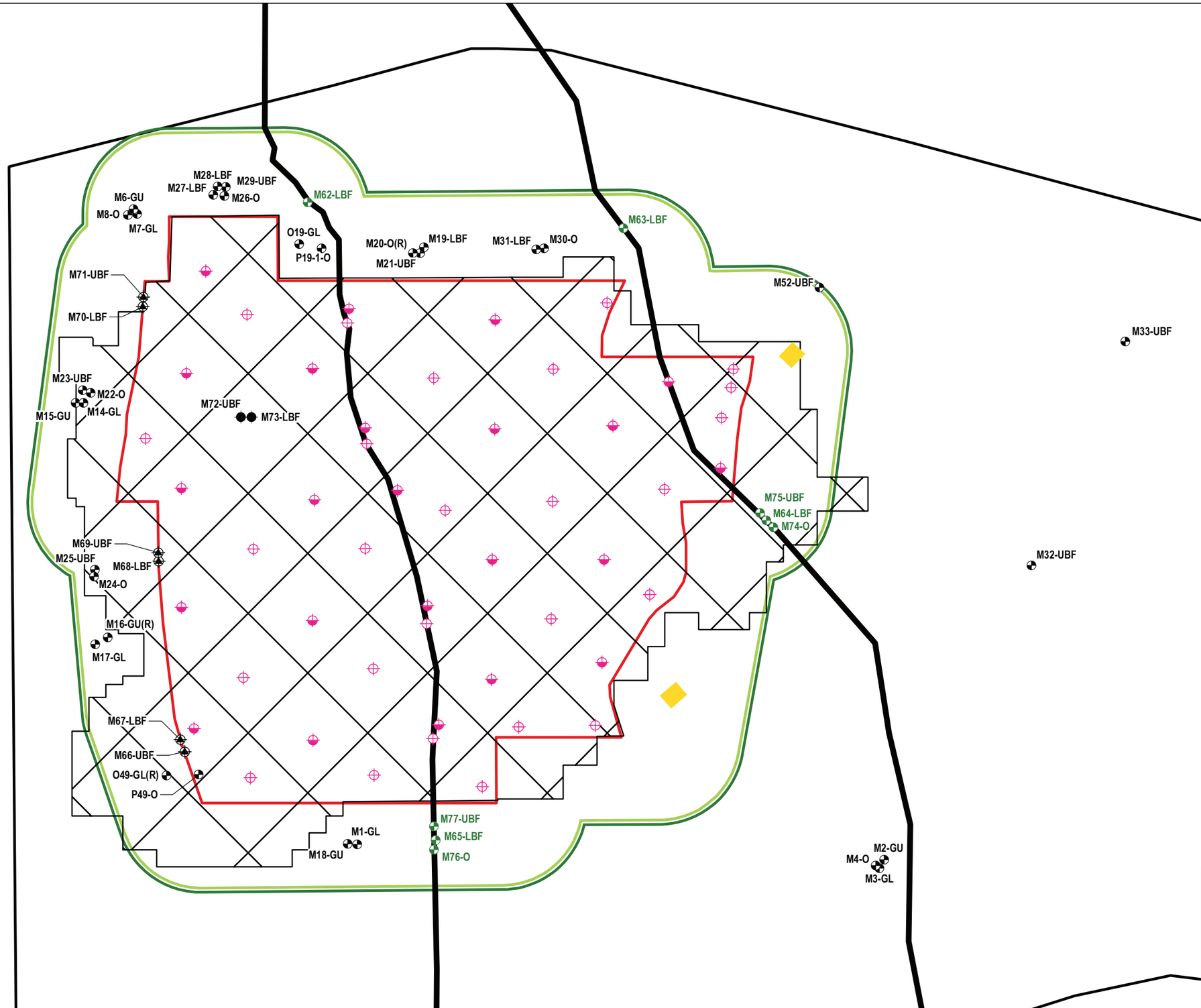
TYPICAL OBSERVATION AND PERIMETER WELL CONFIGURATION

FLORENCE COPPER

MARCH 2022

FIGURE C-4b

GIS FILE PATH: \\haleyaldrich\share\phx_common\Projects\Florence Copper\132473 Florence Groundwater Permitting\GIS\Maps\2021_09\132473_005_0C4b_TYPICAL_OBSERVATION_AND_PERIMETER_WELL.mxd — USER: khensen — LAST SAVED: 2/23/2022 11:37:05 AM



LEGEND

- PROPOSED LOWER BASIN FILL UNIT (LBFU) CONTINGENCY WELL
- PROPOSED UPPER BASIN FILL UNIT (UBFU) CONTINGENCY WELL
- UNDERGROUND SOURCE DRIKING WELL (USDW) MONITORING WELL
- ANNUAL CONDUCTIVITY DEVICE (ACD) DEMONSTRATION WELL
- FAULT MONITORING WELL
- POINT OF COMPLIANCE (POC) WELL
- FAULT
- IN-SITU COPPER RECOVERY WELLFIELD
- AQUIFER EXEMPTION BOUNDARY
- PROPOSED AREA OF RECOVERY (AOR)
- RESOURCE BLOCK
- FLORENCE COPPER PROPERTY BOUNDARY
- FUTURE WELL CLUSTER LOCATION

NOTE

ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.

N

0 600 1,200
SCALE IN FEET

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ACD CONTINGENCY
WELL LOCATIONS

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MARCH 2022

FIGURE C-4c

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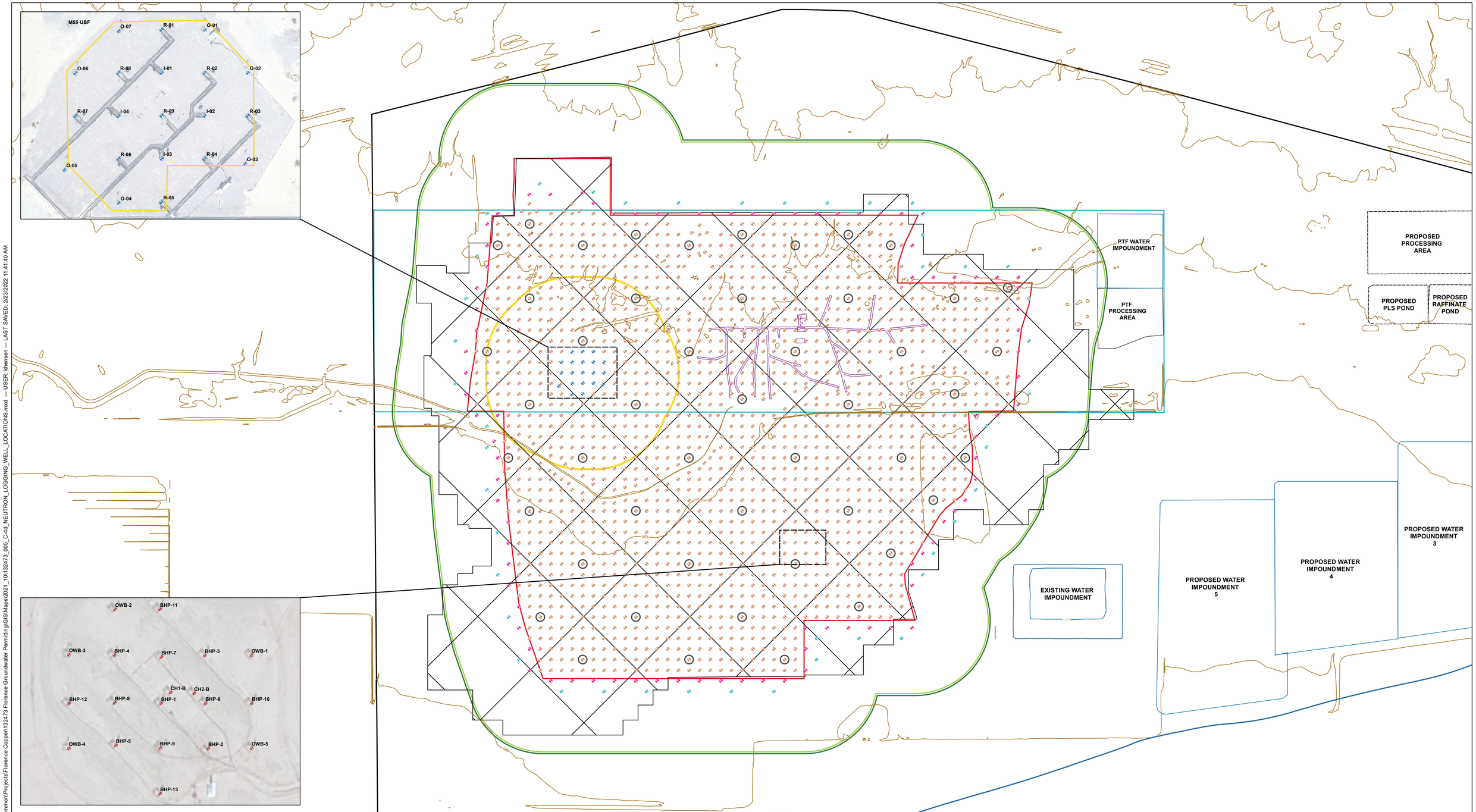

LEGEND

- BHP CLASS III WELL
- PTF CLASS III WELL
- PROPOSED INJECTION / RECOVERY WELL
- PROPOSED OBSERVATION WELL
- PROPOSED PERIMETER WELL
- NEUTRON LOG LOCATION
- UNDERGROUND WORKING
- 100 YEAR FLOOD PLAIN
- TOPOGRAPHIC CONTOUR, 10-FT INTERVAL
- RESOURCE BLOCK
- PROCESSING AREA
- PROPOSED WATER IMPOUNDMENT
- PTF WATER IMPOUNDMENT
- PRODUCTION TEST FACILITY (PTF) PROCESSING AREA
- IN-SITU COPPER RECOVERY (ISCR) WELL FIELD
- PROPOSED AREA OF RECOVERY (AOR) / FORMER BHP AOR
- AQUIFER EXEMPTION BOUNDARY
- STATE MINERAL LEASE BOUNDARY
- PTF AOR BOUNDARY
- FLORENCE COPPER PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. TOPOGRAPHIC CONTOUR DATA SOURCE: FLORENCE COPPER, OCTOBER 2010

N

0 300 600 900 1,200
SCALE IN FEET

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NEUTRON LOGGING LOCATIONS

FLORENCE COPPER

MARCH 2022

FIGURE C-4d

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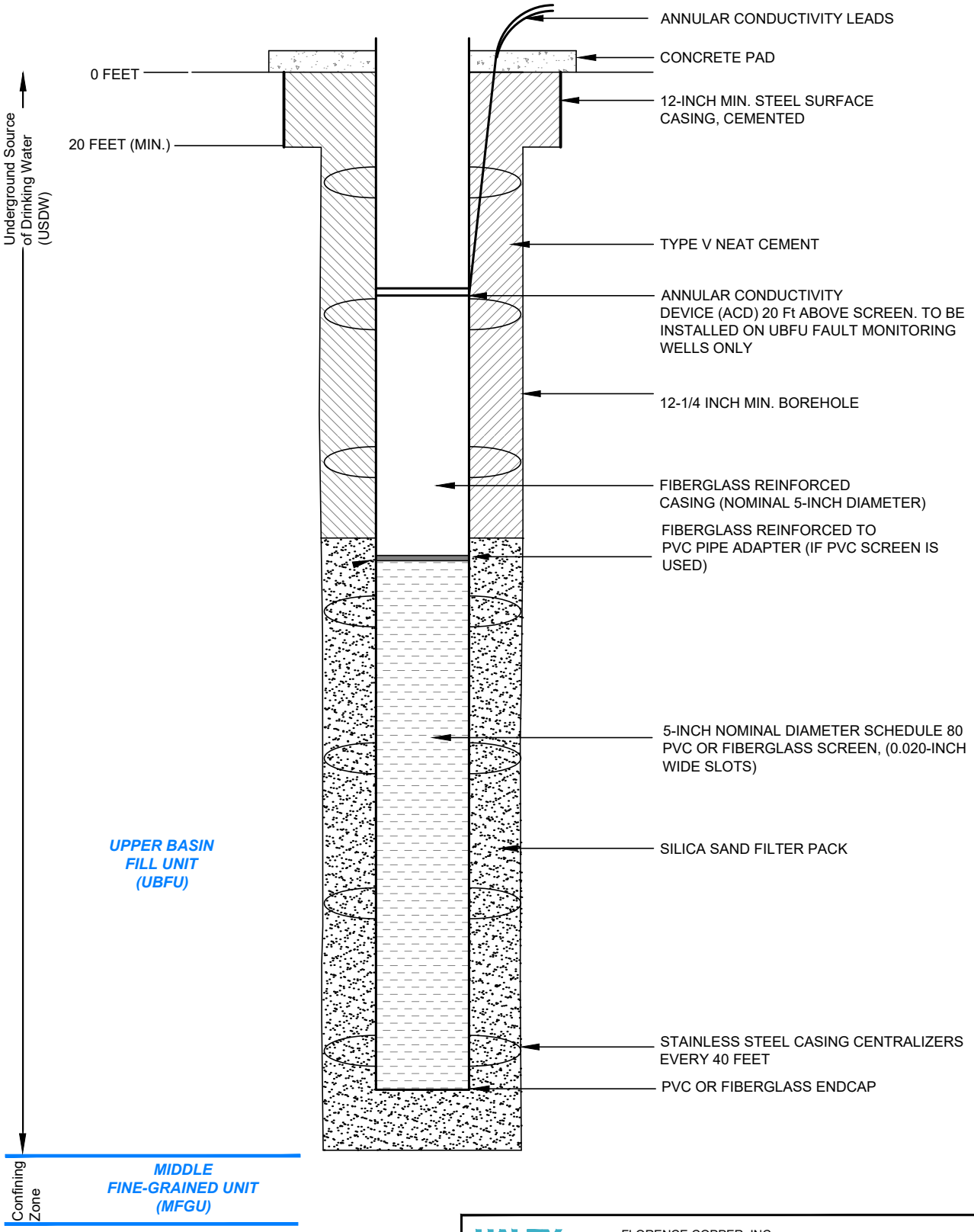

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UBFU MONITORING WELL CONSTRUCTION DIAGRAM

SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-5

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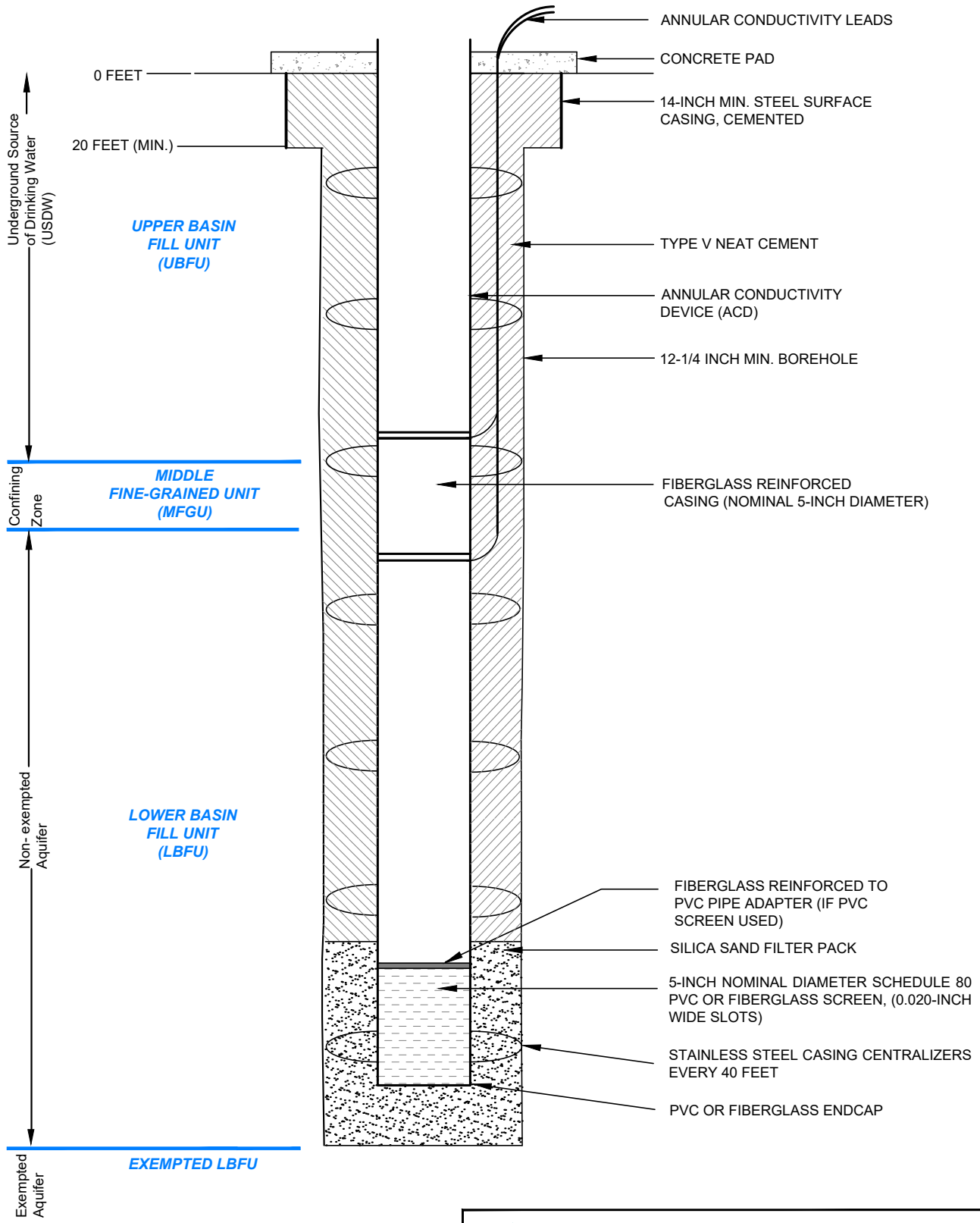
\\HALEYALDRICH.COM\SHARE\PHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\WORKING\101704 SIGNIFICANT AMENDMENT\CAD\WELL DIAGRAMS\132473-002_0002-9-3.DWG



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LBFU USDW MONITORING WELL CONSTRUCTION DIAGRAM

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SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-6

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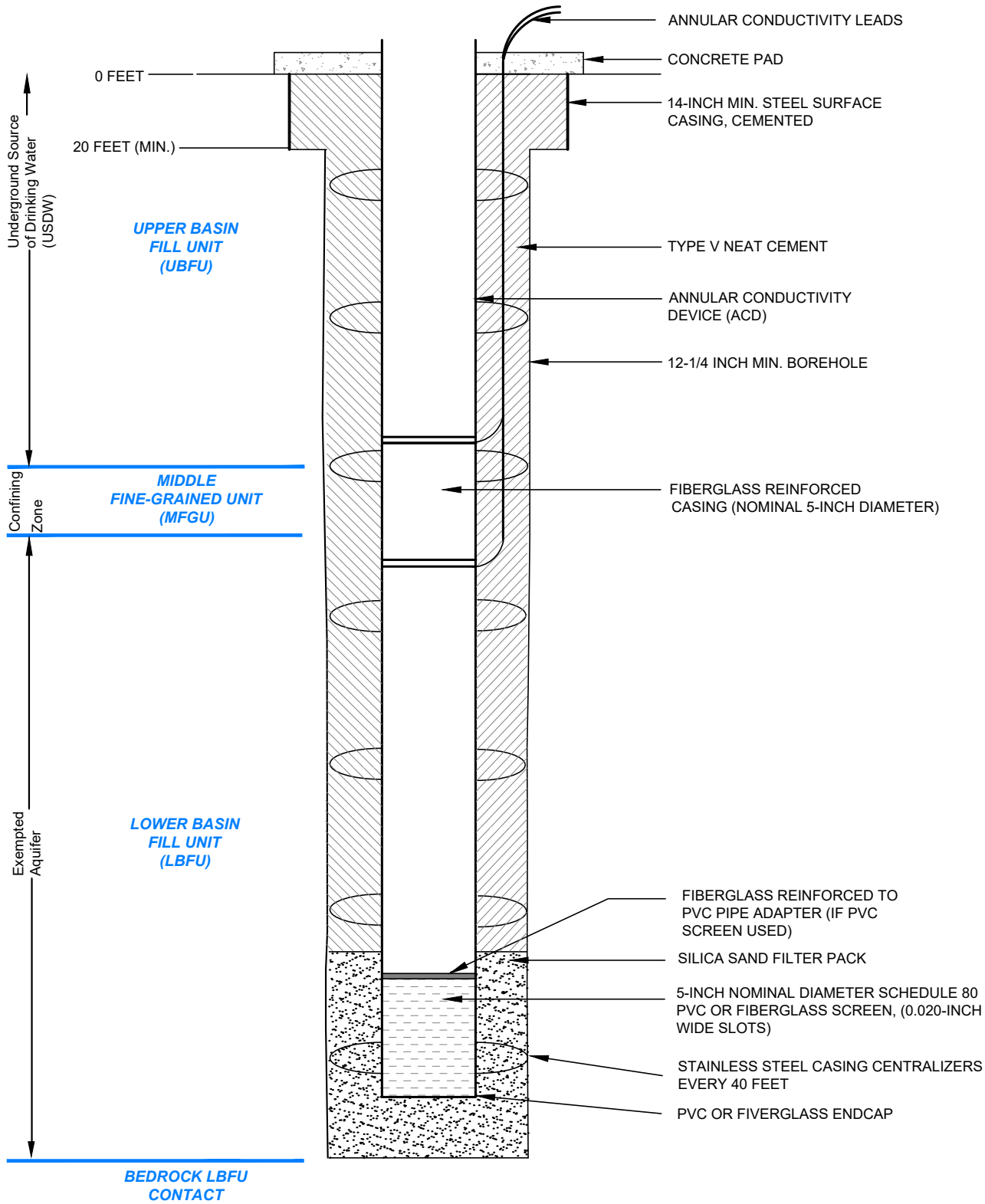

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LBFU FAULT MONITORING WELL CONSTRUCTION DIAGRAM

FLORENCE COPPER

SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-7

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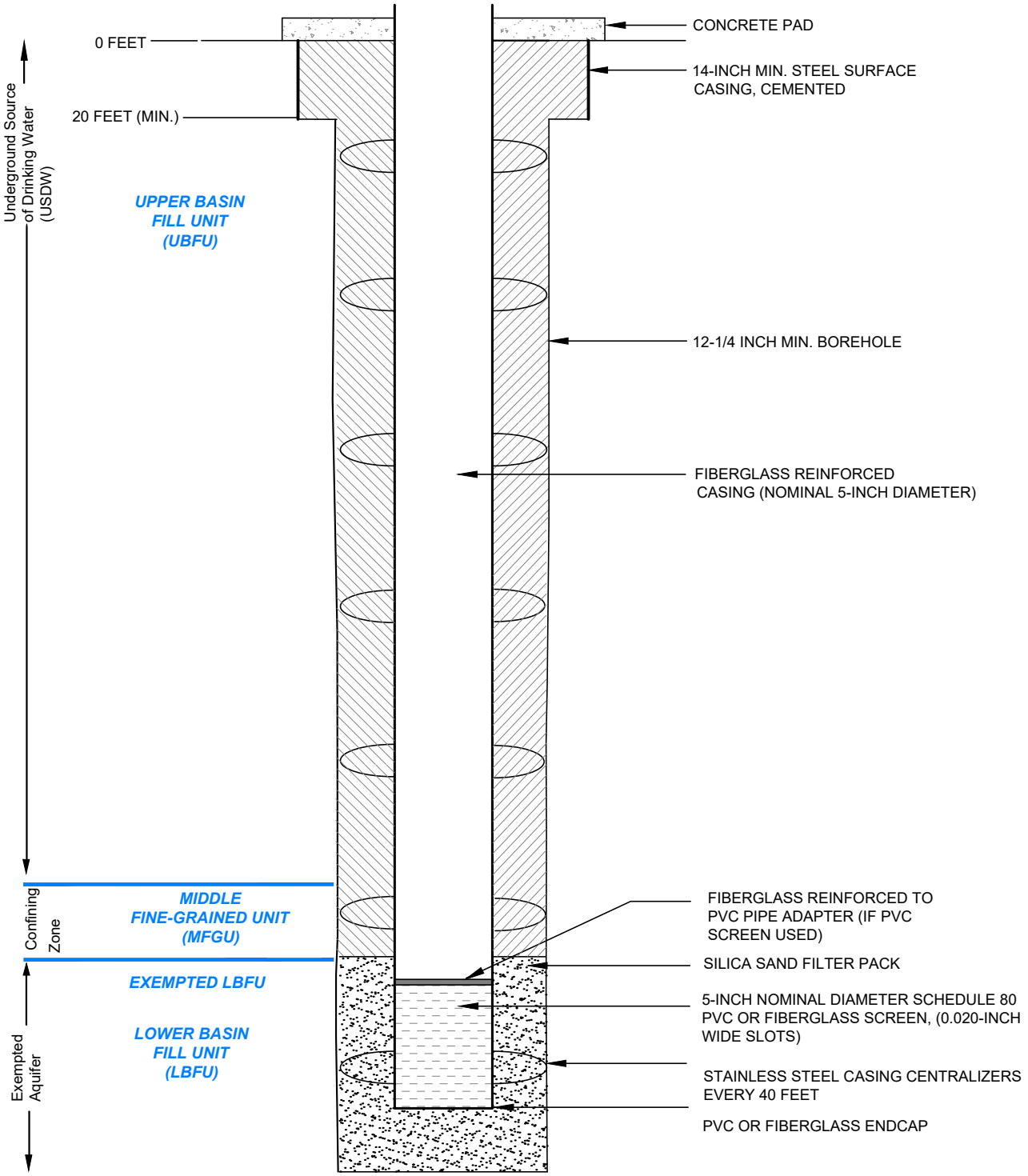

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LBFU ACD CONTINGENCY MONITORING WELL CONSTRUCTION DIAGRAM

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SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-8

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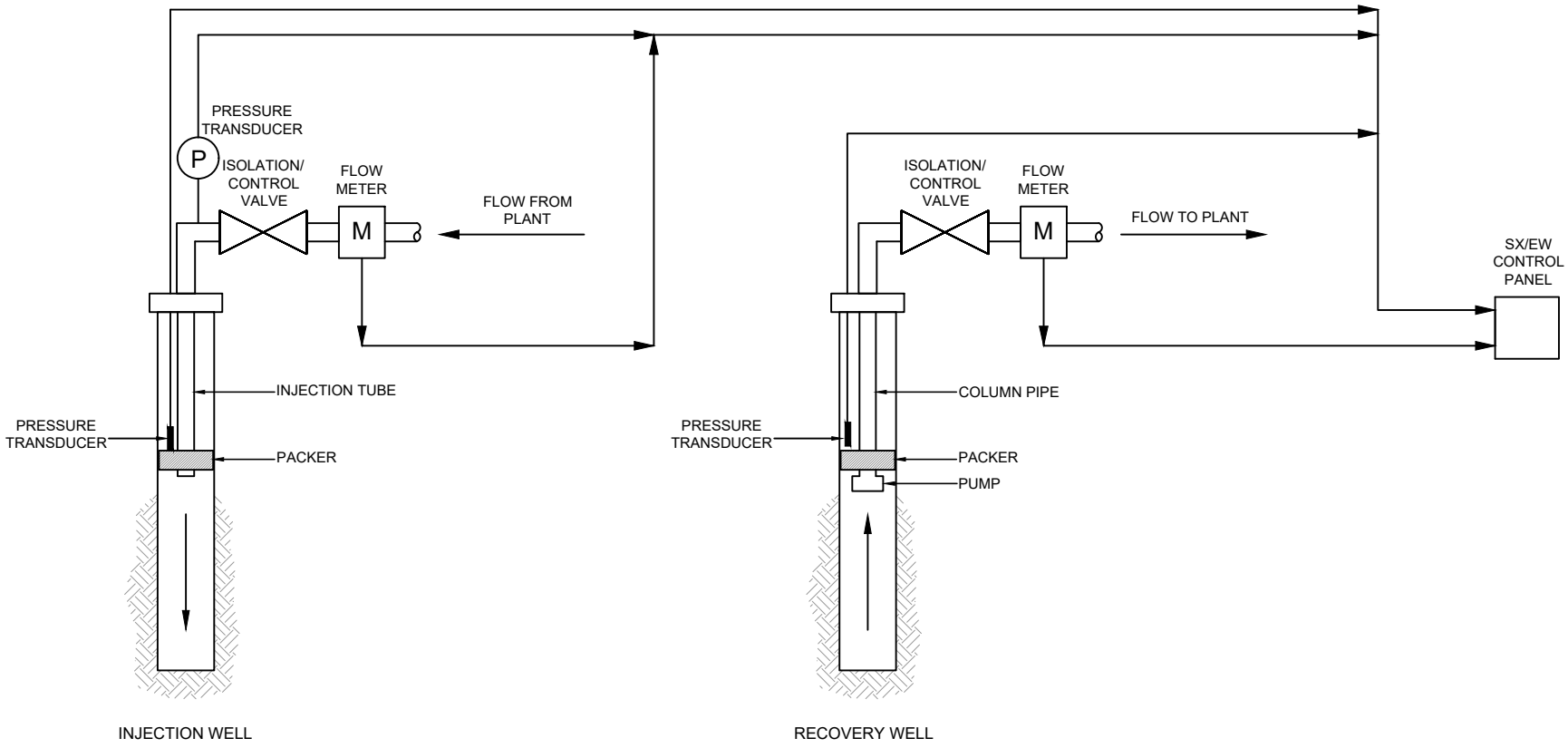

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INJECTION / RECOVERY WELL SYSTEMS CONTROLS

FLORENCE COPPER

SCALE: AS SHOWN
OCTOBER 2021

FIGURE C-9

EXHIBIT C-1

PTF Annular Conductivity Data

EXHIBIT C-1

PTF ANNULAR CONDUCTIVITY DATA

Date	Well ID (HGI)	Well ID (Florence Copper)	Time	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-WB-04	WB-04	1725	61.57	61.61	61.35	PASS	61.50
12/20/2018	JB-WB-04	WB-04	1355	61.8	61.8	61.54	PASS	61.70
4/4/2019	JB-WB-04	WB-04	1238	61.71	61.74	61.57	PASS	61.7
5/2/2019	JB-WB-04	WB-04	1456	62.25	62.3	62.15	PASS	62.2
7/10/2019	JB-WB-04	WB-04	1237	62.12	62.21	62.13	PASS	62.2
10/3/2019	JB-WB-04	WB-04	1221	62.17	62.342	62.314	PASS	62.3

Date	Well ID (HGI)	Well ID (Florence Copper)	Time	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-WB-03	WB-03	1731	76.04	76.57	76.54	PASS	76.40
12/20/2018	JB-WB-03	WB-03	1353	76.13	76.51	76.41	PASS	76.40
4/4/2019	JB-WB-03	WB-03	1248	76.2	76.61	76.59	PASS	76.5
5/2/2019	JB-WB-03	WB-03	1450	76.58	76.85	76.82	PASS	76.8
7/10/2019	JB-WB-03	WB-03	1241	76.45	76.61	76.6	PASS	76.6
10/3/2019	JB-WB-03	WB-03	1226	76.168	76.333	76.403	PASS	76.3

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-WB-02	WB-02	65.54	66.61	66.99	PASS	66.40
12/20/2018	JB-WB-02	WB-02	70.25	71.34	71.57	PASS	71.10
4/4/2019	JB-WB-02	WB-02	73.71	74.93	74.92	PASS	74.5
5/2/2019	JB-WB-02	WB-02	75.31	76.14	75.97	PASS	75.8
7/10/2019	JB-WB-02	WB-02	76.77	77.66	77.3	PASS	77.2
10/3/2019	JB-WB-02	WB-02	77.909	78.754	78.404	PASS	78.4

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-WB-01	WB-01	51.94	51.07	50.88	PASS	51.30
12/20/2018	JB-WB-01	WB-01	52.22	51.61	51.25	PASS	51.70
4/4/2019	JB-WB-01	WB-01	52.42	51.76	51.44	PASS	51.9
5/2/2019	JB-WB-01	WB-01	51.92	51.26	50.95	PASS	51.4
7/10/2019	JB-WB-01	WB-01	52.21	51.37	51.04	PASS	51.5
10/3/2019	JB-WB-01	WB-01	47.764	47.531	47.432	PASS	47.6

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-01	O-01	56.25	55.14	54.78	PASS	55.40
12/20/2018	JB-B-01	O-01	57.7	57.11	56.7	PASS	57.20
4/4/2019	JB-B-01	O-01	57.33	57.59	57.59	PASS	57.5
5/2/2019	JB-B-01	O-01	60.3	59.69	59.46	PASS	59.8
7/10/2019	JB-B-01	O-01	61.63	61.05	60.87	PASS	61.2
10/3/2019	JB-B-01	O-01	63.112	62.552	62.389	PASS	62.7

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-07	O-07	52.49	51.65	51.29	PASS	51.80
12/20/2018	JB-B-07	O-07	53.23	52.49	52.2	PASS	52.60
4/4/2019	JB-B-07	O-07	53.9	53.09	52.83	PASS	53.3
5/2/2019	JB-B-07	O-07	54.12	53.42	53.11	PASS	53.6
7/10/2019	JB-B-07	O-07	55.29	54.44	54.15	PASS	54.6
10/3/2019	JB-B-07	O-07	54.682	53.933	53.661	PASS	54.1

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-06	O-06	59.94	59.36	59.16	PASS	59.50
12/20/2018	JB-B-06	O-06	59.97	59.21	58.91	PASS	59.40
4/4/2019	JB-B-06	O-06	59.52	58.52	58.15	PASS	58.7
5/2/2019	JB-B-06	O-06	59.52	58.46	57.92	PASS	58.6
7/10/2019	JB-B-06	O-06	59.48	58.16	57.58	PASS	58.4
10/3/2019	JB-B-06	O-06	58.679	57.166	56.644	PASS	57.5

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-05	O-05B	77.95	77.65	77.57	PASS	77.70
12/20/2018	JB-B-05	O-05B	79.13	78.74	78.66	PASS	78.80
4/4/2019	JB-B-05	O-05B	81.43	80.96	80.78	PASS	81.1
5/2/2019	JB-B-05	O-05B	82.02	81.49	81.25	PASS	81.6
7/10/2019	JB-B-05	O-05B	83.37	82.74	82.47	PASS	82.9
10/3/2019	JB-B-05	O-05B	84.221	83.605	83.311	PASS	83.7

EXHIBIT C-1

PTF ANNULAR CONDUCTIVITY DATA

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-04	O-04	59.92	59.84	59.85	PASS	59.90
12/20/2018	JB-B-04	O-04	59.69	59.36	59.28	PASS	59.40
4/4/2019	JB-B-04	O-04	59.46	58.92	58.78	PASS	59.1
5/2/2019	JB-B-04	O-04	59.46	58.75	58.6	PASS	58.9
7/10/2019	JB-B-04	O-04	58.66	57.65	57.37	PASS	57.9
10/3/2019	JB-B-04	O-04	57.721	56.476	56.071	PASS	56.8

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-03	O-03	46.88	46.22	45.97	PASS	46.40
12/20/2018	JB-B-03	O-03	48.05	47.37	47.03	PASS	47.50
4/4/2019	JB-B-03	O-03	48.81	47.98	47.55	PASS	48.1
5/2/2019	JB-B-03	O-03	49.15	48.28	47.78	PASS	48.4
7/10/2019	JB-B-03	O-03	49.66	48.65	48.11	PASS	48.8
10/3/2019	JB-B-03	O-03	50.043	49.127	48.624	PASS	49.3

Date	Well ID (HGI)	Well ID (Florence Copper)	1 Resistance (Ω)	2 Resistance (Ω)	3 Resistance (Ω)	Data Acceptance	Resistance Stats Field Average
9/21/2018	JB-B-02	O-02	57.37	57.26	57.1	PASS	57.20
12/20/2018	JB-B-02	O-02	58.92	58.72	58.51	PASS	58.70
4/4/2019	JB-B-02	O-02	60.7	60.6	60.34	PASS	60.5
5/2/2019	JB-B-02	O-02	61.5	61.37	61.09	PASS	61.3
7/10/2019	JB-B-02	O-02	62.15	62.14	61.86	PASS	62.1
10/3/2019	JB-B-02	O-02	62.582	62.633	62.408	PASS	62.5

Attachment D
Injection Operation and Monitoring Program
(40 CFR §§ 146.33 & 146.34)
Application for Class III Underground Injection Control Permit

Florence Copper Project
Florence Copper Inc.

October 2019
Revised June 2020

HALEY ALDRICH

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List of Exhibits

Exhibit No.	Title
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D-2	ISCR Facility Operations Plan (Monitoring and Response Requirements)
D-3	Technical Memorandum: Florence ISCR Project - Process Fluids and Solids Chemistry Update (prepared by HydroGeoLogica, Inc.)
D-4	Formation Testing Report, Production Test Facility (prepared by Haley & Aldrich, Inc.)
D-5	Memorandum: Summary of Bulk Conductivity Monitoring Results, First Quarter 2019, Production Test Facility (prepared by Haley & Aldrich, Inc.)
D-6	APP Amendment Application Attachment 13, Technical Requirements – Contingency Plan
D-7	Attachments 12, 15, and 16 of Application to Amend APP No. P101704
D-8	Proposed Verification Wells Figure

Application for Class III Underground Injection Control Permit
Florence Copper Project

Attachment D: Injection Operation and Monitoring Program (40 CFR §§ 146.33 & 146.34)

D.1 INTRODUCTION

This Attachment describes the proposed injection operation and monitoring program.

This Attachment has been prepared in support of an application (Application) by Florence Copper, Inc. (Florence Copper) to the United States Environmental Protection Agency (USEPA) for an Underground Injection Control Class III (Area) Permit (UIC Permit) for the planned In-Situ Copper Recovery (ISCR) facility at the Florence Copper Project (FCP) in Pinal County, Arizona. With this Application, Florence Copper seeks authorization to construct and operate a commercial-scale ISCR facility at the FCP site. Florence Copper proposes to incorporate the pilot-scale Production Test Facility (PTF), which is currently operating under UIC Permit R9UIC-AZ3-FY11-1, into the planned commercial-scale ISCR facility at the FCP site.

D.2 INJECTION OPERATIONS

The FCP is a copper development project that will use the ISCR method to develop the Poston Butte copper deposit. Florence Copper proposes to construct and operate the planned ISCR facility over a 22-year period which includes on average 4 years of active leaching for each group of wells and a final rinsing phase of roughly 2 years. The FCP will occupy an area of approximately 1,342 acres that consists of two contiguous parcels of land. The land parcels consist of 1,182 acres held in fee simple ownership and 160 acres on Arizona State Trust Lands under Arizona State Mineral Lease 11-26500.

The planned ISCR process involves injecting raffinate (approximately 99.5 percent water mixed with 0.5 percent sulfuric acid) through injection wells into the oxide zone of the bedrock beneath the site for the purposes of dissolving copper minerals from the ore body. The estimated injection zone is between approximately 500 feet below ground surface (bgs) to 1,185 feet bgs. The resulting copper-bearing solution will be pumped by recovery wells to the surface where copper will be removed from the solution in a solvent extraction electro-winning (SX/EW) plant. The barren solution from the SX/EW plant will be re-acidified and re-injected back into the oxide zone.

Florence Copper has constructed and is currently operating a pilot-scale ISCR facility referred to as the PTF under the terms of UIC Permit R9UIC-AZ3-FY11-1 and Aquifer Protection Permit (APP) Permit No. P-106360. Florence Copper has requested that the PTF discharging facilities, and associated monitoring requirements, be incorporated into the site-wide APP No. P-101704 to facilitate commercial-scale ISCR operations. Florence Copper herein requests a UIC Permit to authorize ISCR operations at the planned commercial-scale ISCR wellfield.

The anticipated timeframe required to recover the soluble copper from each resource area is on average 4 years. As currently authorized under APP No. P-106360 and UIC Permit R9UIC-AZ3-FY11-1, the PTF wellfield may be operated for 1 year, with an additional 1-year potential extension. This schedule will

require that ISCR operations stop before the soluble copper is fully recovered from the PTF ISCR wells, and that formation rinsing and neutralization commence. As full-scale ISCR operations progress at the FCP, if authorized by the amended APP No. P-101704 and new UIC Permit, Florence Copper would then need to re-initiate ISCR operations at the PTF wellfield by re-acidifying the formerly rinsed and neutralized PTF injection and recovery area. This process would waste water, energy, reagents, and mineral resource. Consequently, Florence Copper proposes to incorporate the PTF facilities into APP No. P-101704, and continue operating them, including the PTF wellfield, under terms of the amended APP No. P-101704 and new UIC Permit, to conserve water and other resources.

The PTF facilities have been in operation since December 2018. Approximately 138.5M gallons of leach solution has been injected with approximately 156M gallons of solution recovered, representing an over-pumping rate of approximately 113 percent. Resulting copper production in the SX/EW pilot plant is approximately 220 tons of copper cathode through mid-February 2020. The pilot wellfield and SX/EW plant as of March 2020 is operating at the projected production rate of approximately 1M pounds per year.

Operation of the PTF has led to the development of refined pumping and injection strategies to accelerate the initial phases of solution contacting with the formation. These strategies prevent formation of mineral precipitates, while accelerating development of mature leaching solutions. The PTF pilot wellfield has produced a commercial grade PLS from the center recovery well for approximately 10 months.

D.2.1 ISCR Area

The ISCR area occupies approximately 212 acres on the western side of the FCP site, and includes the same area identified as the “mine zone” in the aquifer exemption that USEPA granted on May 1, 1997 in conjunction with issuing UIC Permit AZ39600001. The ISCR area is the same area formerly authorized by UIC AZ39600001 for conducting ISCR operations to recover soluble copper. The oxidized portion of the Poston Butte ore body is the upper portion of the bedrock beneath the site which contains soluble copper oxide minerals and is more than 350 feet bgs. The location of the ISCR wellfield is shown on Figure D-1.

The lateral boundary of the area for which the USEPA granted the aquifer exemption extends 500 feet beyond the ISCR area. The aquifer exemption is described in Attachment H of this Application and is shown on Figure D-1. The FCP site includes portions of Sections 26, 27, 28, 33, 34, and 35, Township 4 South, Range 9 East, Gila and Salt River Base and Meridian. A 160-acre portion of the site in Section 28 is leased from the State of Arizona under Mineral Lease No. 11-26500.

D.2.2 ISCR Wellfield

The 212-acre ISCR area has been divided into operational units for planning purposes. The size of the units vary to accommodate site features, resource cutoff boundaries, and administrative boundaries. The size and orientation of the operational units may be altered in the future as necessary to accommodate planning changes and operational conditions. Each well installed in the ISCR area will be constructed according to a standard design so that it can serve multiple purposes during the life of the

facility. ISCR wells will be used for injection, recovery, observation, or perimeter hydraulic control. Well construction procedures and design details are described in Attachment C of this Application.

The injection and recovery wells will be arranged in a five-spot pattern (operational unit) that effectively surrounds each injection well with four recovery wells. The pattern will be repeated throughout the ISCR area. Approximately 2,200 Class III injection and recovery wells and 300 perimeter and observation wells may be installed and closed at the FCP site over the course of the estimated 22-year project life. Operational units will be developed, operated, and closed as per the operating plan. During operations, one group of operational units will be in operation while others are undergoing development or closure.

Multiple operational units will be operated at one time to ensure fluid injection and recovery rates are at the nominal design capacity of the planned commercial-scale SX/EW plant (approximately 11,000 gallons per minute [gpm]). The number of wells operating at one time will depend on the flow characteristics and thickness of the oxide zone where ISCR operations are being conducted.

The primary operational mechanism for preventing the migration of in-situ solutions (or "fluid" as defined at 40 Code of Federal Regulations [CFR] 146.3) to underground sources of drinking water (USDW) is hydraulic control. ISCR operations will be conducted to ensure that hydraulic control is maintained at all times in all portions of the oxide zone undergoing injection and recovery. Hydraulic control will be maintained from the time that injection commences until after all economically recoverable copper has been extracted and groundwater has been restored to a quality that meets criteria specified in the APP and the UIC Permit. Hydraulic control is achieved when the amount of solution and groundwater pumped from the wellfield during each 24-hour period exceeds the amount of raffinate injected. This will be accomplished by pumping the recovery wells at a rate that is at least 106 percent of the rate of injection. The methods and equipment used to monitor hydraulic control are described below in Section D.4.

Florence Copper maintained hydraulic control throughout the period of time that the PTF has been in operation. Successful hydraulic control is indicated by criteria established in UIC R9UIC-AZ3-FY11-1, Part E. The criteria are listed in Part E.1.a-d. The criteria are: 110 percent of the of the injected volume must be extracted from the injection and recovery zone, an inward gradient of at least 1-foot must be maintained between observation and recovery wells, bulk electrical conductivity measurements must be conducted, and actions must be taken to correct any loss of hydraulic control within 24 hours. These criteria provide objective physical indicators that hydraulic control has been maintained.

The purpose of the 110 percent criterion is to ensure that a cone of depression is formed at the PTF wellfield, inducing inward flow of groundwater from the surrounding formation. This criterion is fundamental to the maintenance of hydraulic control during injection operations. Section G.2.b of UIC R9UIC-AZ3-FY11-1 requires that Florence Copper report the daily injected and recovered volumes to the USEPA on a quarterly basis as a demonstration that hydraulic conductivity has been maintained daily.

The purpose of 1-foot differential criterion is to demonstrate an inward flow of groundwater from the surrounding formation. Section G.2.c of UIC R9UIC-AZ3-FY11-1 requires that Florence Copper report the daily average head measurements in the recovery and observation wells to the USEPA on a quarterly basis as an additional demonstration that hydraulic control has been maintained daily.

The purpose of the bulk conductivity monitoring is to demonstrate injected fluid has not migrated above the injection and recovery zone. Section G.2.c of UIC R9UIC-AZ3-FY11-1 requires that Florence Copper report the bulk conductivity monitoring results on a quarterly basis as an additional demonstration that hydraulic control has been maintained daily.

Florence Copper has submitted quarterly reports for Q4 2018, and Q1 through Q4 2019, which show that hydraulic control criteria described above have been met during PTF operations.

The PTF was designed at the same scale as the planned commercial ISCR wellfield. This design was selected to specifically test selected performance criteria that would be applied to the commercial scale wellfield. The PTF wellfield includes wells installed at the same spacing, depth, screened interval, and pumping rates as the planned commercial wellfield. Hydraulic control was one of the specific criteria tested at the PTF wellfield. Because the PTF wellfield was designed at the same scale as the planned commercial wellfield, the successful demonstration of hydraulic control at the PTF wellfield indicates that hydraulic control can be maintained at the commercial wellfield using the same methodology applied at the PTF.

D.2.3 Facility Fluid Flow Diagrams

The planned permitted facilities include the ISCR injection and recovery wells, raffinate pond, pregnant leach solution (PLS) pond, run-off pond, and water impoundments. Additional support facilities will be constructed including the SX/EW plant, pipelines, tank farm, and associated structures. The ISCR wellfield will be developed in stages, with approximately 462 injection and recovery wells in operation or rinsing at one time. All injection, recovery, and observation wells within the wellfield area will be constructed to UIC Class III injection well standards.

Exhibit D-1 includes a technical memorandum describing fluid flow through the planned commercial-scale ISCR facility and fluid flow diagrams depicting the site water balance during both operations and rinsing stages of the planned project life cycle. The Process Flow Diagram (Exhibit D-1, Figure 6-1) shows the design components and associated flow streams for the operational phase of the planned ISCR process. Flow components for the rinsing phase of the planned ISCR process are shown in Exhibit D-1, Figure 6-2. The flow rates for each of the flow streams are summarized on the diagram and are discussed in further detail in the technical memorandum included in Exhibit D-1. All flow rates shown on the Process Flow Diagram are considered “nominal” flow rates and reflect anticipated full-scale ISCR operations.

D.2.4 Operations Plan

Florence Copper has prepared and submitted a revised operations plan in conjunction with the requested amendment of APP No. P-101704. The operations plan was originally developed in support of the 2014 UIC Permit application and was subsequently incorporated into Attachment E of UIC Permit R9UIC-AZ3-FY11-1. The operations plan was revised to reflect anticipated changes between PTF operations and the planned commercial-scale ISCR facility. The revised operations plan describes the use of the planned monitoring devices and prescribes actions to be taken in the event of a well failure to prevent the migration of contaminating fluids into a USDW. The revised operations plan is included in Exhibit D-2 of this Application. Figures C-5 and D-2 show the locations of wellfield monitoring devices referenced in the operations plan (Exhibit D-2).

D.3 OPERATING DATA

D.3.1 Rate and Volume of Fluid to be Injected

Florence Copper plans an average injection rate of approximately 0.15 gpm per foot (gpm/ft) of injection interval, and a maximum injection rate of approximately 0.20 gpm/ft of injection interval. Injection rates may be lower than the planned average based on the length of the final injection interval used and the location of packer placement. Typical injection rates may be as low as 0.10 gpm/ft of injection interval depending on oxide zone characteristics and packer configuration in each well. The aggregate injection and recovery rates at the ISCR wellfield will be carefully balanced to ensure that hydraulic control is maintained throughout the ISCR wellfield from the time that injection begins until the ISCR wellfield is closed in accordance with the requirements of the UIC Permit.

Injection rates in all wells must be proportionate to the length of the injection interval; consequently, the rate and daily volume of fluids injected may vary from well to well based on the length of the injection interval and characteristics of the oxide zone at each well site. Given the bedrock topography underlying and variable mineralization of the oxide zone beneath the planned 212-acre ISCR wellfield, it is anticipated that the thickness of the oxide zone and the resulting injection intervals will vary substantially from one end of the wellfield to the other. The rate of fluid injection in wells with longer injection intervals will be greater than the rate in wells with shorter injection intervals to maintain a consistent rate of flow through the oxide zone and to achieve the desired solution contact time. Table D-1 shows the potential range of injection rates and daily fluid volumes based on the characteristics of the oxide zone.

The planned nominal aggregate injection rate for the ISCR wellfield is 11,000 gpm. The maximum aggregate injection rate proposed for full-scale ISCR operations is 12,650 gpm, and the maximum extraction rate is equal to the planned injection rate plus the additional 6-percent extraction required to maintain hydraulic control. The maximum ISCR solution extraction rate is 12,650 gpm and the corresponding maximum hydraulic control extraction is 815 gpm, for a total withdrawal of 13,465 gpm. The minimum ratio between injection and recovery will be 106 percent.

The ISCR wells will be constructed with multiple injection intervals separated by sections of blank well casing that will allow packer assemblies to be used to focus injection into targeted intervals of the injection zone. Both injection and recovery wells may be operated without packers. Typical flow rates into each injection well is anticipated to be approximately 60 gpm. Variation in oxide zone characteristics may require some wells to be operated at rates lower or higher than 60 gpm. In all cases, the aggregate injection rate will be balanced to ensure that no more than 12,650 gpm is injected. The values presented in Table D-1 reflect potential injection rates for a variety of well configurations which may be applied to compensate for oxide zone characteristics.

D.3.2 Average and Maximum Injection Pressure

Each of the planned injection and recovery wells will be completed to Class III injection well standards and will be individually designed for the site-specific depth and thickness of the oxide zone at the well location. Because injection pressures are calculated based on the distance from the top of the well

casing to the top of the injection interval, variations in well construction depth will in turn result in variation of the average and maximum injection pressures at each well. The calculated average and maximum injection pressures, therefore, will be specific to each of the planned wells. Each well will be constructed to ensure that the injection interval is at least 40 feet below the top of the oxide zone but spans the remainder of the oxide zone below. Based on available formation thickness data, a representative range of injection pressures have been calculated for planned injection wells at the proposed commercial-scale ISCR wellfield injection wells and are presented in Table D-2. The calculated injection pressures listed in Table D-2 reflect the anticipated minimum and maximum depths to the top of the injection zone based on available data and potential variations in well design.

Typical injection and recovery wells may include one or more injection intervals ranging in length between 190 and 860 feet. The injection pressures presented herein are calculated by multiplying the depth from the top of well casing to the top of the injection interval by a pre-determined factor that is designed to moderate injection pressures and prevent hydraulic fracturing of the formation.

D.3.2.1 Average Injection Pressure

Average injection pressures are calculated as a function of the dynamic elevation of the column of injectate standing above the top of the injection interval during ISCR operations. For the purposes of estimating the average injection pressure, it is assumed that the dynamic elevation of the injected fluid is equal to the elevation of the well head, and that no additional mechanical pressure is applied. Based on operational experience at the PTF wellfield, this assumption is conservative because each of the PTF injection wells is able to achieve the desired flow rates without the application of additional pressure at the well head. Each of the PTF injection wells has been able to sustain appropriate injection rates with well head pressure equal to atmospheric pressure and gravity flow. Similarly, BHP Copper Inc. (BHP Copper) reported that injection during the hydraulic control test conducted in 1997 was also accomplished under atmospheric pressure and gravity flow conditions as well.

Typical groundwater exerts a pressure equivalent to approximately 0.43 pounds per square inch per foot (psi/ft) of depth. Although composed primarily of water, injectate also includes sulfuric acid and dissolved minerals that will increase the density by an estimated 5 percent. Consequently, the injectate solution is estimated to exert a pressure equal to approximately 0.45 psi/ft of depth. This is the value used to calculate the average injection pressures at the top of each injection interval.

Average injection pressures are calculated by multiplying the depth to the top of the injection interval from the top of well casing by 0.45 psi/ft. This method reflects a well head pressure that is equal to atmospheric pressure, while the well casing is flooded with injectate. The pressure generated at the top of the injection interval results solely from the weight of the column of injectate with no additional mechanical pressure applied. Examples of average injection pressures at selected depths representative of the top of potential injection intervals are included in Table D-2.

D.3.2.2 Maximum Injection Pressure

Formation testing conducted in 1995 by BHP Copper determined a minimum fracture gradient of approximately 0.71 psi/ft for rock within the oxide zone. To ensure that injection pressures did not

induce additional fracturing of the oxide zone, UIC AZ396000001 issued to BHP Copper for the FCP in 1997 established a fracture gradient limit of 0.65 psi/ft. This fracture gradient value is included as the injection pressure limitation in UIC R9UIC-AZ3-FY11-1. Florence Copper proposes to continue use of the 0.65 psi/ft fracture gradient as the injection pressure limitation and to determine the maximum injection pressure for each injection well.

Maximum injection pressures are determined by multiplying the fracture gradient limit (0.65 psi/ft) by the depth from the top of well casing to the top of the injection interval. This method of calculating maximum injection pressures reflects the pressure generated by the weight of the column of raffinate and an additional pressure applied by mechanical means to achieve the maximum allowable injection pressure at depth.

As described above, packer assemblies may be used to focus injection in targeted areas of the injection zone. Because operational injection pressures are calculated to the top of each injection interval, the length of the interval does not affect the calculated injection pressures. Consequently, if multiple injection intervals are used, the injection pressure will be calculated at the top of the combined interval.

Example average and maximum injection pressures at selected depths representing the top of potential injection intervals and the corresponding maximum well head pressures are included in Table D-2. The calculated injection pressures listed in Table D-2 reflect the anticipated variable depths to the top of the injection zone based on available data and potential variations in well design.

D.3.3 Annular Fluid

Annular fluid is the fluid that exists between the injection pipe and the interior of the well casing. Over the operational life of a Class III injection well at the FCP site, the nature of the annular fluid in a given well will vary between native groundwater from the oxide zone, raffinate solution, and PLS. The estimated composition of native groundwater and the forecast compositions of raffinate solution are presented in Exhibit D-3. Exhibit D-3 is discussed further below under Section D.3.5.

The proposed Class III injection wells may be operated in one of two modes: pressurized at the well head, or under atmospheric well head pressures. In either mode an injection pipe will be used with or without a packer installed depending on operational conditions. The nature of the annular fluid under each of these injection conditions is described below.

D.3.3.1 Pressurized Injection

Under pressurized operation, an injection pipe and packer assembly will typically be used to isolate and focus injection into a targeted injection interval. The packer assembly will include packer(s) placed at the top and bottom (if required) of the injection interval. Depending on operational conditions the packer may be deflated or removed altogether. For new wells, the well will contain only native groundwater at startup and when the packer assembly is inflated, native groundwater will be trapped in the annulus above the uppermost packer.

After operations have commenced, the packer assembly may periodically be deflated so the assembly can be moved between injection intervals within the injection zone. Deflation and moving of the packer assembly will result in incidental mixing of the native groundwater from the oxide zone, initially trapped above the packer, with the raffinate until eventually the composition of the annular fluid reflects raffinate.

D.3.3.2 Injection at Atmospheric Well Head Pressures

During injection at atmospheric well head pressure conditions, raffinate will be introduced to the well through injection tubing that discharges below the static fluid level in the well. Groundwater will not be isolated above a packer assembly. Operation under atmospheric well head pressure will flood the annulus with raffinate for the entire length of the well at the commencement of operations and will maintain that condition throughout the period of injection.

D.3.3.3 Recovery Wells

All wells used for recovering PLS will be constructed to Class III well standards. Annular fluid within new recovery wells will initially be oxide zone groundwater. As injection begins and fluids are recovered from the injection zone and pumped back to the surface, the annulus of the recovery wells will be flooded with PLS at atmospheric pressure.

D.3.4 Anticipated Changes Resulting from Injection

D.3.4.1 Changes in Pressure

During the planning and permitting process for the PTF, Florence Copper prepared a groundwater model to simulate the change in formation fluid pressure resulting from injection and recovery operations at the PTF wellfield. The principal focus of the modeling effort was to determine how high injected fluids might rise under operational conditions. Because the PTF wellfield represents one full-scale, five-spot well block of the same spacing, depth, and flow rate planned for the commercial-scale ISCR operation, the modeling conducted to simulate pressure changes at the PTF wellfield is representative of a five-spot well block within the planned commercial-scale ISCR area. The model simulation results were reported in Attachment N of the UIC Permit application submitted in July 2014.

The model results indicated a pressure differential of approximately 16.5 psi, equivalent of a head change of 38 feet between the injection and recovery wells over a distance of 71 feet. These results indicate that the water level can be expected to rise at the injection well by approximately 19 feet and draw down at the recovery wells by approximately 19 feet. These modeling results showed that mounding of the injected fluid, if any were to occur, would be contained within the 40-foot-thick exclusion zone. Aquifer testing conducted at the PTF wellfield, subsequent to the modeling exercise, confirmed that the hydraulic parameters used in the groundwater model are representative of actual formation conditions. The pre-operational characterization report is included as Exhibit D-4.

Ongoing geophysical studies conducted at the PTF wellfield confirm that injected fluid has not mounded into the exclusion zone. Florence Copper has installed four bulk conductivity sensors at each of the seven observation wells (928 sensors in total) at the edge of the PTF wellfield and has collected weekly data since PTF operations began. The lowest of the conductivity sensors are placed at approximately the middle of the exclusion zone (approximately 20 feet above the injection zones) and are spaced at 20-foot intervals above that location. Weekly monitoring of the bulk conductivity sensors has not detected any vertical migration of injected fluid into the exclusion zone. These monitoring results represent direct measurement of vertical fluid migration and are consequently more relevant than the modeling results. Bulk conductivity monitoring indicates that there has been less mounding of the injected fluid than reflected by the earlier modeling results. The modeling results reflected potential mounding of approximately 19 feet. The lowest bulk conductivity sensor is placed approximately 20 feet above the injection zone. Bulk conductivity monitoring results showed no measured increase in conductivity, indicating that no mounding has reached the middle of the exclusion zone.

The combined model simulations and bulk conductivity analyses serve to demonstrate that under the planned injection and recovery conditions, the pressure change resulting from injection may be less than 8.2 psi (19 feet of mounding), and that the proposed 40-foot exclusion zone is adequate. Bulk conductivity monitoring data has previously been submitted to USEPA with quarterly monitoring reports for PTF operations and are provided herewith as Exhibit D-5.

D.3.4.2 Fluid Displacement

Native formation fluid within the oxide zone consists of groundwater residing in fractures and is of a quality generally suitable for irrigation and industrial uses. No drinking water wells exist within the oxide zone or the overlying alluvial sediments within the bounds of the aquifer exemption area. At the commencement of injection and recovery, native groundwater will be withdrawn from the fractures of the oxide zone through the recovery wells and be replaced with injected fluid. Consequently, at startup, displacement of native fluid will consist of extraction of native groundwater and subsequent replacement by injected fluid. The source of injected fluid is native groundwater withdrawn from the oxide zone, mixed with dilute sulfuric acid and re-injected into the oxide zone.

Injection and recovery rates will be closely balanced to ensure full recovery of the injected fluid. The aggregate recovery rate will be higher than the aggregate injection rate to ensure that more fluid is withdrawn than is injected, and to maintain the necessary inward hydraulic gradient during ISCR operations and formation rinsing. Because injection and recovery rates will be closely balanced, net groundwater extraction within the ISCR area will consist of the amount of groundwater pumped to maintain hydraulic control. During ISCR operations, this volume of water will nominally be approximately 660 gpm, when the full 11,000 gpm production capacity of the SX/EW plant is attained. During ISCR operations, withdrawal of the approximate net 660 gpm of fluid will be distributed across the active portion of the ISCR wellfield.

The inward hydraulic gradient will cause groundwater to flow toward the active portion of the ISCR wellfield facility from the surrounding formation. Consequently, displacement of native fluid by ISCR operations will be toward the ISCR wellfield.

D.3.4.2.1 Effects of Faults on Native Fluid Displacement

The Bedrock Oxide Zone is an extensively fractured mass of granodiorite and quartz monzonite. The fracturing is the result of regional scale extensional tectonic stresses that effectively pulled the rock mass apart, creating a series of faults and related fracturing throughout the rock mass. The difference between the observed faults and other fracturing is the noted evidence of displacement (i.e., slickensides, fault gouge, or observable offset). Fractures that do not show evidence of displacement are not logged as faults, while fractures that show evidence of displacement are logged as faults. Consequently, the mapped faults consist of fractures that have exhibited evidence of displacement with no regard to the degree and scale of fracturing.

The location of the plane of displacement shifted through time with changing tectonic stresses, resulting in an irregular fault plane at each principal shear zone. The observed faults do not exhibit discrete fault planes. Rather, the faults are characterized as fault zones consisting of numerous shear planes flanked by extensive related fracturing, which combined range in width to several hundred feet thick enveloping the principal shear zone.

The shifting tectonic stresses affecting the rock mass beneath the FCP property have resulted in two principal faults (Sidewinder and Party Line) and numerous smaller, discontinuous faults (e.g., Rattlesnake and Thrasher), which are sub-parallel to the larger faults. The Sidewinder and Party Line faults are the principal faults that transect the ISCR wellfield. The Sidewinder and Party Line faults are assumed to extend the entire distance over which they have been mapped. The Sidewinder and Party Line fault zones range in width from approximately 100 to 300 feet at locations where they have been identified in core logs. These faults have been rendered in the groundwater flow model based on a geologic model that was constructed from core logs. Additional smaller unnamed faults existing within the ISCR area, which are not characterized with regards to continuity, are not rendered in the groundwater flow model.

Based on one aquifer test conducted adjacent to the Party Line fault in 1995, it has been inferred that hydraulic conductivity adjacent and parallel to the larger faults is greater than that observed in the remainder of the fractured rock mass, and that hydraulic conductivity perpendicular to the faults is lower than the surrounding rock mass. The numerous small faults are too small and pervasive to individually characterize within the fractured bedrock framework.

Aquifer tests conducted at the PTF wellfield prior to commencement of ISCR operations included at least one test conducted at a well (R-03) that is projected to intersect the Sidewinder fault. Two additional wells are projected to possibly intersect the Sidewinder fault at greater depth and for a shorter portion of the well bore. No corresponding difference in hydraulic conductivity was observed at the wells which intersected the Sidewinder fault zone. No difference in hydraulic conductivity was observed because the oxide zone adjacent to the fault is extensively fractured to the point that it reflects crushed rock. Consequently, the faults represent neither conduits nor barriers to groundwater flow at the scale of the planned ISCR well spacing. However, the faults rendered in the updated groundwater model were conservatively assigned a hydraulic conductivity ten times that of the surrounding oxide zone. The results of the PTF pre-operational testing are included in Exhibit D-4.

D.3.4.3 Direction of Movement

For the five-spot pattern, each injection well will be surrounded by four recovery wells constructed to withdraw fluid from the injection zone. The recovery wells will be evenly spaced in a square pattern around each injection well at a distance of approximately 71 feet from the injection well. The well spacing may be adjusted to optimize injection and recovery operations based on operational data. The top of the injection interval will be a minimum of 40 feet below the top of the oxide zone. Injection and recovery rates will be closely balanced to ensure full recovery of the injected fluid. The aggregate recovery rate will be higher than the aggregate injection rate to ensure that more fluid is withdrawn than is injected, and to maintain the necessary inward hydraulic gradient during ISCR operations and formation rinsing.

The hydraulic control test conducted by BHP Copper in 1997-98 demonstrated that the proposed well pattern and spacing can be used to induce horizontal well-to-well flow within the oxide zone. The groundwater model prepared by Florence Copper using formation-specific geologic and hydrologic properties in support of PTF permitting also indicated that horizontal fluid flow could be induced between wells constructed in the oxide zone. Operational experience from the PTF confirms that horizontal flow can be induced within the oxide zone between injection and recovery wells. The PTF wellfield is an appropriate analog for the planned ISCR operations in the broader commercial-scale ISCR wellfield.

The bedrock underlying the oxide zone is effectively impermeable, so downward flow of injected solutions is not expected. The oxide zone is underlain locally by a zone of sulfide mineralization that occurs in the same quartz monzonite and granodiorite rocks that compose the oxide zone and is of unknown lateral and vertical extent. The fracture frequency and resulting permeability of the fracture network within the sulfide zone beneath the proposed ISCR wellfield is significantly less than that observed in the overlying oxide zone. For this reason, no ambient downward flow of injected fluid is anticipated, and no recovery wells will be constructed in the sulfide zone to induce downward flow of injected fluid.

Based on formation characterization data, model analyses, and operational data, horizontal flow of injected solution between the injection wells and recovery wells will be established using the proposed wellfield layout and well configuration.

D.3.5 Qualitative Analysis of Constituents in Injected Fluid

Florence Copper has conducted extensive laboratory analyses of core samples and groundwater obtained from the FCP site. In 2011, Florence Copper began a test program for the purpose of examining previous site owners' predictions regarding ISCR performance and to develop improved test methods for ISCR. The essential elements of a test program for ISCR are to use whole core samples and establish test conditions in the laboratory which correspond to field conditions as closely as possible. The Florence Copper ISCR leaching and rinsing program included box tests, individual pressurized tests, and series pressurized tests. The test work was conducted at SGS Mineral Services in Tucson, Arizona. Supporting analytical work was performed at SGS Mineral Services in Vancouver, British Columbia, and Lakefield, Ontario. Mineralogical work was performed at Colorado School of Mines and Montana Tech.

Test work conducted in the lab suggested that each block of wells would produce economic quantities of copper for up to 4 years, followed by up to 2 years of rinsing. The duration of planned operations also

depends on the number of active wells and size of each mining block. The number and sequence of wells planned to be installed each year may be adjusted during operations, however, there is anticipated to be no change in the overall number of resource blocks or the anticipated time to leach and rinse the blocks.

Current and ongoing laboratory test work evaluating PTF derived solution samples confirms a multi-year leaching cycle. Laboratory test work to evaluate rinsing scenarios has helped determine appropriate flow rates and dosages of neutralizing agents, such as sodium bicarbonate, to efficiently restore the buffering capacity of the formation. This testing has informed site-specific parameters such as planned reagent concentrations and reaction rates in the formation. Experience gained in operating the PTF combined with the laboratory test work has resulted in optimized flow rates and reagent concentrations for different phases of planned ISCR operations and confirms the planned overall operational and rinsing periods of the project. The planned leaching and rinsing stages for commercial ISCR operations are confirmed by data generated from the PTF and remain unchanged relative to the durations proposed in the 4 October 2019 UIC Application.

The core samples used in the testing were obtained from core holes drilled at the site in 2011. Drill holes were located in the southern portion of the deposit near the original BHP Copper test wellfield and in the northern portion of the deposit adjacent to the PTF wellfield. In each of the tests conducted, the drill core samples were selected to represent the range of key geological parameters found within the overall deposit including rock type, clay content, metallurgical zone, and fracture intensity.

Core samples were leached and rinsed with the same solutions and formation applied at the PTF wellfield. The laboratory program included a series of tests using sealed flow-through boxes, wherein the boxes were connected in a series to simulate a lengthened flow path through formation material. Manometers were located between boxes to allow observation of the pressure drop due to friction loss at each stage of the flow path. The tests were conducted at a flow rate of 7 liters per day and a hydrostatic head of 12 inches on the solution entering the first box. There was no pressure drop, either overall or between any pair of boxes, during leaching. This is consistent with visual observation of all of the core segments following leaching and rinsing. The leached residues were free of any evidence of flow blockages and showed essentially complete removal of the characteristic blue color of chrysocolla. Some gypsum was visible on fracture surfaces, but it was granular and unconsolidated.

Laboratory simulations of copper recovery were completed after approximately 150 to 200 days each of leaching and rinsing. However, the tests represented ideal conditions with essentially 100 percent solution/solid contact (100 percent sweep efficiency), and flow rates were higher per unit area contacted than those expected in the commercial wellfield. The geochemical model projections used to support the permit application included an estimated sweep efficiency as a function of time and indicated completion of leaching and rinsing within approximately 2.5 to 4 years. However, the formation has variable in mineralogy, fracture intensity, clay and calcite content, and thickness, so we have conservatively assumed a total of 6 years for copper extraction and rinsing of the formation.

The geochemical data generated from this test program was compared to geochemical data generated by previous site owners to determine the best method to forecast process solution composition. These data have since been further compared to geochemical data generated from PTF operations to date. Florence Copper subsequently retained the services of HydroGeoLogica, Inc. and Haley & Aldrich, Inc. to continue evaluation of the combined dataset and to create a new geochemical model to refine the forecasts of process solution composition that was previously prepared in support of amendment of APP

No. P-106360. The principal objectives of the review and modeling activities were to (1) forecast constituent concentrations that could reasonably be expected in fully mature PLS; (2) forecast constituent concentrations in raffinate produced in an on-site SX/EW plant; and (3) verify earlier modeling results that indicated groundwater quality can be restored to Aquifer Water Quality Standard or pre-determined injection zone concentrations by rinsing the ore body with native groundwater. Exhibit D-3 is a technical memorandum prepared by HydroGeoLogica that includes forecast compositions of the principal fluid streams to be generated during ISCR operations.

The HydroGeoLogica report provides reasonable estimates of forecast constituent concentrations that may be expected in the PLS and raffinate, and compare favorably with PTF solutions generated to date and projected mature solutions expected from the PTF in the coming months.

D.3.5.1 Estimated Composition of 98 Percent Sulfuric Acid

Exhibit D-3, Table 1, column 1, shows the estimated composition of 98 percent sulfuric acid. Sulfuric acid is typically produced from the recovery of sulfur dioxide at a smelter facility. The composition shown is representative of the sulfuric acid generated at the ASARCO Hayden smelter, and is typical of acid that will be delivered to FCP for acidifying raffinate during ISCR operations.

D.3.5.2 Forecast Composition of PLS

Exhibit D-3, Table 1, column 2, reflects mature PLS that has been extracted from the ISCR wellfield prior to SX/EW copper recovery. At ISCR wellfield startup, recovered solution will be re-acidified and re-injected until copper concentrations reach a level sufficient to achieve SX/EW copper recovery. After copper is stripped from the PLS, it will be re-acidified and prepared as raffinate for injection.

D.3.5.3 Injectate Solution (Raffinate) Composition

Exhibit D-3, Table 1, column 3, reflects the estimated forecast composition of mature raffinate. The composition is based on the assumption that the solution after processing in the SX/EW plant be similar to the PLS composition, with the exception that it will have lower copper concentrations and lower pH. Raffinate will exit the SX/EW plant and be directed to the raffinate pond before it is conveyed to the ISCR wellfield and acidified, as needed, prior to injection.

Inorganic constituents in the in-situ solutions are a product of both process chemicals as well as chemical reactions resulting from the interaction of raffinate with the host rock of the oxide zone during ISCR wellfield operations. They will be variable in both composition and concentration. Some constituents are relatively predictable because their sources are the inorganic chemicals (such as sulfuric acid and calcium carbonate that will be mixed to acidify or neutralize solutions) which are controlled and measurable; however, other constituents are a function of the interaction between the injection fluids, pH of injection fluids, existing groundwater, and the solubility of minerals present in the oxide zone. Their composition and concentration will be difficult to validate until the injection and recovery process has continued for enough time to develop a mature PLS. Therefore, a qualitative analysis of constituents in mature raffinate solution cannot be definitively provided at this time until a mature PLS is produced.

D.3.5.4 Water Impoundment Solution

Exhibit D-3, Table 1, column 4, reflects water in the water impoundments that has been neutralized by the addition of lime. This solution will include a small PLS bleed stream and hydraulic control water during ISCR operations, and water produced during formation rinsing.

D.3.5.5 Water Impoundment Sediment

Exhibit D-3, Table 1, column 5, reflects sediment in the water impoundments following solution neutralization.

D.3.5.6 Composition of Groundwater after Block Rinsing

Exhibit D-3, Table 1, column 6, shows the estimated composition of groundwater after block rinsing.

D.3.5.7 Composition of Make-up Water

Exhibit D-3, Table 1, column 7, shows the estimated composition of groundwater that will be used as make-up water during ISCR operations. Make-up water will be obtained from an existing on-site well that is located outside of the area of review.

D.4 MONITORING PROGRAM

Pre-operational and operational monitoring devices and procedures are described below.

D.4.1 Pre-Operational Review

Before commencing operations in the ISCR wellfield, Florence Copper will conduct a pre-operational review of all start-up procedures to ensure that the operations comply with UIC Permit conditions, as follows:

1. Mechanical integrity tests (Part I and Part II) have been conducted on all ISCR wells and all wells have passed the tests.
2. All wells have been completed such that they will not inject solutions within the injection exclusion zone (within the top 40 feet of the oxide zone).
3. All core holes and all wells (except Class III wells and wells used for groundwater monitoring) located within 500 feet of the ISCR wellfield have been abandoned in accordance with an approved Plugging and Abandonment Plan.
4. Allowable injection pressure, not to exceed 0.65 psi/ft of depth, has been established for each injection well.
5. Injection fluids have been checked and found to meet permit specifications.
6. Fresh groundwater has been injected, as needed, to assess the hydraulics of the injection and recovery patterns and to confirm that all monitoring devices and controls are in working order.

D.4.2 Operational Monitoring

D.4.2.1 Injection System

The injection system consists of the individual wells, pumps, manifolds, piping, and related controls and meters. Manifolds will be used to distribute raffinate to injection wells and to collect PLS from recovery wells. Mechanical controls and monitoring devices incorporated into the injection system are listed below and illustrated in the drawings in Figures C-5 and D-2 of this Application. The injection system includes:

- One pressure transducer at each injection well head;
- One flow meter at each injection manifold for measuring flow rates (gpm);
- One totalizing flow meter for measuring cumulative flow (gallons) into each injection manifold;
- One isolation valve at each injection well;
- One flow meter at each injection well for measuring flow rates (gpm);
- One valve at each injection well for controlling flow; and
- One pressure transducer to measure annular pressure above the packer or in the well bore if no packer is installed.

Operators will use the injection well head pressure transducers to monitor injection pressures for loss of mechanical integrity and ensure that the maximum allowable injection pressures are not exceeded at the well heads. The allowable injection pressure will be calculated for each injection well. Actual pressures measured at each well head will be compared to the maximum allowable pressure(s) for the well and flow will be adjusted as necessary to ensure injection pressures are within calculated allowable limits.

Operators will also use gauges and meters at each injection manifold to monitor injection pressures and flows on a manifold-by-manifold basis.

Allowable injection pressure will be calculated for each injection well as described above. Actual pressures measured at each manifold will be compared to the maximum allowable pressure(s) for the well with the lowest allowable pressure and will be adjusted as necessary to ensure injection pressures are within calculated allowable limits. Injection pressure will also be measured at each well head.

Every 24 hours, the totalized flow to the injection manifold will be summed and compared to the summed totalized flow from all of the recovery wells. If the summed total flow from recovery wells exceeds the total flow into injection wells, hydraulic control will be verified. If the summed total flow from recovery wells does not exceed the total flow into injection wells, adjustments to recovery and/or injection flow rates will be made accordingly to restore hydraulic control.

Reduced flow in an injection well may be due to changes in formation characteristics or clogging of the formation or the well screens. A sudden increase in flow may indicate a break/failure of the well casing. If a casing breach is believed to have occurred, the operator will shut down that well by turning off flow

and will conduct relevant inspections. Inspections and related reporting will be conducted in accordance with Section D.5.1 below.

The injection and recovery systems will be connected to one or more tanks in the ISCR area. The tanks will be fitted with a high-level alarm and level indicators. Both alarm and level indicator signals will be routed to the control room. An alarm will actuate if either a line fails or the tank high level is exceeded. The feed pump to the tank will be shut down automatically. Spilled solutions will be captured in a lined collection sump able to contain 110 percent of the volume of the tank and line. The spilled volume will be pumped back into the circuit for reuse.

Solutions pumped through pipelines located in pipeline channels between the ISCR wellfield and the SX/EW plant will be metered for flow and pressure. An electronic feedback system will alarm if a pump fails, flow is interrupted, or flow is not in logical mode when a pump is activated. Loss of pressure or pressure exceeding a high setting will cause the pump to automatically shut down. In the event of such an occurrence, the plant operator will inspect the system. A broken line will be repaired within 48 hours and spilled solutions captured in spill control sumps in the lined channels will be pumped back into the process systems or to the water impoundment.

D.4.2.2 Recovery System

The recovery system is similar to the injection system. It is comprised of the individual wells, pumps, recovery manifolds, piping, and related meters and controls as shown on Figures C-5 and D-2 of this Application. The recovery system includes:

- One continuous reading flow meter (gpm) at the recovery manifold;
- One totalizing flow meter (gallons) at the recovery manifold;
- One isolation valve at each recovery well;
- One flow meter at each recovery well; and
- One pressure transducer at each recovery well.

The flow meters on the recovery manifolds will allow the operators to monitor recovery flow rates and use the data to compare against injection flow rates as described above. Inspections and related reporting will be conducted in accordance with Section D.5.1 below.

D.4.2.3 Monitoring Hydraulic Control

Hydraulic control will be monitored every 24 hours by comparing total flows into and out of the ISCR wellfield, and by monitoring water levels in the recovery/observation/point of compliance (POC) well triplets. If hydraulic control is not indicated, the rate of injection will be decreased and/or the rate of recovery will be increased to achieve hydraulic control.

D.5 CONTINGENCY PLANS

Procedures for contingency conditions and associated response actions in the ISCR wellfield are summarized in Table 1 of Exhibit D-2, Operations Plan. Contingency conditions will be identified electronically with alarms or by visual inspections. All contingency conditions require indicated

follow-up actions listed in Table 1 of Exhibit D-2. Actions that involve repair or abandonment of an ISCR well in response to a contingency condition are described below in Section D.5.1.

D.5.1 Plans for Well Failures

Well failures may occur as a result of loss of mechanical integrity of a well, clogged or damaged screens, or a failure in well equipment. The potential for well failure will be monitored by the system controls described in the Operations Plan included as Exhibit D-2. The potential for well failure may be identified by significant changes in injection pressure, injection or recovery flow rates, annular conductivity measurements, or water levels measured to verify hydraulic control. Contingency responses are described in this section and in the Operations Plan.

Except as provided below, a significant change in injection pressure in a well occurring during normal operating conditions shall be reported to the USEPA in quarterly reports:

1. If it is determined that a well failure has occurred and that the well will be repaired, a report will be submitted as soon as possible of any planned physical alterations or additions to the permitted injection wells. Any changes in well construction (i.e., a well workover) will require prior approval by USEPA and may require permit modification under 40 CFR 144.41. Following a well workover, a demonstration of mechanical integrity shall be performed within 30 days and prior to resuming injection activities in accordance with the UIC Permit.
2. If it is determined that the well must be abandoned, a report will be submitted in the next quarterly reporting period. The abandonment and related reporting will proceed in accordance with the Plugging and Abandonment Plan.

Failures related to clogged screens or filter packs and failures related to well equipment will be evaluated as they are detected, and in-plant maintenance orders will be issued and tracked to ensure timely repairs. Such failures and related responses are considered part of normal operations and are not subject to reporting requirements unless the result is workover of the affected well. Any equipment failure in an observation well and/or a recovery well that affects the ability to monitor hydraulic control will be repaired as soon as possible.

D.5.2 Loss of Hydraulic Control

In the event of a loss of hydraulic control, contingency response actions will be implemented within 24 hours of becoming aware of the loss of hydraulic control. If the loss of hydraulic control is due to equipment failure, the response actions will be implemented if the repair cannot be completed within 48 hours following the detection of the equipment failure.

Florence Copper proposes the following contingency language for incorporation into the requested UIC Permit. The section numbering and language presented below reflect the anticipated numbering and proposed language for the contingency plan section of the new UIC Permit.

1. Loss of Hydraulic Control
    A. The Permittee shall initiate the following actions within 24 hours of becoming aware that the volume of fluids recovered from the injection and recovery zone of the ISCR wellfield during a 24-hour period is less than 106 percent of the amount of fluid injected during the same 24-hour period:

i. Adjust the flow rate for the recovery and/or injection wells to restore the percent of recovered fluid volume to at least 106 percent of the injected volume;

ii. Inspect the injection and recovery lines, pumps, flow meters, totalizers, pressure gages, pressure transducers and other associated instruments and facilities;

iii. Initiate pressure testing of wells if the loss of fluids cannot be determined to be caused by a surface facility failure; and

iv. Repair system as necessary to restore the percent of recovered fluid volume to at least 106 percent of the injected volume.

B. A loss of hydraulic control is deemed to occur when the amount of fluid recovered during a 48-hour period is less than 106 percent of the amount of fluid injected during the same 48-hour period. Loss of hydraulic control is also defined by an inward gradient (in head differential) of less than 1 foot or an outward gradient observed in any recovery/ observation/POC well triplet over a 48-hour period. An inward gradient of less than 1 foot (i.e., loss of hydraulic control) shall require action to restore the inward gradient to at least 1 foot in the subsequent 24-hour period.

The minimum inward flow ratio and head differentials may be adjusted during the course of wellfield operation if warranted based on head data from recovery/observation/POC well triplet and from POC water quality data, subject to USEPA approval.

The Permittee shall initiate the following actions within 24 hours of becoming aware of the loss of hydraulic control for more than 48 consecutive hours, as defined above. The Permittee shall:

i. Cease injection in one or more wells as necessary to restore hydraulic control;

ii. Operate recovery wells until the amount recovered equals an amount sufficient to restore the ratio of fluid recovered to injected during the prior 72-hour period to a minimum of 106 percent and restore all recovery/observation/POC well triplet head differentials to at least 1 foot to verify an inward flow gradient;

iii. Verify proper operation of all facilities within the ISCR wellfield; and

iv. Perform any necessary repairs.

C. If action is taken under either A or B above, in the next quarterly report, the Permittee shall describe the causes and impacts of the loss of hydraulic control or the variance from the required recovery to injection ratio and the actions that were taken to correct the event.

D.5.3 Water Quality Exceedance at POC Wells

In the event of a water quality exceedance at a POC well, contingency response actions will be implemented in accordance with provisions set forth in APP No. P-101704. Florence Copper proposes the following contingency language for incorporation into the requested new UIC Permit. The section numbering and language presented below reflect the anticipated numbering and proposed language for the contingency plan section of the new UIC Permit.

1. Water Quality Exceedances at POC Wells

   The following describes contingency plans to be followed after the verification of an alert level (AL) or Aquifer Quality Limit (AQL) exceedance in a POC well during the approximate 22-year life of the ISCR facility and during the 30-year Post-Closure period:

   A. AL exceedance during operational life of the ISCR facility

      i. The Permittee shall collect a verification sample within 14 days after becoming aware of an exceedance of an AL listed in Table 1 or Table 2 of Part II.F.2.

      ii. Within 5 days after receiving the results of verification sampling from the laboratory, the Permittee shall notify the director if the results indicate an exceedance.

      iii. If the results of verification sampling indicate that an AL has not been exceeded, the Permittee shall notify USEPA of the results and assume that no exceedance has occurred. No further action is required until the next scheduled monitoring round.

      iv. Within 30 days of receiving the laboratory results verifying that an AL has been exceeded, the Permittee shall do the following:

         a. Submit a written report to USEPA providing an evaluation of the cause, impacts, or mitigation of the discharge responsible for the AL exceedance, or

         b. Submit a written report to USEPA which definitively demonstrates that the AL exceedance resulted from an error(s) in sampling, analysis, or statistical evaluation.

      v. Upon review of the report documenting the AL exceedance, the Director may require additional monitoring and/or action beyond those specified in this permit.

   B. AQL Exceedance during operational ISCR wellfield Life, Closure, and Post-Closure period.

      i. The Permittee shall collect a verification sample within 14 days of becoming aware of an exceedance of an AQL listed in Table 1 or Table 2 of Part II.F.2.

      ii. Within 5 days of receiving the results of verification sampling from the laboratory, the Permittee shall notify the Director of the results, regardless of whether the results are positive or negative.

      iii. If the results of verification sampling indicate that an AQL has not been exceeded, the Permittee shall assume that no exceedance has occurred and no further action is required until the next scheduled monitoring round.

      iv. Within 30 days of receiving the laboratory results verifying that an AQL has been exceeded, the Permittee shall do the following:

         a. Submit a written report to USEPA providing an evaluation of the cause, impacts, or mitigation of the discharge responsible for the AQL exceedance, or

         b. Submit a written report to USEPA which definitively demonstrates that the AQL exceedance resulted from an error(s) in sampling, analysis, or statistical evaluation.

v. Upon review of the report documenting the AQL exceedance, the Director may require additional monitoring and/or action beyond those specified in this permit.

C. Verification Sample Requirements

The verification sample shall be collected only from the well in which an exceedance was detected and shall be analyzed for the constituents of Table 1 of Part II.F.2. If the constituent that exceeded an AL or AQL is one that is listed in Table 2 of Part II.F.2 but not in Table 1, the verification sample shall be analyzed for all constituents listed in Table 1 and only for constituent(s) from Table 2 that exceed the AL or AQL

D.5.4 APP No. P-101704 Proposed Contingency Plan Language

In addition to the above described contingency plans, Florence Copper has prepared contingency plan language proposed for inclusion in the requested amendment of APP No. P-101704. Significant amendment of APP No. P-101704 has been requested of the Arizona Department of Environmental Quality to authorize construction and operation of the proposed commercial-scale ISCR facility at the FCP site. The contingency plan language proposed in conjunction with the requested amendment of APP No. P-101704 is included herewith as Exhibit D-6.

TABLES

Table D-1. Injection Rates and Volumes					
	Injection Interval Length (feet)	**Typical Injection Rate at 0.15 gpm/ft (gpm)**	**Typical Injection Rate at 0.20 gpm/ft (gpm)**	**Daily Injection Volume at 0.15 gpm/ft (gallons)**	**Daily Injection Volume at 0.20 gpm/ft (gallons)**
Well with Shortest Injection Interval	190	29	38	41,760	54,720
Well with Typical Length Injection Interval	580	87	116	125,280	167,040
Well with Longest Injection Interval	700	105	140	151,200	201,600

Notes:

gpm = gallons per minute

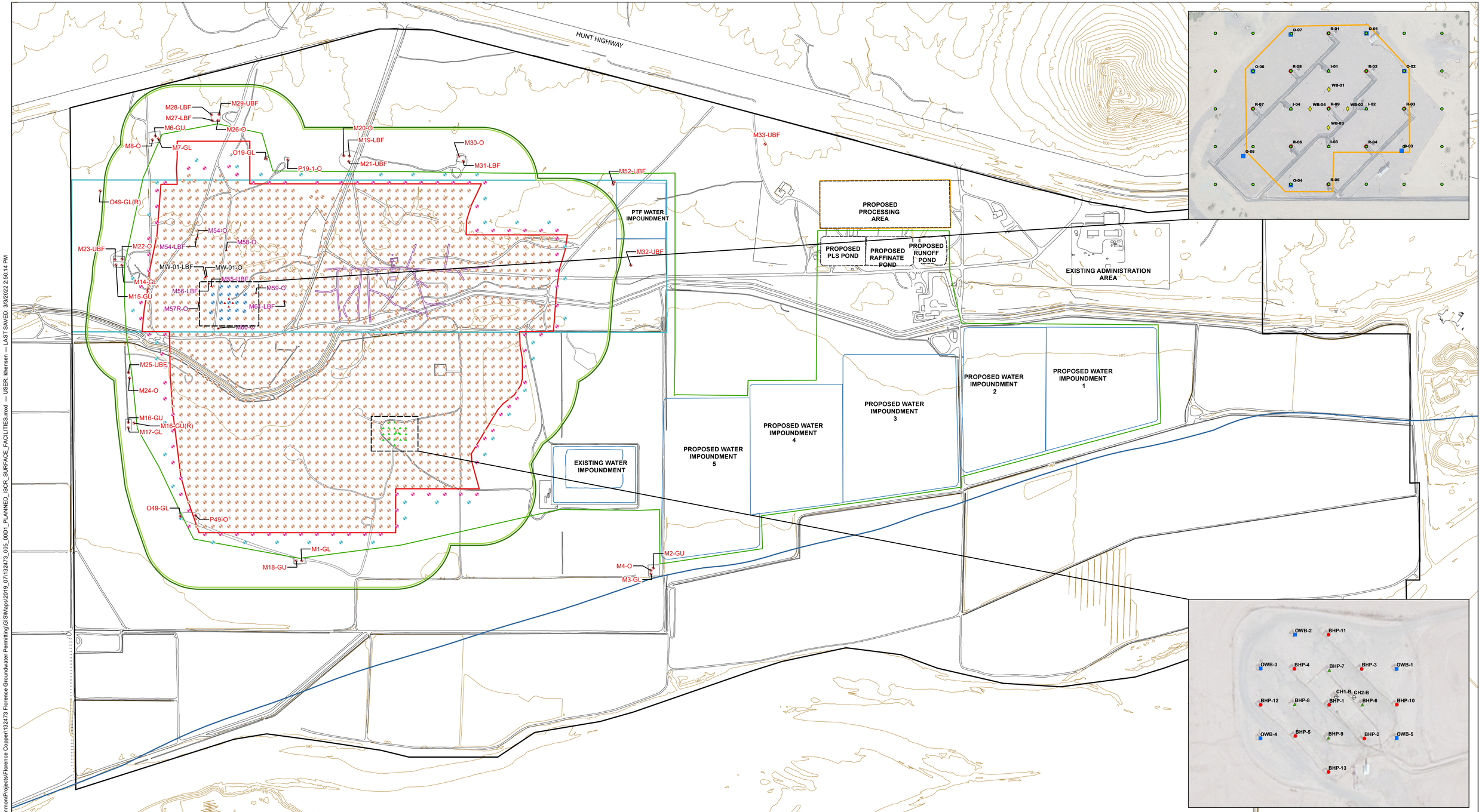
gpm/ft = gallons per minute per foot

Table D-2. Example Calculated Average and Maximum Injection Pressures for Selected Injection Intervals				
Depth to top of Injection Interval (feet)	**Average Injection Pressure at Top of Injection Interval (psi)**	**Average Well Head Pressure (psi)**	**Maximum Injection Pressure at Top of Injection Zone (psi)**	**Maximum Well Head Pressure (psi)**
500	225	Atmospheric	325	100
690	311	Atmospheric	449	138
880	396	Atmospheric	572	176

Notes:

psi = pounds per square inch

FIGURES



LEGEND

- FLORENCE COMMERCIAL WELL LAYOUT
- INJECTION WELL
- MONITORING WELL
- OBSERVATION WELL
- RECOVERY WELL
- WESTBAY WELL
- PROPOSED INJECTION / RECOVERY WELL
- PROPOSED OBSERVATION WELL
- PROPOSED PERIMETER WELL
- PTF WELLFIELD
- POINT OF COMPLIANCE WELL
- BHP TEST WELL
- UNDERGROUND WORKING
- 10ft TOPOGRAPHIC CONTOUR
- 100 YEAR FLOOD PLAIN
- PTF WATER IMPOUNDMENT
- PROPOSED WATER IMPOUNDMENT
- PTF PROCESSING AREA
- PROCESSING AREA
- PROPOSED PROCESSING AREA
- PROPOSED PMA BOUNDARY
- ISCR WELL FIELD
- PROPOSED AOR / FORMER BHP AOR
- AQUIFER EXEMPTION BOUNDARY
- FLORENCE COPPER PROPERTY BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. TOPOGRAPHY DATA BY FLORENCE COPPER, OCTOBER 2010. 10-FOOT INTERVALS SHOWN.

N

0 400 800 1,200 1,600
SCALE IN FEET

HALEY ALDRICH

FLORENCE COPPER, INC.
FLORENCE, ARIZONA 85132

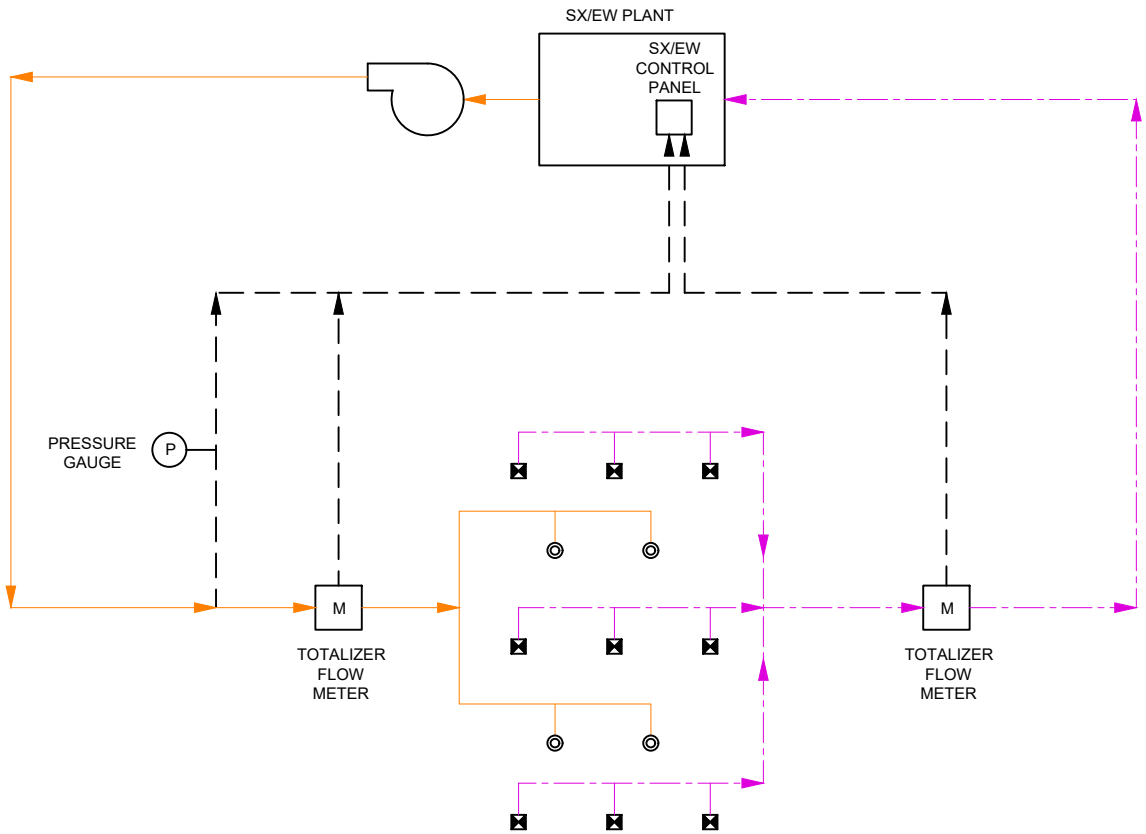
PLANNED ISCR SURFACE FACILITIES

FLORENCE COPPER

MARCH 2022

FIGURE D-1

GIS FILE PATH: \\haleyaldrich\share\phx_common\Projects\Florence Copper\132473 Florence Groundwater Permitting\GIS\Maps\2019_07\132473_005_00D1_PLANNED_ISCR_SURFACE_FACILITIES.mxd — USER: khensen — LAST SAVED: 3/3/2022 2:50:14 PM



LEGEND:

- RECOVERY WELL
- INJECTION WELL

HALEY ALDRICH

FLORENCE COPPER, INC.
FLORENCE, ARIZONA

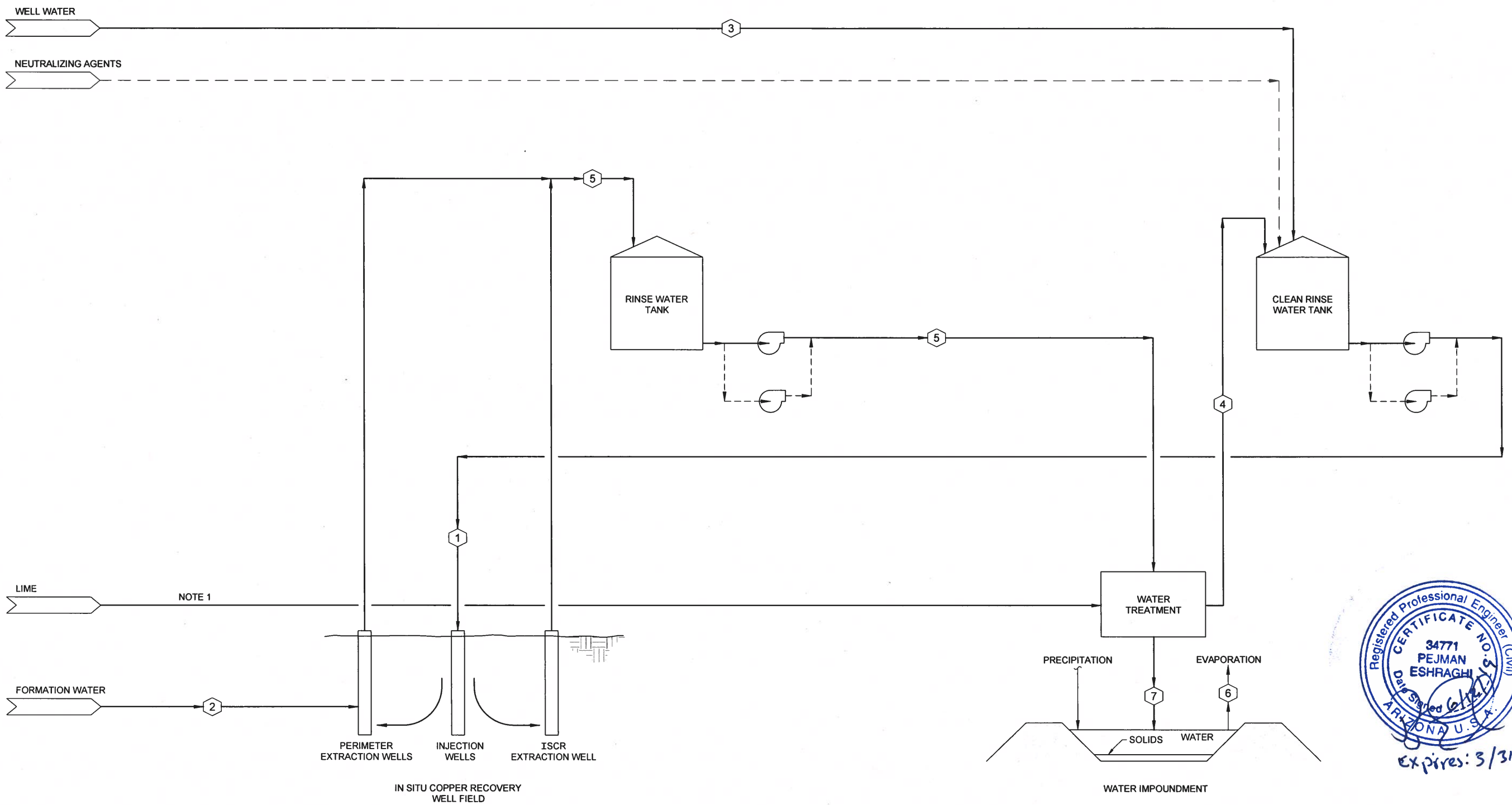
INJECTION / RECOVERY WELL SYSTEM OVERVIEW

SCALE: AS SHOWN
JULY 2019

FIGURE D-2

EXHIBIT D-1

Technical Memorandum: Design Flow Values for ISCR Operations and Rinsing Phases (prepared by Haley & Aldrich, Inc.)



Stream Numbers	1	2	3	4	5	6	7
Description	Clean Rinse Water in	HC Flow	Fresh Water Makeup	Flow from Treatment	Total Rinse Water Recovered	Evaporation	Solids (Note 2)
Nominal Flow	1,880 gpm	120 gpm	760 gpm	1,120 gpm	2,000 gpm	880 gpm	22 yd^3/day
							18 Tons/day

NOTES

1. LIME WILL BE ADDED AT A VARIABLE RATE DEPENDING ON THE RINSE WATER COMPOSITION.
2. SOLIDS GENERATION WILL DECLINE TO ZERO OVER TIME.

LEGEND

(3) STREAM NO.

STREAM TYPES

——— MAIN PROCESS FLOW

- - - - - ALTERNATIVE PROCESS FLOW

HALEY ALDRICH

FLORENCE COPPER
FLORENCE, ARIZONA

FLORENCE COPPER ISCR
RINSING FLOW SHEET

SCALE: AS SHOWN
JUNE 2019

FIGURE 6-2

Registered Professional Engineer (Civil)
CERTIFICATE NO. 34771
PEJMAN ESHRAGHI
Date Signed 6/14/19
ARIZONA U.S.A.
Expires: 3/31/2021

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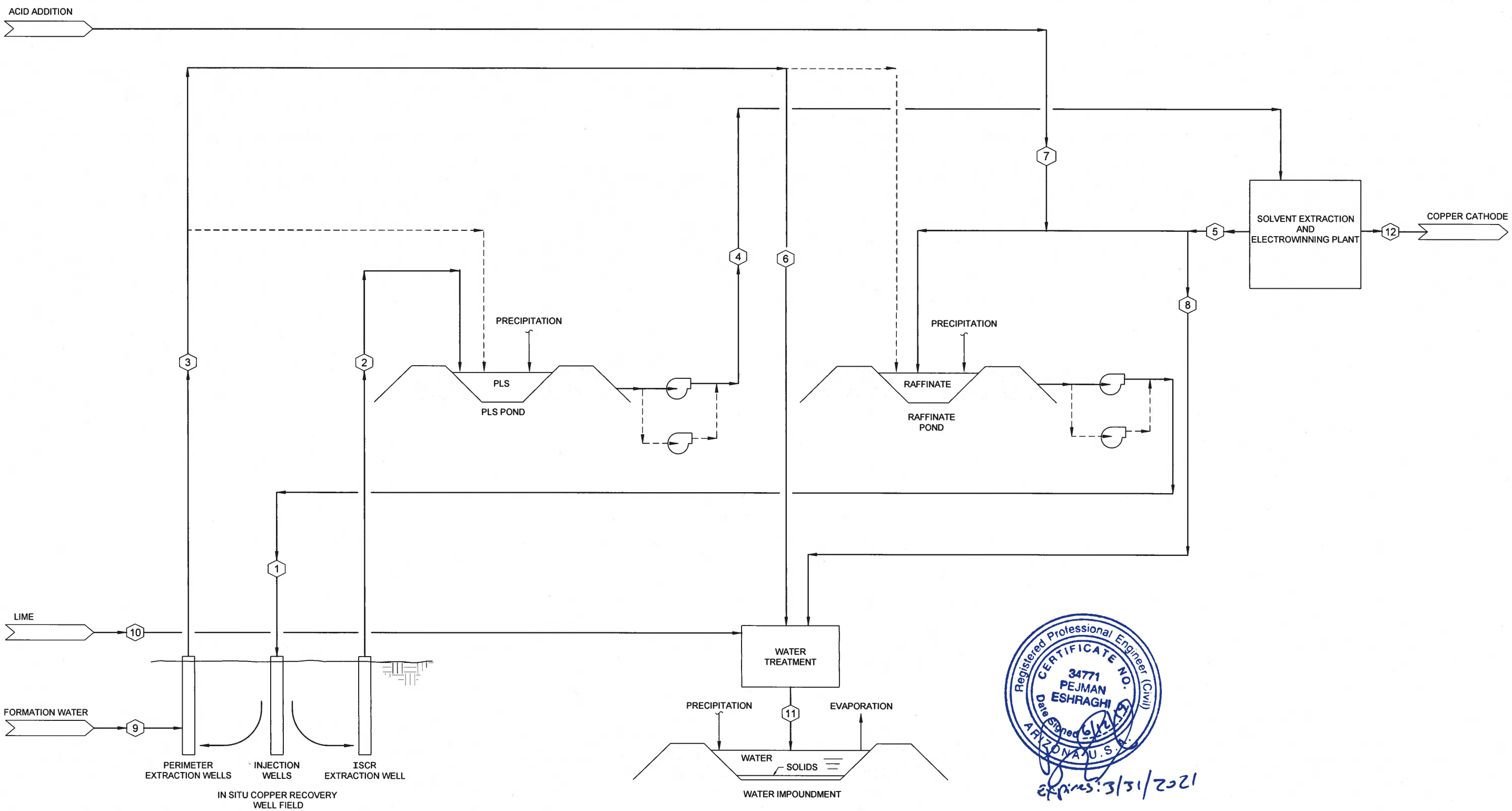
\\HALEYALDRICH.COM\SHAREPHX_COMMON\PROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\WORKING\101704 SIGNIFICANT AMENDMENT\CAD\132473-002_0002.DWG



Stream Numbers	1	2	3	4	5	6	7	8	9	10	11	12
Description	Leach Solution	PLS	HCS	SX Feed	Total Raffinate	HCS to Treatment	Acid Addition	Raffinate Bleed	Formation Water	Lime	Solids	Copper
Nominal Flow	11,000 gpm	11,000 gpm	660 gpm	11,000 gpm	11,000 gpm	660 gpm	633 Tons/day	53 gpm	660 gpm	33 Tons/day	129.3 Tons/day	85 M Lb/yr
											107.8 yd^3/day	

LEGEND

(3) STREAM NO.

STREAM TYPES

——— MAIN PROCESS FLOW

- - - - - - - ALTERNATIVE PROCESS FLOW

Registered Professional Engineer (Civil) CERTIFICATE NO. 34771 PEJMAN ESHRAGHI Date Signed 6/10/19 ARIZONA U.S.A.

Expires: 3/31/2021

HALEY ALDRICH

FLORENCE COPPER
FLORENCE, ARIZONA

FLORENCE COPPER ISCR
OPERATIONS FLOW SHEET

SCALE: AS SHOWN
JUNE 2019

FIGURE 6-1

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\\HALEYALDRICH.COM\SHARE\PHX_COM\ONPROJECTS\FLORENCE COPPER\132473 FLORENCE GROUNDWATER PERMITTING\WORKING\101704 SIGNIFICANT AMENDMENT\CAD\132473-002_0001R004.DWG

HALEY & ALDRICH, INC.
One Arizona Center
400 E. Van Buren St., Suite 545
Phoenix, AZ 85004
602.760.2450

Registered Professional Engineer (Civil)
CERTIFICATE NO. 34771
PEJMAN ESHRAGHI
Date Signed 6/12/19
ARIZONA U.S.A.
Expires: 3/31/2021

TECHNICAL MEMORANDUM

12 June 2019
File No. 132473-002

TO: Florence Copper Inc.
Dan Johnson, Vice President, General Manager

FROM: Haley & Aldrich, Inc.
Pejman Eshraghi, P.E.
Mark D. Nicholls, R.G.

SUBJECT: Application to Amend APP P-101704
Design Flow Values for ISCR Operations and Rinsing Phases

Introduction

The information provided in this technical memorandum and the attached Figures 6-1 and 6-2, describe the flow streams and rates associated with the planned in-situ copper recovery (ISCR) operations at the Florence Copper Project (FCP). Figure 6-1 shows the operations water flow components and estimated flow rates. Figure 6-2 shows the water flow components and estimated flow rates associated with formation rinsing process after full-scale ISCR operations have been completed at the FCP.

ISCR Operations Flow Components

ISCR OPERATIONS FLOW STREAM 1

The ISCR process begins with the injection of solution (Operations Flow Stream 1, Leach Solution) into the Bedrock Oxide Unit which contains soluble copper oxide minerals. Injection will occur at designated injection wells in the ISCR well field. The injected solution dissolves the copper-bearing minerals and is subsequently recovered from the bedrock oxide (Operations Flow Stream 2, Pregnant Leach Solution [PLS]). Florence Copper Inc. (Florence Copper) has set the flow rate for the ISCR well field based on the production capacity of the solvent extraction/electrowinning (SX/EW) processing facility. The nominal flow rate set by Florence Copper for injection of the leach solution is 11,000 gallons per minute (gpm) (Figure 6-1), and the maximum estimated flow rate is 12,650 gpm.

ISCR OPERATIONS FLOW STREAM 2

As the leach solution (Operations Flow Stream 1) dissolves copper-bearing minerals, the concentration of copper in the solution will increase. The copper enriched PLS is subsequently recovered from the bedrock oxide using wells in the ISCR well field. The copper content in PLS is estimated to be nominally 2 grams per liter (GPL) based on laboratory analyses of core samples and site-specific conditions. The extraction rate for the PLS is matched to the leach solution injection rate (Operations Flow Stream 1), and consequently is set to the planned capacity of the SX/EW plant. The nominal flow rate set by Florence Copper for recovery of PL is 11,000 gpm (Figure 6-1), and the maximum estimated flow rate is 12,650 gpm.

ISCR OPERATIONS FLOW STREAM 3

Both Aquifer Protection Permit and Underground Injection Control permit require that Florence Copper maintain hydraulic control of injected solution (Operations Flow Stream 1) by extracting more fluid than is injected. The excess extraction will serve to draw groundwater toward the well field from the surrounding formation to ensure inward groundwater flow. Florence Copper proposes to withdraw the excess groundwater at the edge of the well field to prevent dilution of the copper-bearing solutions. The groundwater withdrawn to maintain hydraulic control is represented by Operations Flow Stream 3 and will contain dilute concentrations of dissolved copper and other minerals, is referred to as hydraulic control solution (HCS). The estimated maximum HCS flow is set at 6-percent of the maximum value of the injected leach solution (Operations Flow Stream 1). Operations Flow Stream 3 will be routed to treatment, or will be combined with either PLS or raffinate, depending on process requirements. Excess HCS will be neutralized and routed to the water impoundments for evaporation (Figure 6-1). The nominal flow rate for HCS (Operations Flow Stream 3) is 660 gpm (Figure 6-1) and the maximum estimated flow rate is 815 gpm.

ISCR OPERATIONS FLOW STREAM 4

The PLS extracted from the ISCR well field will be pumped from the PLS pond into the SX/EW plant to be stripped of copper. The flow rate from the PLS pond to the SX/EW plant (Operations Flow Stream 4) will typically be in equilibrium with the extraction rate of PLS from the ISCR well field. Consequently, the flow rate from the PLS pond to the SX/EW processing facility is based on the production capacity of the SX/EW processing facility. The nominal flow rate flow rate established by Florence Copper for PLS flow into the SX/EW processing facility is 11,000 gpm (Figure 6-1) and the estimated maximum flow rate is 12,650 gpm.

ISCR OPERATIONS FLOW STREAM 5

At the SX/EW plant, the PLS will be stripped of copper to become “barren” raffinate solution. The raffinate solution will be transferred to a raffinate pond at a rate that is in equilibrium with the PLS inflow rate (Operations Flow Stream 4) to the SX/EW processing facility. Consequently, the flow rate from the SX/EW processing facility to the raffinate pond is based on the production capacity of the SX/EW processing facility. The nominal flow rate established by Florence Copper for raffinate flow to the raffinate pond (Operations Flow Stream 5) is 11,000 gpm (Figure 6-1), and the estimated maximum flow rate is 12,650 gpm.

ISCR OPERATIONS FLOW STREAM 6

As described above, HCS recovered from the perimeter of the ISCR well field will be routed primarily to treatment and then to the water impoundments for evaporation. The HCS may however be routed back into the process circuit depending on operation conditions. The maximum estimated flow to the water impoundments is equal to the HCS flow rate (Operations Flow Stream 3). Consequently, the nominal flow rate for HCS (Operations Flow Stream 6) to the water impoundments is 660 gpm (Figure 6-1) and the estimated maximum flow is 815 gpm.

ISCR OPERATIONS FLOW STREAM 7

Sulfuric acid will be added to the injected solution (Operations Flow Stream 1) prior to injection. The sulfuric acid will be added after solution leaves the SX/EW processing facility and prior to the raffinate pond (Operations Flow Stream 7). The estimated nominal quantity of acid to be added is 633 tons per day (Figure 6-1), and the estimated maximum quantity required is 808 tons per day.

ISCR OPERATIONS FLOW STREAM 8

The PLS and raffinate solutions will be recirculated for the duration of ISCR operations. The recirculation will result in the accumulation of dissolved mineral constituents in these solutions. In order to balance solution volumes and maintain solution chemistry, a small portion of the flow (raffinate bleed stream) from the SX/EW will be routed to treatment and then to water impoundment (Operations Flow Stream 8) and the volume will be replaced by the addition of acid (Operations Flow Stream 7) to the raffinate solution (Figure 6-1). The estimated nominal flow rate of the raffinate bleed stream is 53 gpm and the estimated maximum flow rate is 67 gpm.

ISCR OPERATIONS FLOW STREAM 9

The HCS flow described above (Operations Flow Stream 3) is derived entirely from groundwater pumped from the perimeter wells. Operations Flow Stream 9 is included to illustrate that the HCS flow is sourced from groundwater. The estimated nominal flow from groundwater (Operations Flow Stream 9) is estimated to be 660 gpm (Figure 6-1), and the estimated maximum flow is 815 gpm.

ISCR OPERATIONS FLOW STREAM 10

All of the water and process solutions pumped to the water impoundments for disposal by evaporation will be neutralized with lime as necessary. The quantity of lime used will vary based on the characteristics of the solutions reporting to the water impoundments. Operations Flow Stream 10 represents the anticipated nominal quantity of lime required and is estimated to be 33 tons per day (Figure 6-1). The estimated maximum quantity of lime required is 38 tons per day.

ISCR OPERATIONS FLOW STREAM 11

Neutralized water reporting to the water impoundments will be evaporated using mechanical evaporators. The residual solids will be composed of mineral material contained in the solution and

lime used for neutralization. The estimated nominal solids accumulation rate (Operations Flow Stream 11) (Figure 6-1) will be 107.8 cubic yards per day and the estimated maximum rate will be 124 cubic yards per day.

ISCR OPERATIONS FLOW STREAM 12

Copper will be extracted from the PLS (Operations Flow Stream 4) at the SX/EW processing facility. The nominal rate of copper production (Operations Flow Stream 12) is 85 million pounds per year (Figure 6-1), and the estimated maximum rate of copper production will be 97 million pounds per year.

Formation Rinsing Flow Components

The duration of the rinsing phase is anticipated to be 48 months. The streams and rates shown are based on the results of rinsing conducted by BHP Copper Inc. (BHP Copper; a previous site owner), which conducted a limited scale hydraulic control test in 1997 and 1998. The information derived from the BHP Copper test is further supported by subsequent laboratory testing conducting by Florence Copper, the results of geochemical and hydrological modeling completed in 2010 and 2019.

The input variables and assumptions for calculating the flow rates shown on Figure 6-2 are described below and are based on data and information provided by Florence Copper. The calculated flow rates shown on Figure 6-2 are the current best estimate of anticipated flow for formation rinsing following completion of the planned ISCR operations.

RINSING FLOW STREAM 1

Rinsing Flow Stream 1 includes a nominal flow value of 1,880 gpm, which is derived from groundwater (Rinsing Flow Stream 3) and treated water (Rinsing Flow Stream 4) (Figure 6-2). The estimated maximum flow value for this flow stream is 2,475 gpm.

The groundwater component is extracted from wells outside of the ISCR wellfield area. Rinsing Flow Streams 3 and 4 are pumped from the wells and the treatment system into the clean water rinse surge tank, and from there to the well field (Rinsing Flow Stream 1) where it will be injected to rinse the formation. An additional unquantified flow of neutralizing agents (sodium bicarbonate or other non-hazardous neutralizing agent), mixed with rinse water, is also shown on the rinsing flow sheet. The required quantity of neutralizing agents is dependent on laboratory analyses of rinse water chemistry during the rinsing operations.

RINSING FLOW STREAM 2

Rinsing Flow Stream 2 is composed of groundwater extracted at an estimated nominal flow rate of 120 gpm extracted from wells at the perimeter of the ISCR well field during rinsing operation to maintain hydraulic control (Figure 6-2). The estimated maximum flow rate for Rinsing Flow Stream 2 is 275 gpm. Groundwater is pumped from the perimeter wells to ensure that all injected solutions are recovered. Groundwater will flow to the perimeter wells from the formation both outside and inside the well field, drawing groundwater toward the well field thereby maintaining hydraulic control.

RINSING FLOW STREAM 3

Rinsing Flow Stream 3 is makeup water pumped from groundwater using wells outside of the ISCR wellfield area. The nominal makeup water flow rate is 760 gpm (Figure 6-2) and the estimated maximum rate is 935 gpm. This water is pumped from the wells into the clean water rinse surge tank where it is staged for re-injection to rinse the formation.

RINSING FLOW STREAM 4

Rinsing Flow Stream 4 originates as rinse water extracted from the ISCR well field and treated before it is re-circulated for further rinsing (Figure 6-2). The flow stream economizes the amount of water used to rinse the formation and the resulting number of water impoundments required to evaporate the residual rinse water. The estimated nominal flow for Rinsing Flow Stream 4 is 1,120 gpm, and the estimated maximum flow is 1,540 gpm.

RINSING FLOW STREAM 5

Rinsing Flow Stream 5 is the total volume of rinse water recovered, including hydraulic control solutions. This flow stream is the sum of "Clean Rinse Water in" and the "HC Flow," represented as Rinsing Flow Streams 1 and 2 on Figure 6-2. The estimated nominal flow rate for Rinsing Flow Stream 5 is 2,000 gpm and the estimated maximum flow is 2,750 gpm.

RINSING FLOW STREAM 6

Rinsing Flow Stream 6 is evaporation of the concentrated waste stream from the treatment process. This water is routed to the water impoundments (Figure 6-2) where it will be evaporated using mechanical evaporators. Reliance on the evaporators is highest in winter months when natural evaporation is reduced. The estimated nominal evaporation flow is 760 gpm, and the estimated maximum evaporation flow is 935 gpm.

RINSING FLOW STREAM 7

Rinsing Flow Stream 7 represents the accumulation of solids in the water impoundments. The solids originate as dissolved mineral included in Rinsing Flow Stream 6, which are further concentrated by evaporation (Figure 6-2). The estimated nominal rate of solids accumulation is 22 cubic yards per day, and the estimated maximum accumulation rate is 30 cubic yards per day. The solids accumulation rate will decrease to zero over time.

EXHIBIT D-2

ISCR Facility Operations Plan
(Monitoring and Response Requirements)

Exhibit D-2. ISCR Facility Operations Plan (Monitoring and Response Requirements)
July 2019

		Component	Monitoring Device	Condition	Possible Cause*	Response	Follow-up Action
System Monitoring and Control Devices	Injection System	Injection Manifold and Pipeline	Pressure Gage or Transducer with upper and lower set points	Pressure exceeds upper setting	Improper pump setting, clogged screens, reduced formation permeability, obstructed well or equipment.	Alarm in control room, stop flow at injection manifold.	Restart injection at lower flow rates.
				Pressure below lower setting	Line break, casing or screen breach.	Alarm in control room, stop flow at injection manifold.	Repair system before restarting flow to injection manifold.
			Flow Meter	Flow rate too high	Improper pump setting, line break, injection well short circuit.	Alarm in control room, stop or reduce flow at injection manifold.	Inspect/repair injection system, increase flow rates in adjoining recovery manifolds as necessary.
				Flow rate too low	Improper pump setting, clogged screens, reduced formation permeability, obstructed well or equipment.	Alarm in control room, reduce flow rates in adjoining recovery manifolds.	Inspect/repair system, adjust injection flow rate as necessary.
			Totalizing Flow Meter	Daily total flow: Total in > total out	Loss of hydraulic control.	Reduce injection flow rate or increase recovery flow rate.	Follow Part II.G of UIC Permit and related reporting and record-keeping requirements.
		Injection Well Head	Flow Meter	No flow	Power loss, line break, instrument failure.	Reduce recovery rate in adjacent wells.	Repair system, adjust flow rates as necessary.
				Flow rate too high	Improper pump setting, injection well short circuit, damaged well casing or equipment.	Reduce injection flow rate as necessary.	Inspect/repair injection system.
				Flow rate too low	Improper pump setting, reduced formation permeability, obstructed well or equipment.	Reduce flow rates in adjoining recovery manifolds.	Inspect/repair system, adjust injection flow rate as necessary.
			Transducer	Pressure exceeds upper limit	Improper pump setting, clogged screens, reduced formation permeability, obstructed well or equipment.	Alarm in control room, stop flow at injection manifold.	Restart injection at lower flow rates.
				Pressure below lower limit	Line break, casing or screen breach.	Alarm in control room, stop flow at injection manifold.	Repair system before restarting flow to injection manifold.
		Injection Well Annular Space	Transducer	Fluid level too high	Loss of packer pressure, injection tubing failure, formation bypass to upper screened zone.	Inspect packer pressure, pressure test packer lines, inspect injection tubing, inspect fluid level conditions at other injection wells.	Repair or replace packer or inflation equipment if necessary, replace damaged injection tubing, monitor fluid level conditions.
	Recovery System	Recovery Manifold and Pipeline	Flow Meter	Flow rate too high	Improper pump setting.	Reduce recovery manifold flow rates as necessary.	Inspect/repair system, reduce recovery flow rate as necessary.
				Flow rate too low	Improper pump setting, reduced formation permeability, obstructed well or equipment.	Increase pump rate.	Inspect/repair system, reduce injection flow rate in adjacent manifolds as necessary.
			Totalizing Flow Meter	Daily total flow: Total in > total out	Loss of hydraulic control.	Reduce injection flow rate or increase recovery flow rate as necessary.	Follow Part II.G of UIC Permit and related reporting and record-keeping requirements.
		Recovery Well Head	Flow Meter Pressure Transducer (in selected wells only)	No flow	Power loss, instrument failure.	Alarm in control room, stop injection in adjoining injection wells.	Repair system before restarting injection.
				Fluid level too high	Improper pump setting, short circuit in adjacent injection wells.	Alarm in control room, adjust pump setting, inspect well, reduce injection in adjoining wells as necessary.	Inspect/repair recovery well and adjacent injection wells as necessary.
				Fluid level too low	Improper pump setting, clogged screen, reduced formation permeability.	Alarm in control room, automatic shut-off of pump.	Evaluate formation, restart well at lower flow rate if necessary.
		Observation Well	Daily sample for TDS analysis	TDS equal to or greater than injected fluid	Localized loss of hydraulic control	Stop injection at the nearest injection well(s). Increase solution extraction from the recovery wells surrounding the injection wells that have been idled to increase or re-establish the inward hydraulic gradient. Increase solution extraction from the 5-spots adjacent to the idled wells.	Monitor water levels in the recovery, observation, and perimeter wells to confirm that the inward hydraulic gradient has been re-established. Monitor water quality daily at the observation wells in which solution was detected.

Exhibit D-2. ISCR Facility Operations Plan (Monitoring and Response Requirements)
July 2019

		Component	Monitoring Device	Condition	Possible Cause*	Response	Follow-up Action
System Monitoring and Control Devices (continued)	ISCR Area Tanks	Raffinate/Lixiviant Tanks	Level Indicators	Fluid level too high	If in production mode, insufficient flow to injection wells or insufficient raffinate bleed to water impoundment. If in recirculation mode, too much flow from PLS tanks.	Alarm in control room, automatic shut-off of pumps at raffinate tanks.	Inspect/repair injection system, adjust pump settings at raffinate tank.
				Fluid level too low	If in production mode, flow too high to injection manifolds or too much raffinate bleed to water impoundment. If in	Alarm in control room, automatic shut-off of injection pumps.	Inspect/repair injection/raffinate system, adjust pumps at raffinate tank.
		PLS Tanks	Level Indicators	Fluid level too high	Recovery rate too high, or flow to SX/EW too low if in production mode, or flow to raffinate tank too low if in recirculation mode.	Alarm in control room, automatic shut-off of recovery and injection wells.	Inspect/repair injection system, adjust pumps to PLS pond and injection manifolds.
				Fluid level too low	Recovery rate too low or flow to SX/EW too high if in production mode, or flow to raffinate pond too high if in recirculation mode.	Alarm in control room, automatic shut-off of injection wells.	Inspect/repair injection/recovery system; inspect/repair lines to raffinate tanks.
	Beneficiation Area Ponds	Raffinate/Lixiviant Pond	Level Indicators	Fluid level too high	If in production mode, insufficient flow to injection wells or insufficient raffinate bleed to water impoundment. If in recirculation mode, too much flow from PLS pond.	Alarm in control room, automatic shut-off of pumps at raffinate tanks.	Inspect/repair injection system, adjust pump settings at raffinate pond.
				Fluid level too low	If in production mode, flow too high to injection manifolds or too much raffinate bleed to water impoundment. If in recirculation mode, insufficient flow from PLS pond.	Alarm in control room, automatic shut-off of injection pumps.	Inspect/repair injection/raffinate system, adjust pumps at raffinate pond.
		PLS Pond	Level Indicators	Fluid level too high	Recovery rate too high, or flow to SX/EW too low if in production mode, or flow to raffinate pond too low if in recirculation mode.	Alarm in control room, automatic shut-off of recovery and injection wells.	Inspect/repair injection system, adjust pumps to PLS pond and injection manifolds.
	Pipeline Corridor			Fluid level too low	Recovery rate too low or flow to SX/EW too high if in production mode, or flow to raffinate pond too high if in recirculation mode.	Alarm in control room, automatic shut-off of injection wells.	Inspect/repair injection/recovery system; inspect/repair lines to raffinate pond.
	Runoff Pond	Sumps	Liquid Detectors	Liquid present	Precipitation or leak.	Alarm in control room. If not raining, arm immediate shut-off of associated pumps.	Assess liquid; return liquid to plant or water impoundment; evaluate and repair pipeline if needed.
	Water Impoundments	Sump	Liquid Level Indicator	Liquid accumulating in sump	Precipitation, leak, spill, wash down.	Alarm in control room; determine nature of liquid. Pump to PLS, raffinate ponds, or neutralizing unit/water impoundment depending on volume and source of liquid.	Inspect sump to confirm that accumulating liquids are being removed.
External Monitoring		Leak Collection and Removal System (LCRS)	Conductivity probe	Presence of liquid in sump above pump-down level	Leak in upper (primary) liner.	Measure and record volume of liquid removed from LCRS sump, determine if ALR or RLL is exceeded.	If ALR or RLL is exceeded, follow APP contingency plan and related reporting and record-keeping requirements.
		Paired Recovery/Observation Wells	Pressure Transducer	Average daily head in recovery well > average daily head in observation well	Loss of hydraulic control.	Increase recovery flow rate or decrease injection flow rate as necessary.	Follow Part II.G of UIC Permit and related reporting and record-keeping requirements.
			Pressure Transducer	Localized daily head in recovery well > average daily head in observation well	Localized loss of hydraulic control.	Stop injection at the nearest injection well(s). Increase solution extraction from the recovery wells surrounding the injection wells that have been idled to increase or re-establish the inward hydraulic gradient. Increase solution extraction from the 5-spots adjacent to the idled wells.	Monitor water levels in the recovery, observation, and perimeter wells to confirm that the inward hydraulic gradient has been re-established. Monitor water quality daily at the observation wells in which solution was detected.

**Faulty monitoring devices will be evaluated as a possible cause of each listed condition.*

EXHIBIT D-3

**Technical Memorandum: Florence ISCR Project –
Process Fluids and Solids Chemistry Update
(prepared by HydroGeoLogica, Inc.)**

HydroGeoLogica **TECHNICAL MEMORANDUM**

To:	Ian Ream, Dan Johnson
Company:	Florence Copper Inc.
From:	Brent Johnson, Erik Guldbech
Date:	May 31, 2019
Subject:	**Florence ISCR Project – Process Fluids and Solids Chemistry Update**

Introduction

Florence Copper Inc. (Florence Copper) has constructed a pilot-scale Production Test Facility (PTF) in Florence, Arizona as part of a planned in-situ copper recovery (ISCR) mining operation. The PTF and subsequent planned operations involves specific chemical, hydrogeological, and water management processes.

As part of the planning and design of the PTF and planned site-scale operations, Florence Copper has requested HydroGeoLogica (HGL) work with Haley & Aldrich to update predictions of the chemistry of process fluids and solids during operations. This memorandum describes the results of the update which were developed using measured values from the field (e.g., groundwater), laboratory results, historical data, and modeling using Geochemists Workbench (GWB 12, Bethke, 2018). Results represent an update of previous estimates chemistry predictions provided by DB Stephens, (2014), and SWS (2012).

Solution and Solid Material Chemistry Descriptions

Table 1 shows a chemistry summary of key mining solutions and one solid (treatment pond sediment) material. In some cases, predicted solutions are identical to previous predictions. In other cases, predictions have been updated to account for recent testing results and/or mine plan changes. A description of each solution is provided below.

Solution 1: Sulfuric Acid Composition

Sulfuric acid solution designed for mineral leaching is commonly acquired through a distributor and is available in a wide range of concentrations. Florence Copper anticipates using a leach solution

comprising 99.5% water and 0.5% sulfuric acid for commercial mining. The estimated composition of Solution 1 in Table 1 is typical of a sulfuric acid solution provided by distributors which is then diluted with water for use on site (Asarco-Martin, 2018).

Solution 2: Forecast Composition PLS

The composition of pregnant leach solution (PLS) from in-situ copper recovery operations is characterized by high sulfate concentrations resulting from sulfuric acid present in raffinate. Florence Copper conducted a pressure rinse test (PRT) to estimate copper extraction kinetics, PLS grade, and acid consumption. The test apparatus consisted of seven, pressurized vessels (PRT #29 - #35) containing mineralized core. Raffinate, and then rinse solutions, were introduced into PRT #29 and then flowed sequentially through the other PRTs until exiting the test at the base of PRT #35. The leaching phase of testing extended 225 days and was following by a 340-day, three-phase rinsing cycle. The results of the PRT program represent an undiluted PLS solution. Considering groundwater will mix with PLS throughout operation, the forecast composition of recovered PLS (Solution 2, Table 1) is expected to be a mixture of 90% PLS and 10% groundwater.

Geochemical calculations relied on results from PRT #35 because it was the last section of core connected in series and thereby represented the most mature PLS. Florence Copper conducted daily metals analysis from solutions collected from each section of core during the PRT and the results were averaged and presented as weekly composites. Solution 2 represents the average concentrations of metals and some anions from these weekly composites (#1 - #24) during the leaching period, day 58-225, to represent typical PLS. Average sulfate concentrations during the leaching phase were not available therefore the sulfate concentration on the first day of the rinse phase (before any dilution was observed) was used as a proxy. GWB was used to estimate pH by setting the solution in equilibrium with atmospheric CO_2. Sample PW-2 (Turner Laboratories) was used to represent the expected composition of groundwater during commercial operations.

Solution 3: Forecast Composition of Raffinate

The solvent extraction (SX) process removes copper from PLS, leaving a barren acidic solution, or raffinate, available for re-use. The Florence Copper SX plant consists of four reverse-flow mixer-settlers and associated facilities. Reactions in an SX plant can vary significantly between facilities, resulting in some uncertainty in estimating an exact solution composition. Florence Copper anticipates using the organic reagent ACORGA M5774 or similar, to extract copper from PLS and estimates a 90% copper recovery rate. Testing by the manufacturer of ACORGA M5774, Cytec Solutions, indicates physical entrainment of specific impurities (Al, Si, Ca, Mg, Fe, Zn, and Mn) is 0.01% to 0.2%, depending on the impurity. Forecast composition of raffinate (Solution 3) reflects a 90% decrease in copper compared to PLS and a 0.01% - 0.2% decrease in the PLS metal impurities.

Solution 4: Forecast Composition of Solution Impoundment

Any water that has no economic value and is not able to be directly discharged due to constituents elevated above Arizona Water Quality Standards is considered waste water. Waste water will be directed to, and stored in, a lined impoundment, treated to maintain a circumneutral pH (at least 6.5) using lime (CaO), and evaporated.

The solutions directed to the impoundment are expected to consist primarily of water extracted from the proposed well field with sulfate exceeding 500 mg/L and copper concentrations below commercial grade (0.2 mg/L). Solutions satisfying these criteria will be generated during the initial leaching and the rinsing phases of an ore block. Additionally, a small amount of raffinate bleed will be neutralized and diverted to the solution impoundment.

A representative "waste water" quality was estimated by mixing the three streams of source water: rinse water (85%), background groundwater (10%), and raffinate bleed (5%). The rinse water component was simulated by mixing representative water from each phase of the three-phase rinsing cycle under the assumption that, at any given time during commercial operations, there will be approximately a third of all rinse water extraction wells in each of the three phases of rinsing. During the leaching program, the three-phase block rising cycle consisted of 62 days of rinsing with fresh groundwater, 89 days of sodium bicarbonate rising, followed by another 27 days of groundwater rising. Commercial scale production anticipates three-phase rinse cycles extending 18 months (6 months for each phase at ½ pore volume per month). Using results from PRT #35, a 30% groundwater rinse, 30% sodium bicarbonate rinse, 30% secondary groundwater rinse was mixed in GWB. This mixture serves as a proxy for any pumped solution considered waste water. The 5% raffinate bleed (Solution 3) was added to simulate discharge from SX/EW plant operations. Finally, the resulting waste solution was titrated (in GWB) with 1.6 g/L of lime to pH 6.5 while allowing selected oxy-hydroxide oversaturated mineral phases to precipitate out of solution. Waste water, Solution 4 (Table 1) reports solution concentrations following the titration. The following mineral phases were allowed to precipitate during the simulation:

- Aluminum hydroxides
- Aluminum sulfates
- Barite
- Bronchantite
- Calcite
- Calcium phosphate
- Cobalt hydroxide
- Jarosite

- Copper hydroxides
- Copper sulfate
- Copper phosphate
- Ferrihydrite
- Gypsum
- Lead hydroxides
- Magnesium Hydroxide
- Nickel Hydroxides
- Zinc Hydroxides

Solid 5: Forecast Composition of Solution Impoundment Sediment

Solid 5 represents the predicted chemical composition of solids precipitated, by weight, during the simulated (GWB) titration of 1.6 g/L of lime. Concentrations of metals removed from solution by both adsorption and precipitation processes are included in sediment totals.

Solution 6: Forecast Composition of Solution After Block Rinsing

After copper concentrations decline below commercial grade within each leaching block, raffinate injections cease and the three-phase rinse cycle (total of 9 pore volumes) begins. In the PRT, nine pore volumes were eluted by day 497 (excluding a brief period of ferric sulfate injection to evaluate in-situ treatment options). Results from day 497 represent solution composition of the ore block after completion of three phase block rinsing.

Solution 7: Composition of Make-up Water

Results from groundwater testing of PW-2 (Turner Laboratories) is the expected composition of make-up water to be used on site.

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Florence Copper, 2016. An Investigation into In-situ Leach Simulation on Drill Core Samples from the Florence Copper Project. October 25, 2016.

SWS, 2012. Geochemical Evaluation of Forecast Process Solutions at Florence Copper Project for Pilot Testing of In-situ Copper Recovery. Schlumberger Water Services. February 22, 2012.

Sources of data:

Florence Copper project files and database and APP submittals (2014-2018)

Table 1 - Solutions and Solid Materials Chemistry Summary

	Arizona Water Quality Standard	1 Composition of H_2SO_4	2 PLS	3 Raffinate	4 Water Impoundment Solution with 1.6 g/L Lime Treatment	5 Water Impoundment Sediment After Lime Treatment	6 Groundwater After Block Rising	7 Makeup Water
	mg/L	mg/L	mg/L	mg/L	mg/L	%	mg/L	mg/L
Metals								
Aluminum	None	na	2,356	2,332	0.006	6.36%	< 0.2	<2.0
Antimony	0.006	0.05 - 0.15	0.45	0.44	0.45	< 0.01 %	0.0015	<0.2
Arsenic	0.05	0.1 -0.4	0.78	0.77	0.16	0.02%	< 1.0	<0.0005
Barium	2	na	0.45	0.45	0.0046	< 0.01 %	0.0014	<0.05
Beryllium	0.004	na	0.0001	0.00005	na	< 0.01 %	na	<0.002
Cadmium	0.005	na	0.45	0.45	0.19	< 0.01 %	0.0014	<0.002
Calcium	None	na	507	502	448	7.88%	160	61
Chromium	0.1	na	1.80	1.78	0.25	< 0.01 %	0.0015	<0.03
Cobalt	None	na	6.31	6.24	< 0.001	0.02%	< 0.3	<0.1
Copper	None	0.2 - 0.5	1,275	127.5	2.99	1.51%	0.15	0.044
Iron	None	7 – 15	1,656	1,639.44	0.00003	4.07%	0.016	0.34
Lead	0.05	0.1 - 0.7	1.80	1.78	0.05	0.01%	< 2	<0.02
Magnesium	None	na	1,799	1,781	346	0.03%	6.95	14
Manganese	None	0.05 - 0.15	62	61	10.38	< 0.01 %	0.20	<0.02
Mercury	0.002	na	0.00008	0.00008	0.0001	< 0.01 %	< 0.0001	<0.001
Nickel	0.1	0.07 - 0.20	3.60	3.57	0.62	< 0.01 %	0.0076	<0.05
Potassium	None	na	513	508	186	0.02%	15	6.2
Selenium	0.05	na	0.0020	0.0020	0.002	< 0.01 %	na	<0.04
Silver	None	na	0.45	0.45	0.08	< 0.01 %	< 0.08	<0.1
Sodium	None	na	406	402	701	< 0.01 %	230	120
Thallium	0.002	na	0.45	0.45	1.01	< 0.01 %	< 3	<0.05
Zinc	None	0.05 - 0.75	26	26	4.10	< 0.01 %	< 0.7	0.095
Anions								
Bicarbonate	None	na	< 0.0017	< 0.0017	1.40	< 0.01 %	120	160
Chloride	None	< 1	16	15.8	15.63	< 0.01 %	227	160
Flouride	4	na	0.025	0.025	0.025	< 0.01 %	na	<0.5
Nitrate	None	< 5	0.82	0.81	0.05	< 0.01 %	na	1.9
Phosphate	None	na	269	267	0.96	0.45%	< 5	<0.5
Sulfate	None	1.77×10^6	30,954	30,644	6,981	79.55%	630	76
Sulfurous Acid	None	2.0 - 15	na	na	na	na	na	na
Field Parameters								
TDS	None	na	39,527	33,383	5886	na	1,304	550
pH	None	na	1.73	1.64	7.02	na	6.22	7.2
Radiochemicals								
Uranium	None	na	0.0013	0.0012	0.0013	< 0.01 %	< 1	0.013

EXHIBIT D-4

Formation Testing Report, Production Test Facility
(prepared by Haley & Aldrich, Inc.)

HALEY ALDRICH

www.haleyaldrich.com

FORMATION TESTING REPORT
PRODUCTION TEST FACILITY
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

by Haley & Aldrich, Inc.
Phoenix, Arizona

REGISTERED GEOLOGIST
CERTIFICATE NO.
49659
LAUREN A.
CANDREVA
Date Signed 8/1/2018
ARIZONA, U.S.A.
Exp 4/30/21

for Florence Copper Inc.
Florence, Arizona

File No. 129687-009
August 2018

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HALEY ALDRICH

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1. Introduction

Florence Copper Inc. (Florence Copper) is in the final stages of constructing a Production Test Facility (PTF) at the Florence Copper Project (FCP) in Florence, Arizona. The purpose of the PTF is to demonstrate the feasibility of In-Situ Copper Recovery at the FCP site as a step toward commercial production at the site. The PTF is being constructed and will be operated in accordance with the United States Environmental Protection Agency (EPA) Underground Injection Control (UIC) Permit No. R9UIC-AZ3-FY11-1 (UIC Permit) and the Arizona Department of Environmental Quality (ADEQ) Temporary Aquifer Protection Permit (APP) No. P-106360.

On 22 March 2018, Florence Copper submitted the "Notification of Intent and Scope of Planned Formation Testing for the PTF Area" (the "Plan"; Florence Copper, 2018), pursuant to requirements of the UIC Permit. The Plan provided details to the EPA and ADEQ regarding the planned execution of formation testing required under Part II.A.2 of the UIC Permit and under Section 2.7.4.3 and Section 3.0 of the APP. Approval of the Plan was received from the EPA in a letter dated 3 May 2018, and via email from ADEQ on 9 May 2018 with clarification made via email communication.

This document provides a summary of the results of formation testing described in the approved Plan. The testing included pump tests conducted at each of the outermost recovery wells, pump tests conducted in upper basin fill and lower basin fill wells, and a dye tracer test. The testing results are presented below in the order that each test element was described in the Plan. The locations of each of the wells tested and monitored during the test are shown on Figure 1.

2. Field Implementation

2.1 PUMPING TESTS AT FOUR OUTERMOST RECOVERY WELLS

The APP requires that Florence Copper conduct pumping tests on each of the four outer recovery wells R-01, R-03, R-05, and R-07. In accordance with the Plan and input received from ADEQ, a step-rate test, constant-rate test, and recovery test were conducted at each of the wells. In addition, spinner-flowmeter surveys were conducted during the constant-rate test at each well.

The step-rate tests consisted of four steps sustained for a minimum of 30 minutes each followed by a constant-rate test that extended a minimum of 8 hours. The constant-rate was conducted by extending the last step of the step-rate tests. Pumping was stopped during the constant-rate tests once the drawdown at the downgradient monitoring well reached a stable drawdown rate.

During testing activities, the pumping well and monitoring wells were monitored using dedicated pressure transducers equipped with data loggers. Manual readings were also collected in the pumping and key observation wells during each test. Discharge and totalizer measurements were recorded using a digital flowmeter with instantaneous flow rate display. Discharge was adjusted as necessary to maintain a constant pumping rate using a ball valve located at the well head. Manual depth to water measurements and totalizer readings were recorded on a standardized field form for each well in the monitoring group.

Water levels in monitoring wells M54-LBF, M54-O, M55-UBF, M56-LBF, M57-O, M58-O, M59-O, M60-O, M61-LBF, MW-01-LBF, and MW-01-O (secondary monitoring wells) were monitored with dedicated transducers at a rate of one measurement per 5 minutes throughout the duration of each recovery well pumping and recovery test. Hydrographs showing drawdown at each of the secondary monitoring wells during testing activities are included in Appendix A.

Southwest Exploration LLC (SW Exploration) was contracted to conduct spinner flowmeter surveys during each constant-rate test. The spinner flowmeter tool was installed in the wells prior to the installation of the test pump to allow tool access in the well screen interval.

2.1.1 R-01 Pumping Test

Haley & Aldrich, Inc. (Haley & Aldrich) personnel conducted the pumping test of recovery well R-01 beginning on 24 May 2018. During this test, the pumping well (R-01) and nearby wells O-07, O-01, and I-01 (primary monitoring wells) were monitored with dedicated transducers at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 23 May 2018 with the pump intake at approximately 305 feet below top of casing (btoc). Prior to the start of pumping, depth to water measurements were taken in the pumping well and three primary monitoring wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-01	232.02	5/24/2018 07:27
I-01	233.34	5/24/2018 07:29
O-01	233.73	5/24/0218 07:34
O-07	231.96	5/24/2018 07:27

The pump at R-01 was started on 24 May 2018 at 07:45. The first pumping step was conducted at an average rate of 6 gallons per minute (gpm) for 31 minutes; step 2 was conducted at an average rate of 11 gpm for 31 minutes; step 3 was conducted at an average rate of 19 gpm for 30 minutes; and, step 4 extended into the constant rate test and was conducted at an average rate of 40 gpm for 483 minutes. After 103 minutes of pumping at the constant rate, SW Exploration conducted a spinner-flowmeter survey of R-01. After 575 minutes of total pumping (including step-rate and constant-rate pumping), the pump was turned off and water level recovery monitoring commenced. Pumping was discontinued at 17:20.

After pumping was discontinued, manual depth to water measurements were recorded for the pumping and primary monitoring wells periodically for approximately 90 minutes. The aquifer was allowed to recover overnight before any further activities were conducted at the well. Following overnight recovery, on 25 May 2018, depth to water measurements of the pumping well and three primary monitoring wells were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-01	233.46	5/25/2018 07:01
I-01	233.83	5/25/2018 08:55
O-01	234.15	5/25/2018 09:47
O-07	232.30	5/25/2018 09:43

The drawdown values observed during the R-01 pumping test and the spinner flow meter profiling results are plotted on Figures 2 and 3, respectively.

2.1.2 R-03 Pumping Test

Haley & Aldrich personnel conducted the pumping test at recovery well R-03 beginning on 22 May 2018. During this test, the pumping well (R-03) and nearby wells O-02, O-03, and I-02 (primary monitoring wells) were monitored with dedicated transducers at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 21 May 2018 with the intake at approximately 305 feet btoc. Prior to the start of pumping, depth to water measurements were taken in the pumping well and three primary monitoring wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-03	231.85	5/22/2018 07:43
I-02	232.08	5/22/2018 07:35
O-02	231.00	5/22/2018 07:37
O-03	230.40	5/22/2018 07:30

The pump at R-03 was started on 22 May 2018 at 07:54. The first pumping step was conducted at an average rate of 6 gpm for 32 minutes; step 2 was conducted at an average rate of 8 gpm for 31 minutes; step 3 was conducted at an average rate of 22 gpm for 31 minutes; and, step 4 extended into the constant-rate test and was conducted at an average rate of 41 gpm for 481 minutes. After approximately 90 minutes of pumping at the constant-rate, SW Exploration conducted a spinner-flowmeter survey of R-03. After 575 minutes of total pumping (including step-rate and constant-rate pumping), the pump was turned off and water level recovery monitoring commenced. Pumping was discontinued at 17:29.

After pumping was discontinued, manual depth to water measurements were recorded for the pumping and primary monitoring wells periodically for approximately 90 minutes. The aquifer was then allowed to recover overnight before any further activities were conducted at the pumping well. On 23 May 2018, depth to water measurements of the pumping well and three primary monitoring wells were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-03	232.43	5/23/2018 07:13
I-02	232.63	5/23/2018 07:32
O-02	231.54	5/23/2018 07:36
O-03	231.04	5/23/2018 07:28

The drawdown values observed during the R-03 pumping test and the spinner flow meter profiling results are plotted on Figures 4 and 5, respectively.

2.1.3 R-05 Pumping Test

Haley & Aldrich personnel conducted the pumping test at recovery well R-05 beginning on 20 May 2018. During this test, the pumping well (R-05) and nearby wells O-04 and I-03 (primary monitoring wells) were monitored with dedicated transducers at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 19 May 2018 with the pump intake at approximately 305 feet btoc. Prior to the start of pumping, depth to water measurements were taken in the pumping well and two primary monitoring wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-05	230.16	5/20/2018 07:35
O-04	229.56	5/20/2018 07:30
I-03	230.53	5/20/2018 07:25

The pump at R-05 was started on 20 May 2018 at 07:40. The first pumping step was conducted at an average rate of 5 gpm for 32 minutes; step 2 was conducted at an average rate of 11 gpm for 32 minutes; step 3 was conducted at an average rate of 20 gpm for 33 minutes; and, step 4 extended into the constant-rate test and was conducted at an average rate of 42 gpm for 504 minutes. After 103 minutes of pumping at the constant rate, SW Exploration conducted a spinner-flowmeter survey of

R-05. After 601 minutes of total pumping (including step-rate and constant-rate pumping), the pump was turned off and water level recovery monitoring commenced. Pumping was discontinued at 17:41.

After pumping was discontinued, manual depth to water measurements were recorded for the pumping and primary monitoring wells periodically for approximately 90 minutes. The aquifer was then allowed to recover overnight before any further activities were conducted at the pumping well. On 21 May 2018, depth to water measurements at the pumping well and two primary monitoring wells were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-05	230.60	5/21/2018 07:12
O-04	230.01	5/21/2018 08:30
I-03	231.18	5/21/2018 07:10

The drawdown values observed during the R-05 pumping test and the spinner flow meter profiling results are plotted on Figures 6 and 7, respectively.

2.1.4 R-07 Pumping Test

Haley & Aldrich personnel conducted the pumping test at recovery well R-07 beginning 17 May 2018. During this test, the pumping well (R-07) and nearby wells O-05, O-06, and I-04 (primary monitoring wells) were monitored with dedicated transducers at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 16 May 2018 with the pump intake at approximately 493 feet btoc. Prior to the start of pumping, depth to water measurements were taken in the pumping well and three primary monitoring wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-07	230.45	5/17/18 08:14
O-05	230.24	5/17/18 06:45
O-06	230.85	5/17/18 06:30
I-04	230.45	5/17/18 06:35

The pump at R-07 was started on 17 May 2018 at 08:16. The first pumping step was conducted at an average rate of 5 gpm for 37 minutes; step 2 was conducted at an average rate of 10 gpm for 59 minutes; step 3 was conducted at an average rate of 20 gpm for 40 minutes; and, step 4 extended into the constant-rate test and was conducted at an average rate of 39 gpm for 488 minutes. After 624 total pumping minutes, the pumping was terminated, and the recovery commenced. Pumping was discontinued at 18:40.

After pumping was terminated, manual depth to water measurements were recorded for the pumping and primary monitoring wells periodically for approximately 90 minutes. The aquifer was then allowed to recover overnight before any further activities were conducted at the pumping well. On 18 May

2018, depth to water measurements of the pumping well and three primary monitoring wells were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
R-07	230.82	5/18/18 07:07
O-05	230.10	5/18/18 07:40
O-06	230.69	5/18/18 07:25
I-04	230.27	5/18/18 07:35

During the pumping test, the cable supporting the spinner-flowmeter tool became wrapped around the pump and consequently the tool could not be lowered to conduct the survey. On 18 May 2018, the tool was freed from the pump after pumping had terminated. The pump was re-installed to a depth of approximately 333 feet btoc and started pumping at 09:11, at a rate of approximately 40 gpm. After approximately 89 minutes of pumping, SW Exploration conducted a spinner-flowmeter survey. This test was in addition to the planned step- and constant-rate tests to collect the spinner-flowmeter data.

The drawdown values observed during the R-07 pumping test and the spinner flow meter profiling results are plotted on Figures 8 and 9, respectively.

2.2 FORMATION TESTING, UPPER BASIN FILL AND LOWER BASIN FILL UNITS

2.2.1 M55-UBF Pumping Test

On 14 May 2018, Haley & Aldrich personnel conducted a 3-hour, constant-rate pumping test of supplemental monitoring well M55-UBF. The pumping well (M55-UBF) and nearby wells M56-LBF, O-06, and O-07 were monitored using pressure transducers over the duration of the pumping and recovery test period. The transducers recorded data at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 14 May 2018 and the intake was set at approximately 253 feet btoc. Prior to the start of pumping, depth to water measurements were taken in the pumping well and three monitoring wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
M55-UBF	229.38	5/14/18 12:50
M56-LBF	230.66	5/14/18 13:00
O-06	232.04	5/14/18 13:04
O-07	232.09	5/14/18 13:08

The pump at M55-UBF was started on 14 May 2018 at 13:28. The initial rate of discharge was 33 gpm. By 13:35, the discharge rate was adjusted to approximately 20 gpm using a ball valve at the well head; this rate of 20 gpm was then held constant throughout the duration of the test. Discharge was measured using an analog totalizer and calculated by timing the discharge over a period of 1 minute. In addition to the transducer measurements, manual depth to water and drawdown measurements were recorded every 15 minutes on a constant-rate aquifer test data field form for M55-UBF.

The pumping test was terminated after 180 minutes of pumping. The aquifer was then allowed to recover overnight. On 15 May 2018, depth to water measurements of the pumping well and three monitoring wells were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
M55-UBF	229.57	5/15/18 06:40
M56-LBF	230.70	5/15/18 07:30
O-06	231.67	5/15/18 12:39
O-07	231.72	5/15/18 12:43

The drawdown values observed during the M55-UBF pumping test are plotted on Figure 10.

2.2.2 M56-LBF Pumping Test

On 31 May 2018, Haley & Aldrich personnel conducted a 3-hour, constant-rate pumping test of supplemental monitoring well M56-LBF. The pumping well (M56-LBF) and nearby wells M55-UBF, O-06, and O-07 were monitored using pressure transducers over the duration of the pumping test and recovery period. The transducers recorded data at a rate of one measurement per minute.

The submersible pump used to conduct the test was installed on 31 May 2018 with the intake set at approximately 312 feet btoc. Prior to the start of pumping, depth to water measurements were taken in the pumping and four monitored wells and were recorded as follows:

Well ID	Depth to Water (feet btoc)	Date/Time
M56-LBF	229.21	5/31/18 11:38
M55-UBF	226.54	5/31/18 11:15
O-06	229.55	5/31/18 11:32
O-07	229.63	5/31/18 11:21

The pump at M56-LBF was started on 31 May 2018 at 11:56. The discharge rate was set to approximately 15 gpm using a ball valve at the well head and held constant at this rate throughout the duration of the pumping test. Discharge and totalizer measurements were recorded using a digital meter with instantaneous flow rate display. In addition to the transducer measurements, manual depth to water and drawdown measurements were recorded every 15 minutes on a constant-rate aquifer test data field form for M56-LBF.

Pumping was discontinued after 186 minutes and the aquifer was then allowed to recover overnight before any further activities were conducted at the pumping well. On 01 June 2018, the depth to water measurement for M56-LBF was recorded as 229.07 feet btoc.

The drawdown values observed during the M56-LBF pumping test are plotted on Figure 11.

2.3 TRACER TESTING

In accordance with Part II.C.8 of the UIC Permit, Florence Copper conducted a tracer test to characterize the formation flow characteristics within the PTF well field. During the tracer test, fluorescent dye was injected in each of the four injection wells (I-01, I-02, I-03, and I-04) while pumping was ongoing at the center recovery well (R-09) at the center of the PTF well field in an attempt to draw the tracer through the formation. The outer recovery wells (R-01 through R-08) were incorporated and used as water level observation points, and the advancement of the tracer from the injection wells was monitored based on observed arrival and concentration observed at the Westbay® wells. There are four Westbay multi-sampling level wells with five sampling zones in each well. The Westbay wells are located between the center recovery well and the injection wells as shown on Figure 1.

Prior to injection of the tracer compound, the center recovery well was started to establish the flow field between the injection wells and recovery well. Groundwater was pumped from the center recovery well (R-09) and distributed by a manifold to the four injection wells (I-01, I-02, I-03, and I-04). The pump intake in R-09 was set at approximately 500 feet below ground surface (bgs). The four injection wells were equipped with straddle packer assemblies to constrain injection into an interval near the center of the screened interval. The bottom packers were landed at approximately 890 feet bgs and the top packers were landed at approximately 656 feet bgs in the blank stainless sections of the well casing.

Native groundwater was circulated for approximately 22 hours prior to introducing the tracer compound. During this time, flow rate from the center recovery well and injection rates into the injection wells were adjusted and monitored to ensure the operating rates would be sustainable for the duration of the test.

On 20 June 2018 at 12:31, dilute fluorescent dye was introduced to the system by pumping dye solution into the discharge line from the pumping well R-09, prior to the distribution manifold leading to the four injection wells. The dilute dye solution was generated by mixing 4 pounds of powdered dye with 55 gallons of fresh water in a mixing tank. The 55-gallons of dye solution was injected over a period of 22.5 hours using a peristaltic pump. At the time of injection, the flow rate of R-09 was approximately 80 gpm. The concentration of fluorescent dye injected was measured at approximately 320 parts per billion (ppb) after a 9:1 dilution with fresh water (approximately 2,880 ppb actual) with a portable fluorescence meter calibrated for fluorescent dye.

Once all of the tracer compound had been injected, Haley & Aldrich personnel began sampling of the four adjacent Westbay wells: WB-01, WB-02, WB-03, and WB-04. Each Westbay well consists of five individual sampling zones that are sealed off by inflatable packers. Zone 1 is approximately 1,127 feet bgs, Zone 2 is approximately 987 feet bgs, Zone 3 is approximately 847 feet bgs, Zone 4 is approximately 706 feet bgs, and Zone 5 is approximately 566 feet bgs. Groundwater samples of each zone were taken daily in the same order. Groundwater samples collected from each zone were then measured for fluorescent dye concentration using a portable calibrated fluorescent meter. It should be noted that not all zones functioned properly during the entirety of the test; therefore, not all zones were able to be sampled every day. Background samples were also collected from functioning zones in each Westbay well and tested for fluorescence before any dye injection occurred. After collection of each groundwater sample, the Westbay sampling equipment was decontaminated using a bleach solution and de-ionized water.

On 25 June 2018 at 14:22, the generator powering the pump at R-09 cut out and the pump was shut off. Pumping did not re-start until 17:37. The pump was off for a total of 3 hours and 15 minutes. The temporary shutoff of the recirculation is expected to have no significant impacts on the tracer transport behavior. The tracer test was terminated when it was confirmed that fluorescent dye was detected in at least one sample zone in each Westbay well. On 28 June 2018 at 15:32, the tracer re-circulation test was ended, and the pump was shut off.

Key findings developed from the tracer test results are discussed below in Section 3.3.

3. Test Results

The aquifer pumping results were analyzed using the program, AQTESOLV (http://www.aqtesolv.com/ and Duffield, 2007). The pumping rate and observed drawdown data were analyzed using the Hantush-Jacob, Moench, and Theis solutions to characterize the hydraulic properties of the tested aquifer zones. The drawdown at observation wells during extraction at the recovery wells was also evaluated to determine the influence of the pumping well.

3.1 RESULTS OF PUMPING TESTS AT FOUR OUTERMOST RECOVERY WELLS

Table 1 summarizes the testing conditions, key observations, and qualitative data interpretation. The water elevation and drawdown trends for the outermost recovery wells, including R-01, R-03, R-05, and R-07, are plotted in Figures 2 through 5. The spinner flow profiling results are plotted on Figures 6 through 9. The raw data for the spinner flow survey are provided in Appendix B. The AQTESOLV results are summarized in Table 2; the full results, including curve fitting solutions, are provided in Appendix C.

The key conclusions of the pumping tests conducted at four outermost recovery wells are:

- The pumping rates at the pumping wells were similar (approximately 40 gpm); however, the maximum drawdowns observed at the pumping wells ranged from 9.5 feet to 30.4 feet, showing some local variability of hydraulic properties in the tested aquifer.
- The spatial drawdown patterns of each of the pumping tests indicate that horizontal anisotropy is not significant in the tested aquifer, evidenced by similar drawdowns observed at the monitoring wells located at similar distances, but in different directions, from the pumping wells.
- A pumping rate of 40 gpm at R-05 and R-07 can induce a significant drawdown (>4 feet) at MW-01-O, indicating a net excess pumping rate of 40 gpm during solution mining in the bedrock formation at the PTF can effectively control the movement of injected solution. Based on the observed magnitude of drawdown at the downgradient operational monitoring well, it is likely the injected solution could be controlled at a lower net extraction rate.
- The observed aquifer responses can be simulated using the analytical solution based on Darcy's law, indicating that the equivalent porous medium assumption is appropriate for the tested aquifer.
- The results of the quantitative analysis using AQTESOLV are consistent with aquifer parameters used in the groundwater flow model prepared in support of APP and UIC permit applications. The estimated average hydraulic conductivity for the tested aquifer is 0.54 feet per day (ft/d), which is consistent with the hydraulic conductivity value (0.57 ft/d) used for the more permeable oxide layers in the site-specific numerical groundwater flow model.[1] The estimated specific storage is 5.2E-7 $feet^{-1}$, which is about an order of magnitude less than the value (5E-6 $feet^{-1}$)used in the model. The specific storage parameter only affects how fast the flow system approaches the steady-state flow conditions and does not have a significant impact on the size of the capture zone achievable by a pumping well at steady-state conditions.

[1] Application for temporary individual Aquifer Protection Permit, Attachment 14A – Hydrologic study Part B, Groundwater flow model (Item 19.H) submitted by Curis Resources (Arizona) Inc.

- The spinner flow profiling results qualitatively show the variability of horizontal hydraulic conductivity at various depths, and that:
  - The lower screened interval is much less permeable than the middle and upper screened intervals; and
  - Low water yield intervals are present between 700 feet bgs and 1000 feet bgs.

3.2 RESULTS OF PUMPING TESTS AT M55-UBF AND M56-LBF

Table 1 summarizes the testing conditions, key observations, and qualitative data interpretation of wells M-55-UBF and M56-LBF. Due to limitation of available drawdown (approximately 20 feet) at pumping well M55-UBF, the test could not produce observable drawdown at the observation wells. The water elevation and drawdown trends for these two pumping tests are plotted in Figures 10 and 11. The AQTESOLV results are provided in Table 2; the full results, including curve fitting, are provided in Appendix C. The AQTESOLV results indicate that the horizontal hydraulic conductivity values of UBF and LBF units (12 ft/d and 2.1 ft/d, respectively) are lower than or near the lower-end values used in the model (20 ft/d and 1 ft/d, respectively).

For the M56-LBF test, a total drawdown of 39.1 feet was achieved at the pumping well. Based on the AQTESOLV analysis using the assumption that the LBF and upper oxide zone are an integrated aquifer, a vertical anisotropic ratio less than 0.1 may exist, suggesting that the vertical hydraulic conductivity between the LBF and upper oxide units is less than 0.5 ft/d. The results indicate that the vertical hydraulic conductivity values used in the model may overestimate the hydraulic connection between the LBF and oxide units.

3.3 TRACER TEST RESULTS

The tracer breakthrough results are shown in Figures 12 through 16. The water elevation trends for each of the wells with a transducer installed during the tracer test are plotted on Figure 17. The tracer was injected only through the middle-screened interval (approximately 675 to 890 feet bgs) in each injection well. The tracer observations at the Westbay wells are summarized below:

- WB-01: The first tracer arrival was detected on 25 June 2018, at a concentration of 0.3 and 200 ppb. First breakthrough was detected in zones 1 and 2, and had been detected in each zone 26 June 2018, approximately 6 days after injection began (Figure 12).
- WB-02: The first tracer arrival was detected on 24 June 2018, at a concentration of 0.8 ppb. First breakthrough was detected in zone 1 and had been detected in each zone, except zones 1 and 5 by 28 June 2018, approximately 8 days after injection began (Figure 13). Zone 5, the deepest zone, did not detect a tracer concentration during the test period.
- WB-03: The first tracer arrival was detected on 23 June 2018, at a concentration of 30 ppb. First breakthrough was detected in zone 5 and had been detected in zones 1, 3, and 5 by 27 June 2018, approximately 7 days after injection began (Figure 14).
- WB-04: The first tracer arrival was detected on 22 June 2018, at a concentration of 50 and 15 ppb. First breakthrough was detected in zones 3 and 4, and had been detected in each zone by 28 June 2018, approximately 8 days after injection began (Figure 15).

The breakthrough behavior at recovery well R-09 shows a gradual increase in tracer concentration. The first breakthrough at R-09 occurred on 23 June 2018, at a concentration of 10 ppb. Toward the end of

monitoring, the tracer concentration trend appeared to level off at a concentration of 30 ppb, indicating that the concentration was close to peak 7 days after initial tracer injection. Based on the 70-foot distance between the injection wells and well R-09, the average tracer velocity between the injection wells to the recovery well is approximately 10 feet per day under test pumping conditions.

In summary, the tracer test results have verified the following:

- The recirculation between injection and recovery wells can control the flow direction of the injected fluid.
- The tracer breakthrough occurred within the anticipated time frame (within 14 days) described in the Plan, which was developed based on the transport parameters used in the groundwater flow model. Consequently, the tracer test confirms that the formation properties used in the groundwater flow model are representative of actual conditions observed in the PTF well field area.

4. Conclusion

Florence Copper has completed pre-operational formation testing at the PTF at the FCP Site. The pre-operational testing is prescribed in UIC Permit R9UIC-AZ3-FY11-1 and was conducted in consultation with ADEQ in order to satisfy additional requirements set forth in APP No. P-106360. The pre-operational testing included pump tests completed at the four outermost recovery wells in the PTF well field, pump testing on one well completed in the upper basin fill unit, pump testing of one well completed in the lower basin fill unit, and a tracer test completed in the PTF well field.

The testing was conducted for the purpose of examining assumptions used during the permitting process regarding hydraulic behavior of the formation as it relates to the ability to maintain hydraulic control and to meet Best Available Design Control Technology (BADCT) requirements.

Results of the testing described in this document demonstrate that;

1. The hydraulic properties used in the groundwater flow model are representative of actual hydraulic properties observed in the PTF well field.
2. No strong horizontal anisotropy exists within the oxide formation in the PTF well field.
3. The equivalent porous media assumption used in development of the groundwater flow model is appropriate.
4. There is sufficient hydraulic connection between the PTF recovery wells, observation wells, supplemental monitoring wells, and point of compliance wells to demonstrate that a cone of depression has been created by the planned pumping.
5. The cone of depression created by planned PTF pumping is sufficient to establish and maintain hydraulic control.

These findings indicate that the PTF well field can establish and maintain hydraulic control of injected fluids and can achieve BADCT requirements set forth in APP No. P-106360.

5. References

1. Duffield, G.M., 2007. AQTESOLV for Windows Version 4.50.002 Professional: HydroSOLVE, Inc., http://www.aqtesolv.com/

2. Florence Copper Inc., 2018. *Notification of Intent and Scope of Planned Formation Testing for the PTF Area Florence Copper Project, Florence Arizona*. 22 March.

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TABLES

TABLE 1
SUMMARY OF PUMPING TEST CONDITIONS AND OBSERVATIONS
FLORENCE COPPER INC.
FLORENCE, ARIZONA

Pumping Well ID	Date/Time Start	Date/Time Stop	Approximate Pumping Rate (gpm) Step 1	2	3	4	Observations
R-01	5/24/2018 7:45	5/24/2018 17:20	6	11	19	40	Total drawdown at the pumping well: 14.3 feet. The decrease in the water head level related to each pumping step can be easily observed in the drawdown plot (Figure 2). Three nearby wells were monitored for drawdown during the R-01 pumping test (distance to the pumping well provided): O-07 (71 ft), I-01 (71 ft), and O-01 (71 ft). The average drawdown of these wells was approximately 6.4 feet, with well O-01 observing the largest total drawdown of 6.7 feet. The drawdown trends for the observed wells displayed consistent drawdown levels throughout the extent of the test. The fact that the three observation wells located on the east, south, and west. The results support that no strong horizontal aquifer anisotropy near R-01.
R-03	5/22/2018 7:54	5/22/2018 17:29	6	8	22	41	Total drawdown at the pumping well: 29.9 feet. The decrease in the water head level related to each pumping step can be easily observed in the drawdown plot (Figure 3). Three nearby wells were monitored for drawdown during the R-03 pumping test (distance to the pumping well provided): O-02 (71 ft), I-02 (72 ft), O-03 (80 ft). The average drawdown of wells O-02 and I-02 was approximately 8.0 feet, with well O-03 observing the largest total drawdown of 8.6 feet. The drawdown trends displayed consistent drawdown levels throughout the extent of the test. The results indicate that there is no strong horizontal aquifer anisotropy near R-03.
R-05	5/20/2018 7:40	5/20/2018 17:41	5	11	20	42	Total drawdown at the pumping well: 30.4 feet. The decrease in the water head level related to each pumping step can be easily observed in the drawdown plot (Figure 4). Four nearby wells were monitored for drawdown during the R-05 pumping test (distance to the pumping well provided): O-04 (70 ft), I-03 (71 ft), M60-O (129 ft), and MW-01-O (427 ft). The drawdown trends for the observed wells displayed consistent drawdown levels throughout the extent of the test. The average drawdown of wells O-04 and I-03 was approximately 7 feet, which is similar to the RO-01 and RO-03 pumping tests. The results support that no strong horizontal aquifer anisotropy exists near R-05. The maximum drawdown observed at M-01-O was 4.7 feet, indicating that a 40 gpm pumping rate at the recovery well can significantly influence groundwater hydraulics in the oxide zone 400 feet away from the pumping well. The results indicate that a net excess pumping rate of 40 gpm during solution mining in the formation at the Proposed Test Facility can effectively control the movement of injected solution.
R-07	5/17/2018 8:16	5/17/2018 18:40	5	10	20	39	Total drawdown at the pumping well: 9.5 feet. The decrease in the water head level related to each pumping step can be easily observed in the drawdown plot (Figure 5). Six nearby wells were monitored for drawdown during the R-07 pumping test (distance to the pumping well provided): O-06 (71 ft), I-04 (71 ft), O-05 (91 ft), M57-O (209 ft), MW-01-O (244 ft), and M60-O (233 ft). The average drawdown of wells O-06 and I-04 was approximately 5.9 feet,
M55-UBF	5/14/2018 13:28	5/14/2018 16:28	20				Total drawdown at the pumping well: 9.4 feet. A consistent pumping rate of approximately 20 gpm was maintained for the duration of the pump test. Nearly immediately after the start of pumping, a decrease in the water head level was observed, but maintained a fairly consistent drawdown depth of approximately 9 feet. Three nearby wells were monitored for drawdown during the M55-UBF pumping test (distance to the pumping well provided): M56-LBF (32 ft), O-06 (80 ft), and O-07 (82 ft). A decrease in water level was not observed in nearby wells during the pumping period, indicating that the hydraulic connection between the UBF and LBF units is limited.
M56-LBF	5/31/2018 11:56	5/31/2018 15:02	15				Total drawdown at the pumping well: 39.1 feet. A consistent pumping rate of approximately 15 gpm was maintained for the duration of the pump test. Nearly immediately after the start of pumping, the decrease in the water level was substantial, but maintained a fairly consistent drawdown depth of approximately 39 feet. Three nearby wells were monitored for drawdown during the M56-LBF pumping test (distance to the pumping well provided): M55-UBF (32 ft), O-06 (107 ft), and O-07 (109 ft). A decrease in water head level was not observed in nearby wells during the pumping period, indicating that the hydraulic connection between the LBF and the oxide units is restricted.

Notes:
gpm = gallons per minute
ft = feet

TABLE 2
AQUIFER HYDRAULIC DATA OBTAINED FROM AQTESOLV ANALYSIS
FLORENCE COPPER INC
FLORENCE, ARIZONA

R-01 - Pumping Well						
Observation Wells	Estimated Aquifer Parameters					
	T (ft^2/d)	S	1/B (ft)	Sw	C	P
O-01	407	9.8E-04	7.5E-04	-3.6	0.13	1.75
O-07	411	1.4E-03	9.1E-04	-3.5	0.13	1.75
I-01	407	1.0E-03	8.6E-04	-3.6	0.13	1.75

R-03 - Pumping Well						
Observation Wells	Estimated Aquifer Parameters					
	T (ft^2/d)	S	1/B (ft)	Sw	C	P
O-02	434	7.8E-04	2.4E-05	-0.2	0.34	1.63
O-03	364	3.4E-04	7.3E-04	-1.5	0.34	1.63
I-02	331	7.8E-04	1.6E-03	-1.5	0.34	1.63

R-05 - Pumping Well						
Observation Wells	Estimated Aquifer Parameters					
	T (ft^2/d)	S	1/B (ft)	Sw	C	P
0-04	522	7.8E-04	2.7E-04	2.3	0.13	1.50
I-03	447	6.0E-04	5.9E-04	0.9	0.13	1.50
M60-O	615	7.9E-04	1.7E-04	3.8	0.13	1.50
MW-01-O	426	1.0E-04	4.0E-04	-0.1	0.13	1.50

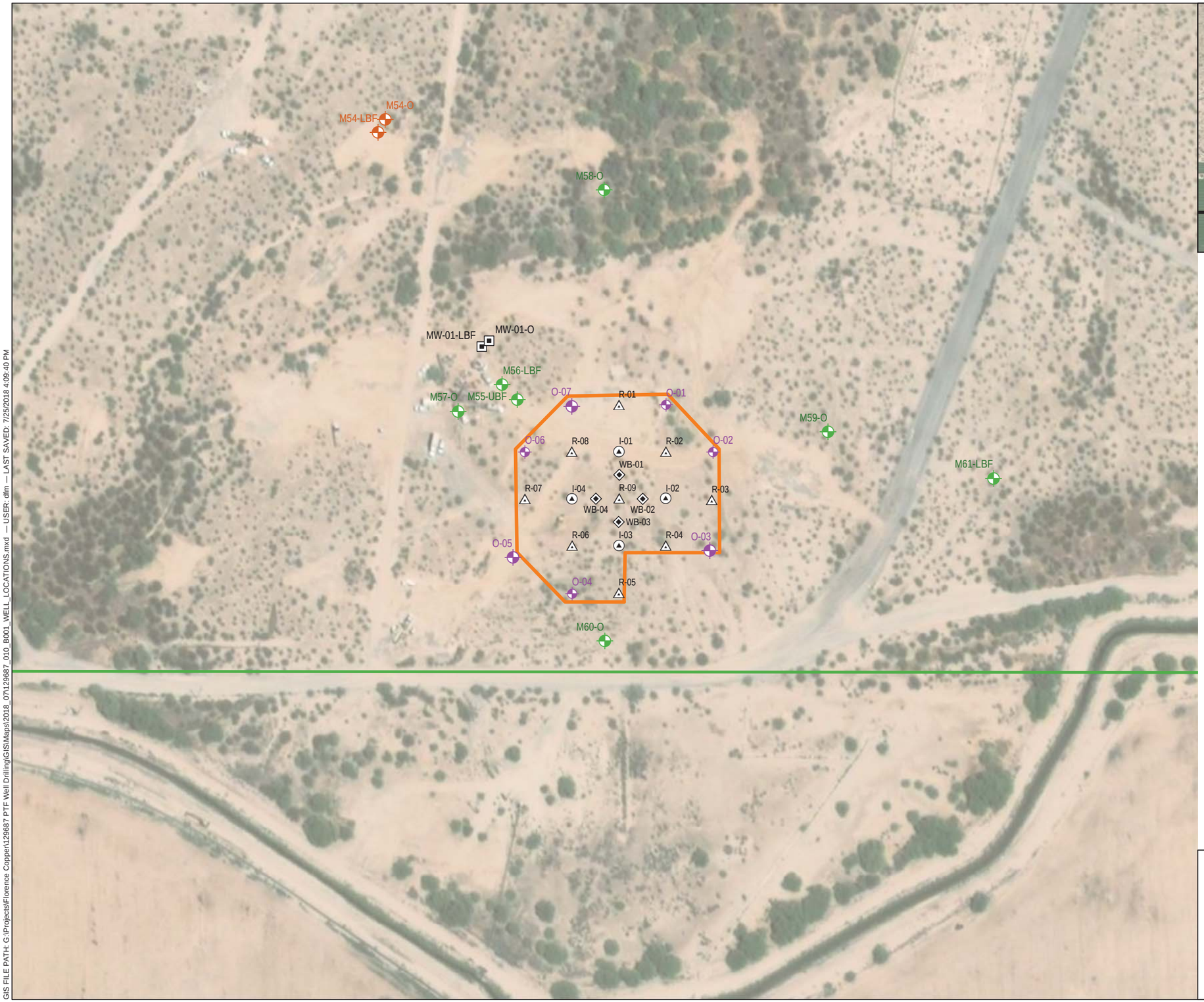
R-07 - Pumping Well						
Observation Wells	Estimated Aquifer Parameters					
	T (ft^2/d)	S	1/B (ft)	Sw	C	P
O-05	407	1.3E-04	4.4E-04	-5.2	0.087	1.64
0-06	544	5.0E-04	2.4E-05	-4.3	0.087	1.64
I-04	522	7.5E-04	1.9E-04	-4.2	0.087	1.64
M60-O	544	4.2E-04	7.2E-04	-4.3	0.087	1.64
M57-O	482	1.1E-04	3.8E-04	-5.1	0.087	1.64
MW-01-O	453	6.5E-05	2.4E-05	-5.6	0.087	1.64

UBF and LBF Pumping Wells					
Pumping Wells	Key Estimated Aquifer Parameters				
	T (ft^2/d)	K (ft/d)	S	Ss (ft^{-1})	Sy
M55-UBF	483	12	1.2E-03	2.3E-05	0.1
M56-LBF	107	2.1	3.2E-03	6.4E-05	

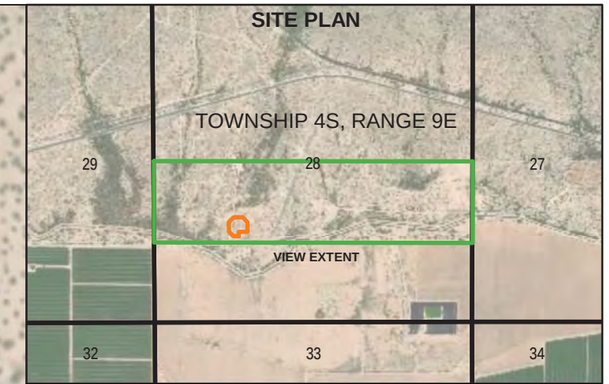
Notes:

1. *T = transmissivity, S = storage coefficient, 1/B = leaky factor, Sw = skin factor, C = nonlinear well loss coefficient; P = nonlinear well loss exponent; K = hydraulic conductivity; Ss = specific storage ; ft= feet; ft/d = feet per day; ft^2/day = square feet per day.*
2. *Aquifer thickness was (H) assumed to be 841 feet.*
3. *Geometric means of T and S using the results of R-01, R-03, R-05, and R-07 are 451.5 ft^2/d and 4.34E-4.*
4. *The average hydraulic conductivity (calculated using the ratio of the geometric mean of T to H) was estimated to be 0.54 ft/d.*
5. *The estimated specific storage (calculated using the ratio of the geometric mean of S to H) was 5.2E-7 ft^{-1}.*

FIGURES



SITE PLAN



0 1,250 2,500
SCALE IN FEET

LEGEND

- OBSERVATION WELL
- SUPPLEMENTAL MONITORING WELL
- POINT-OF-COMPLIANCE WELL

PTF WELLS

- INJECTION
- RECOVERY
- WESTBAY WELL
- OPERATIONAL MONITORING
- PTF WELL FIELD
- STATE LAND LEASE

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 150 300
SCALE IN FEET

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FLORENCE, ARIZONA

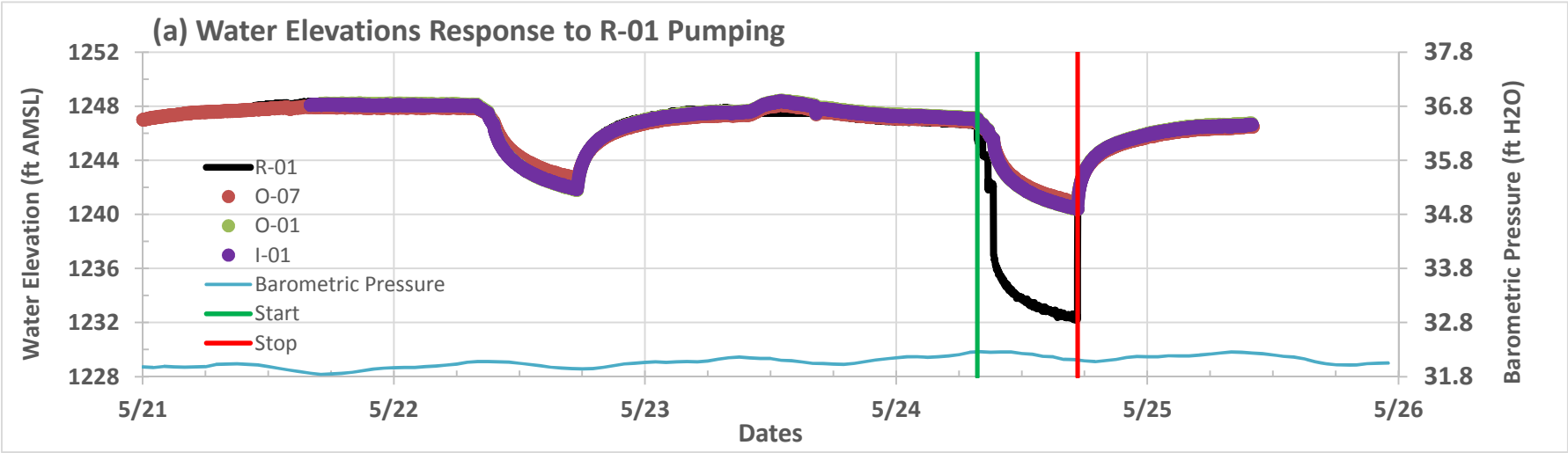
AQUIFER TESTING WELL LOCATIONS

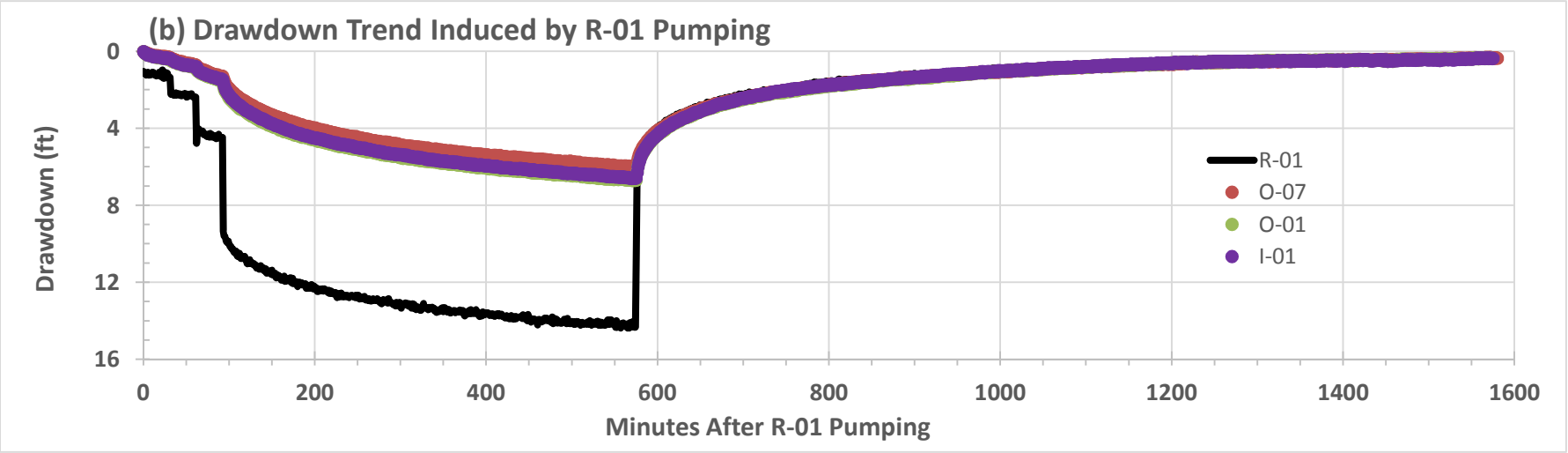
FLORENCE COPPER INC.

JULY 2018

FIGURE 1

GIS FILE PATH: G:\Projects\Florence Copper\129687 PTF Well Drilling\GIS\Maps\2018_07\129687_010_B001_WELL_LOCATIONS.mxd — USER: dfm — LAST SAVED: 7/25/2018 4:09:40 PM





NOTES

1. Transducer data are based on compensated values. Water elevation values are based on transducer data.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.
3. The influence of R-03 pumping is shown between 5/22 and 5/23.
4. The influence of R-01 pumping is shown between 5/24 and 5/25.

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R-01 PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

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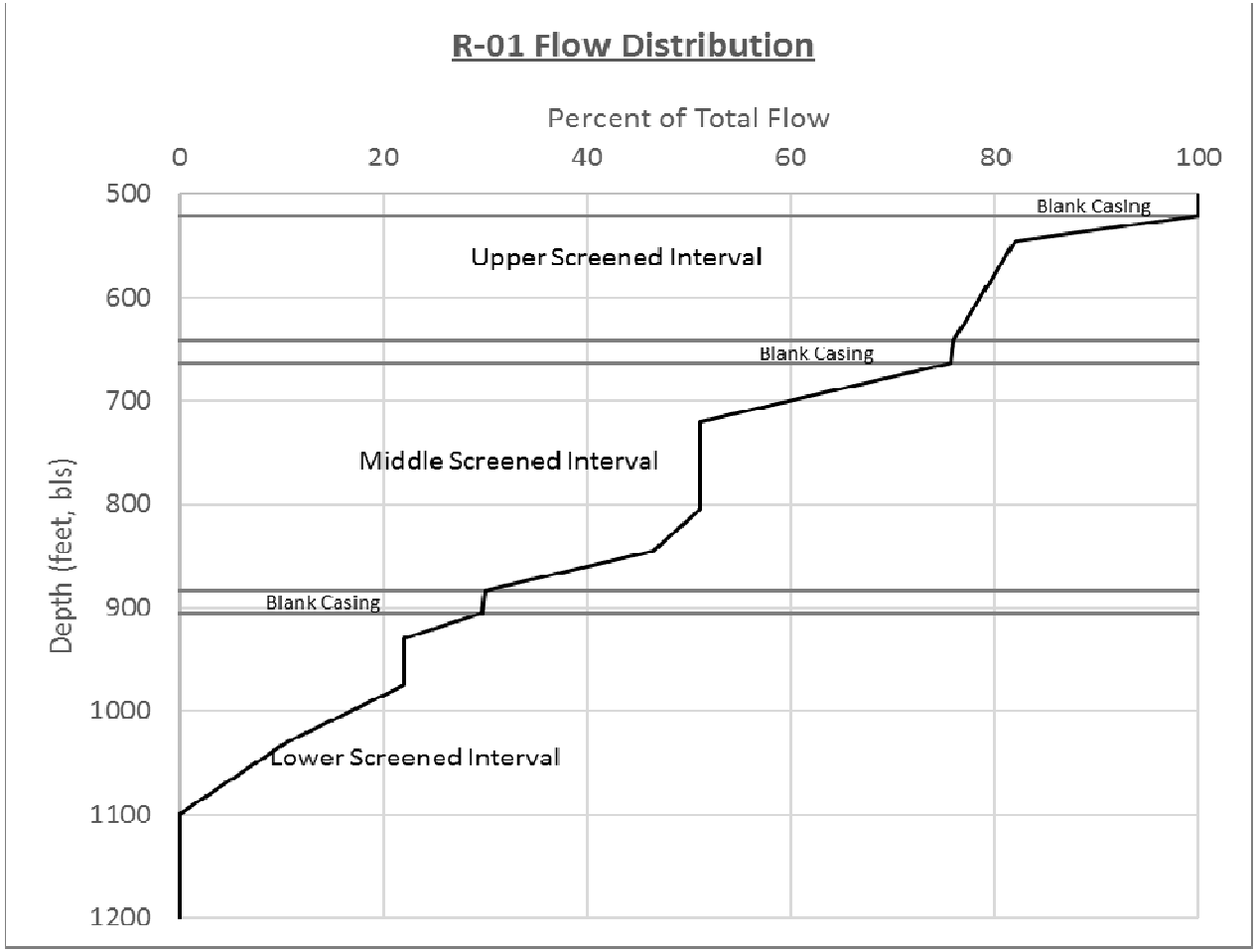
FIGURE 2

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 02_R-01_Hyc



NOTES

bls = below land surface
Raw data are provided in Appendix B.

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R-01 SPINNER FLOW PROFILING

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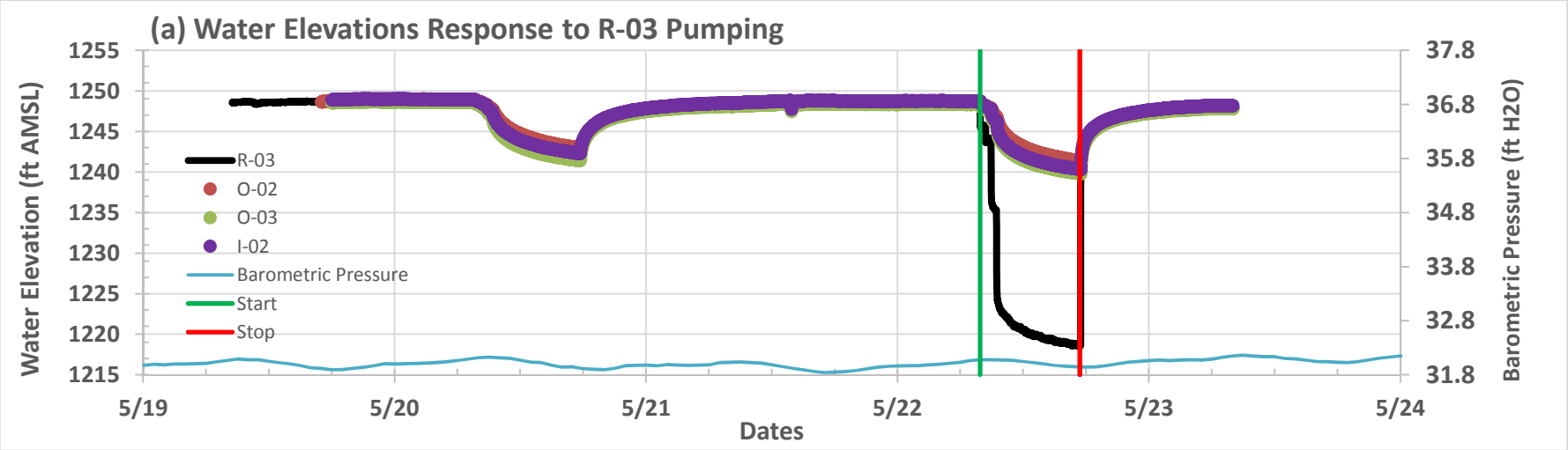
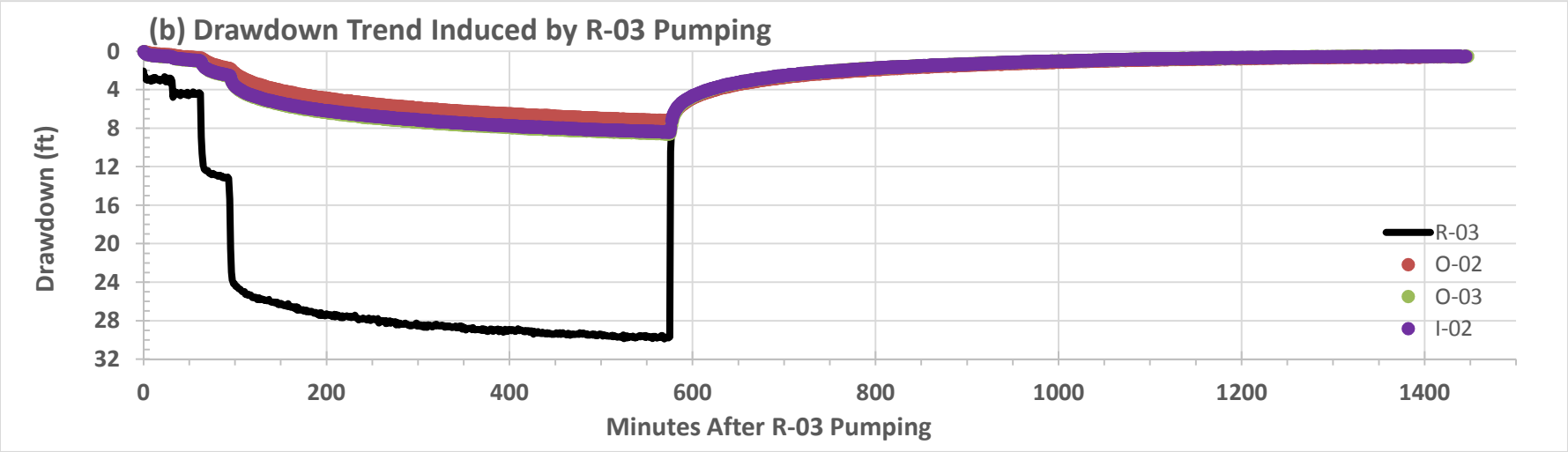
FIGURE 3

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 03_R-01_Spi





NOTES

1. Transducer data are based on compensated values. Water elevation values are based on the transducer data.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.
3. The influence of R-05 pumping is shown between 5/20 and 5/21.
4. The influence of R-03 pumping is shown between 5/22 and 5/23.

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R-03 PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

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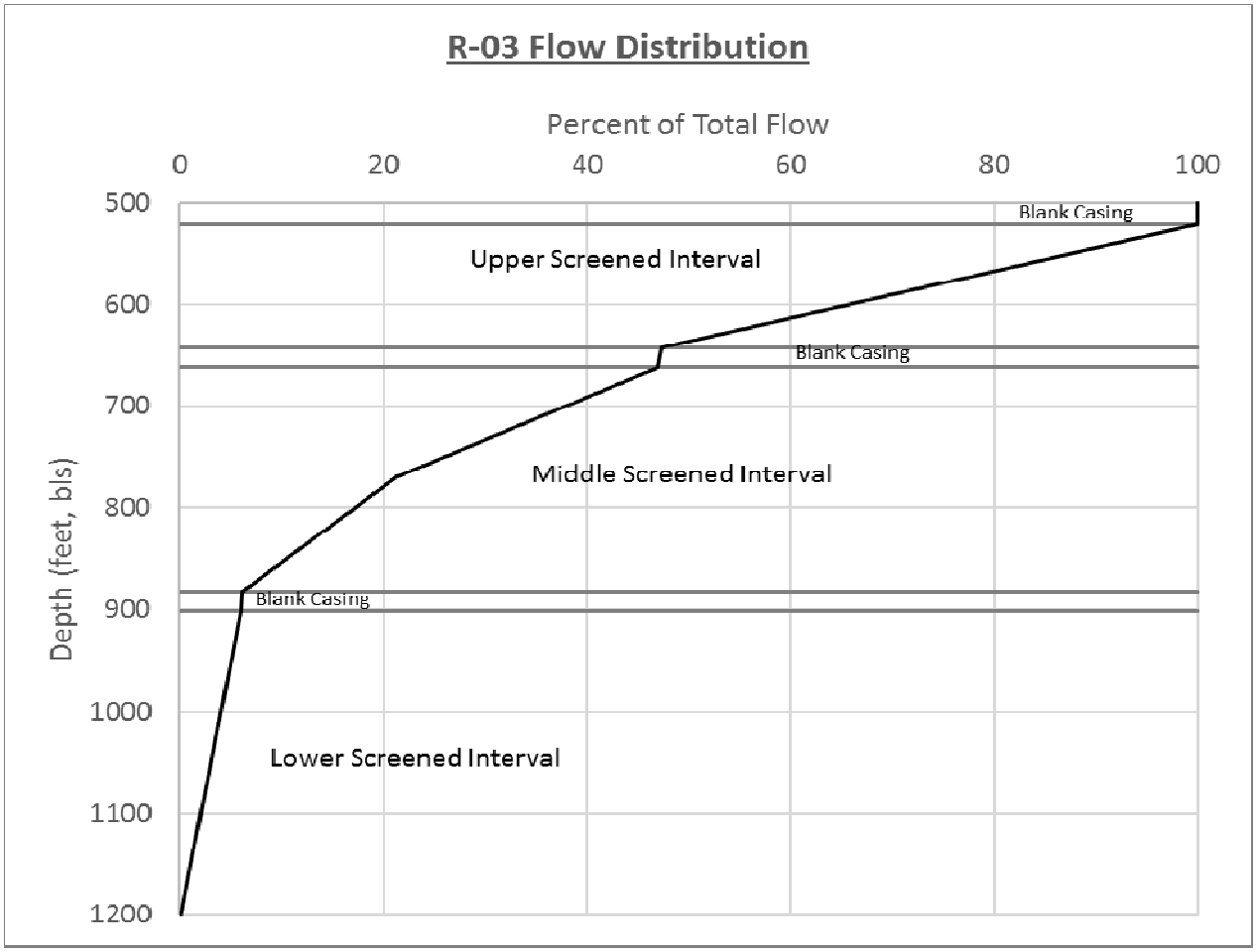
FIGURE 4

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 04_R-03_Hyc



NOTES

bls = below land surface
Raw data are provided in Appendix A.

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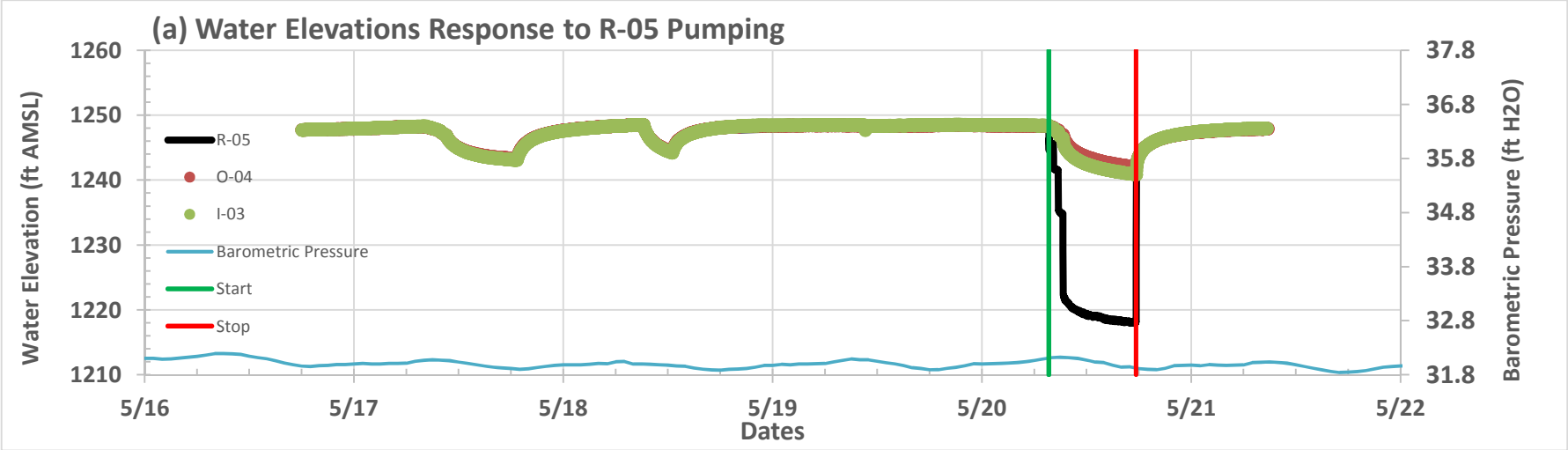
FLORENCE, ARIZONA

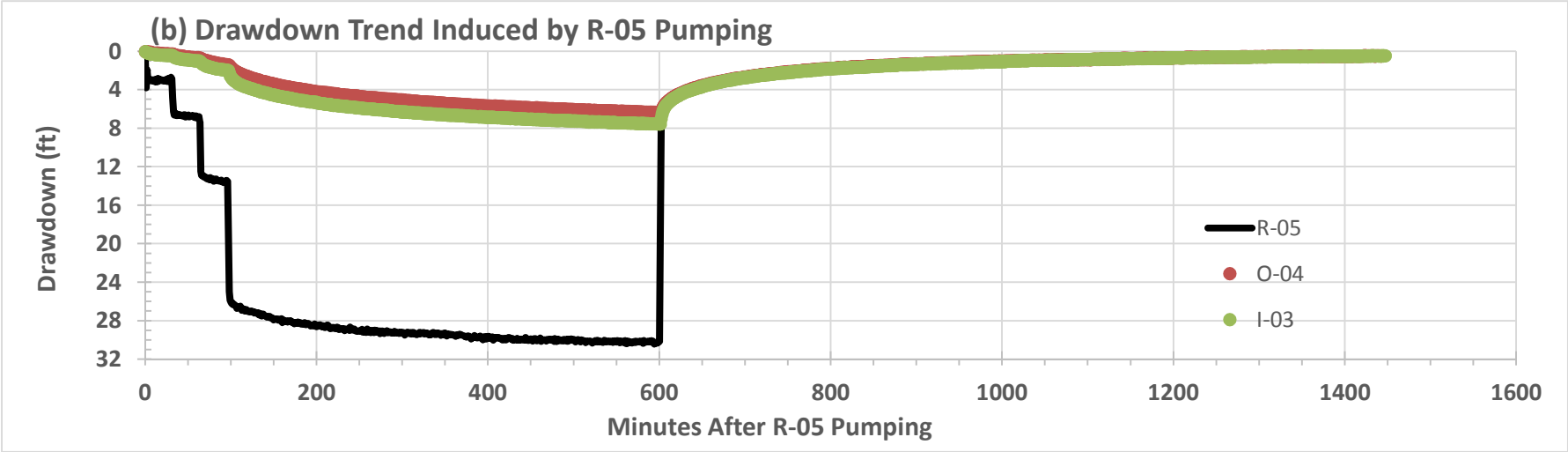
R-03 SPINNER FLOW PROFILING

JULY 2018

FIGURE 5

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 05_R-03_Spi





NOTES

1. Transducer data are based on compensated values. Water level elevation values are based on transducer data.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.
3. The influence of R-07 pumping is shown between 5/17 and 5/18.
4. The influence of R-07 spinner flow profiling is shown between 5/18 and 5/19.

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R-05 PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

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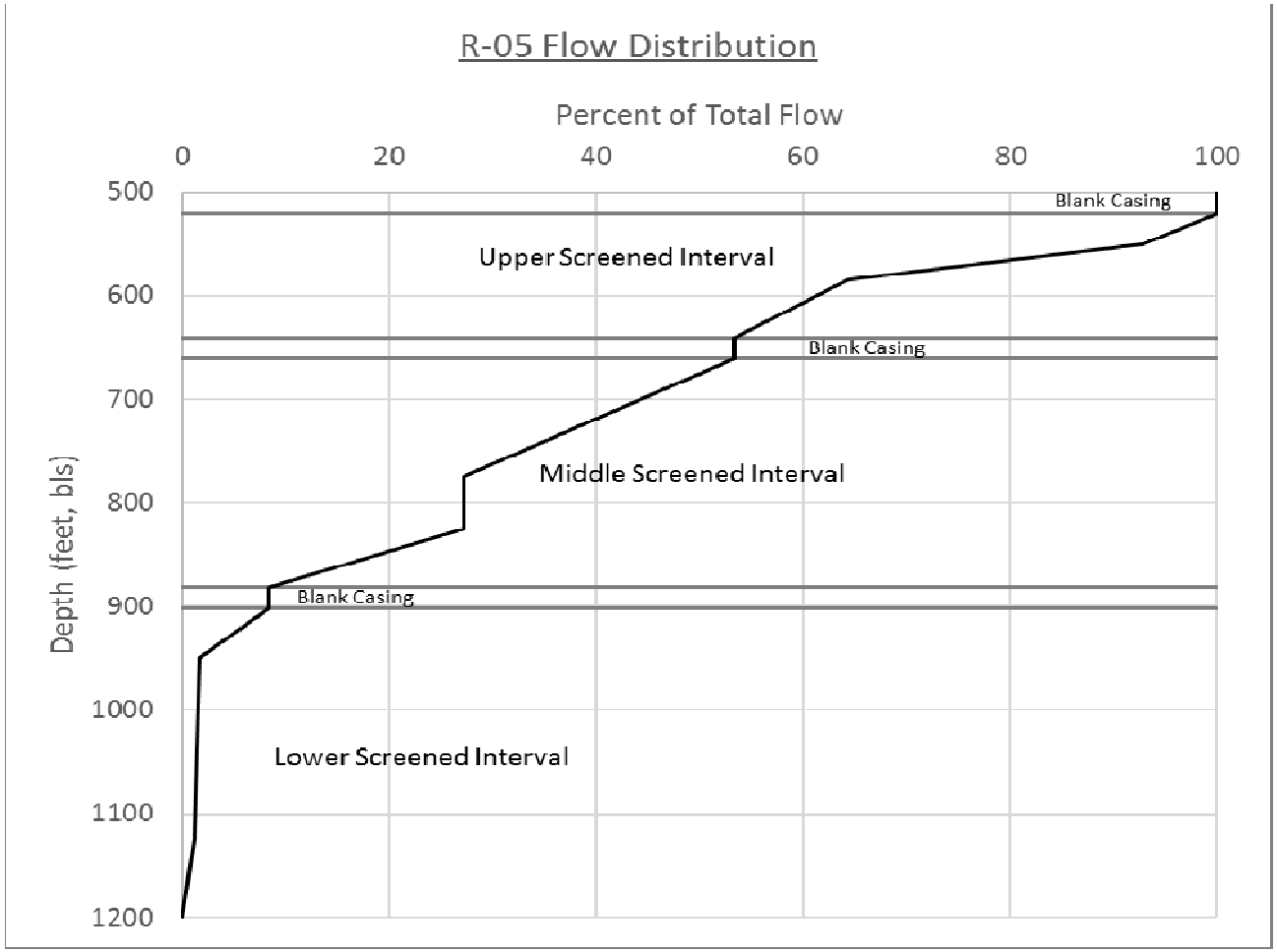
FIGURE 6

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 06_R-05_Hyc



NOTES

bls = below land surface
Raw data are provided in Appendix A.

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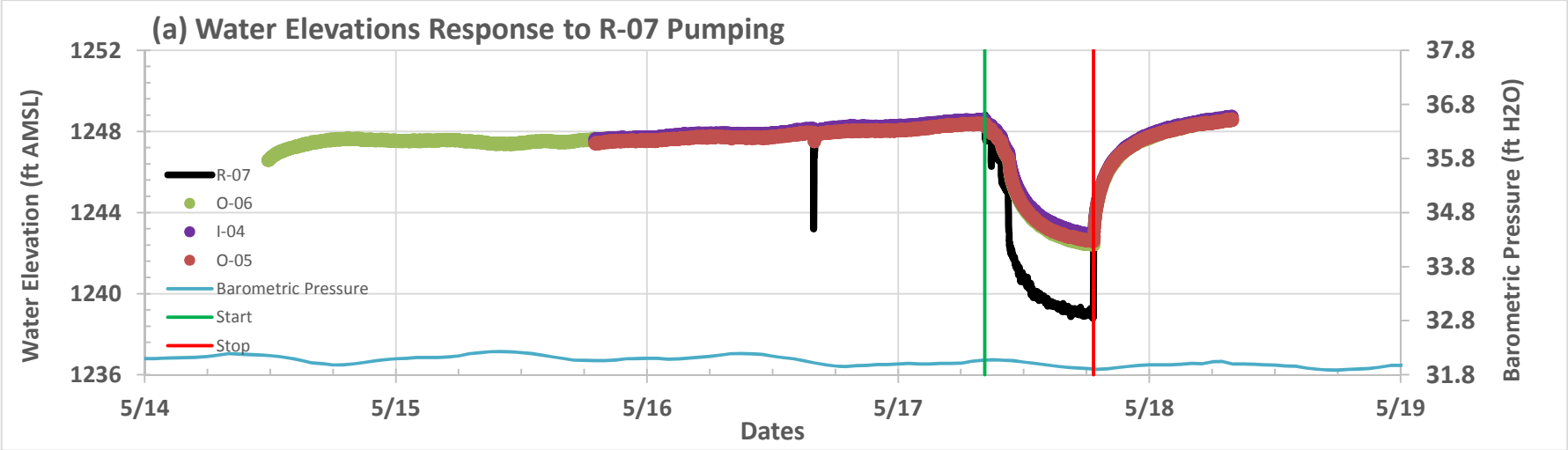
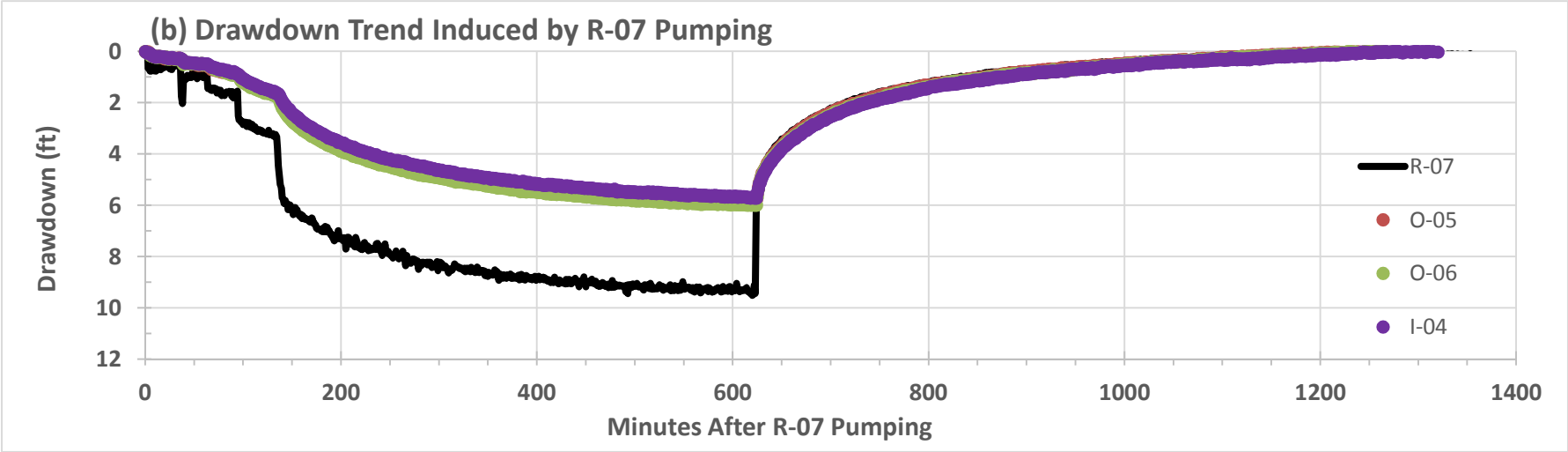
R-05 SPINNER FLOW PROFILING

JULY 2018

FIGURE 7

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 07_R-05_Spi





NOTES

1. Transducer data are based on compensated values. Water elevation values are based on the transducer data.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.
3. The influence of R-07 pumping is shown between 5/17 and 5/18.

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R-07 PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

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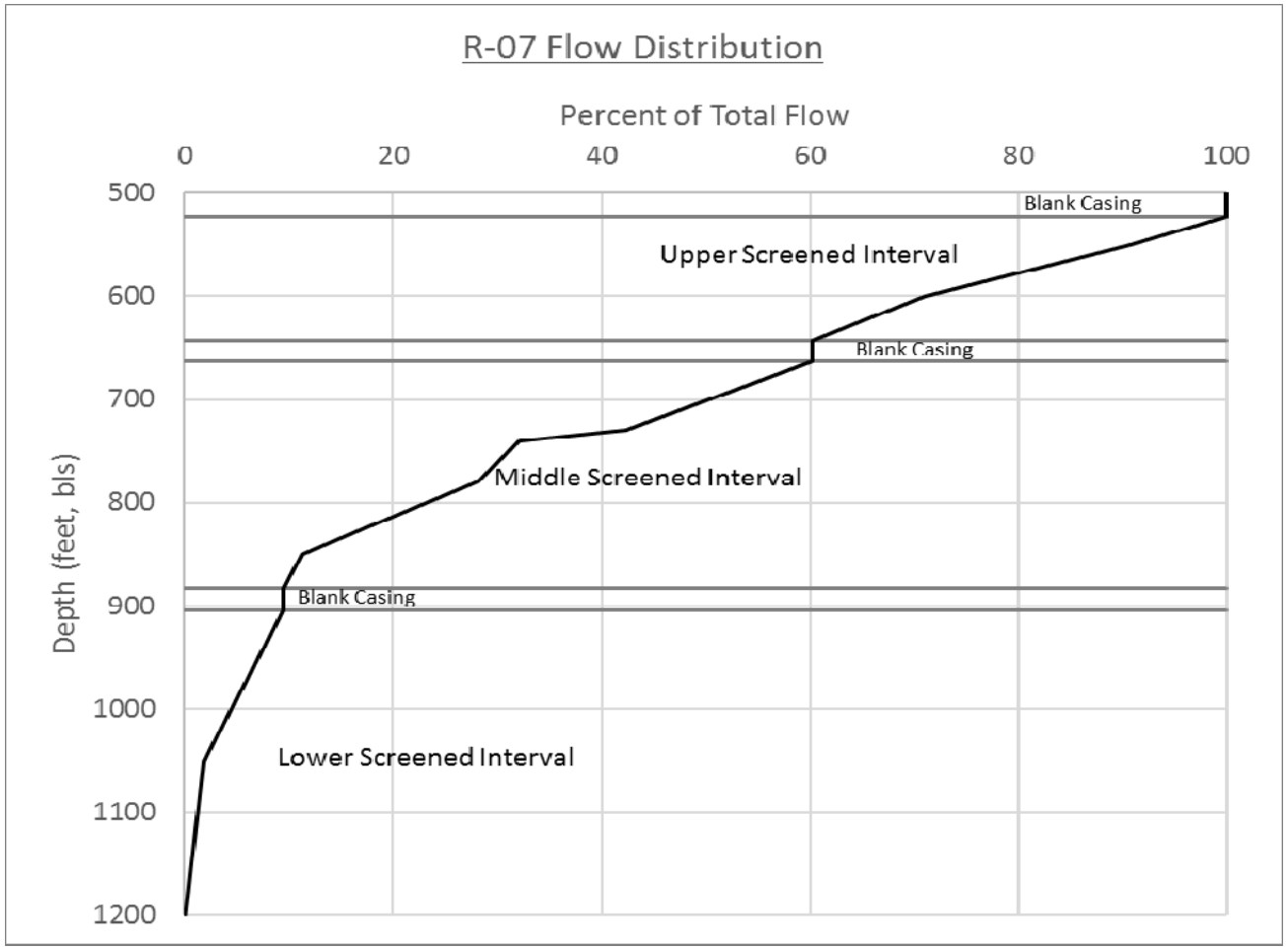
FIGURE 8

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 08_R-07_Hyc



NOTES

bls = below land surface
Raw data are provided in Appendix A.

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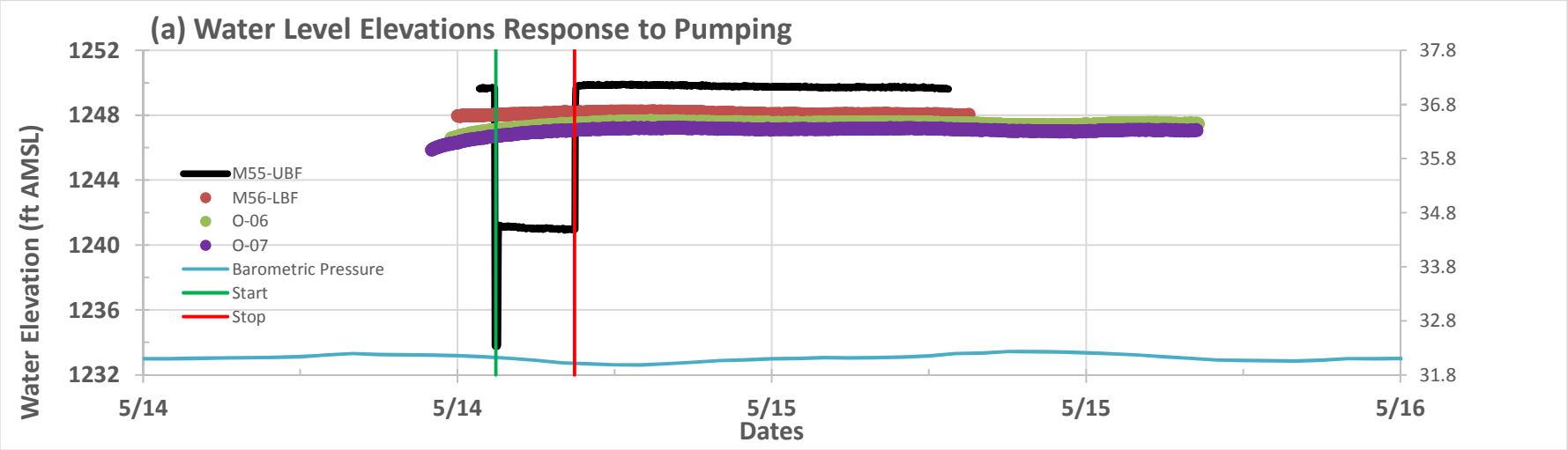
FLORENCE, ARIZONA

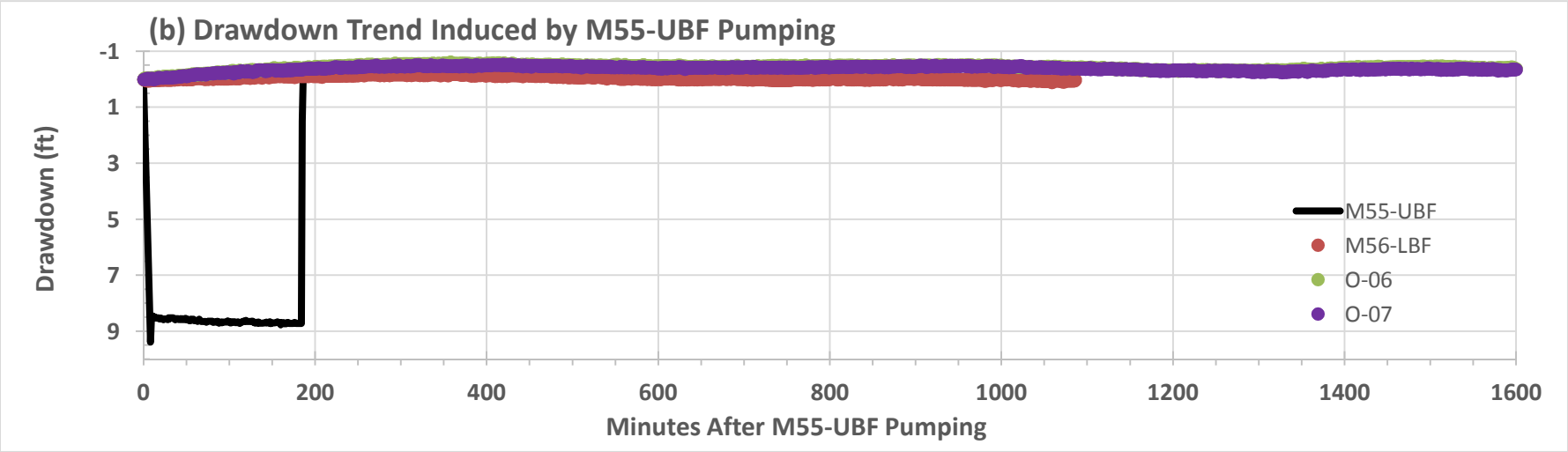
R-07 SPINNER FLOW PROFILING

JULY 2018

FIGURE 9

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 09_R-07_Spi





NOTES

1. Transducer data are based on compensated values.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.

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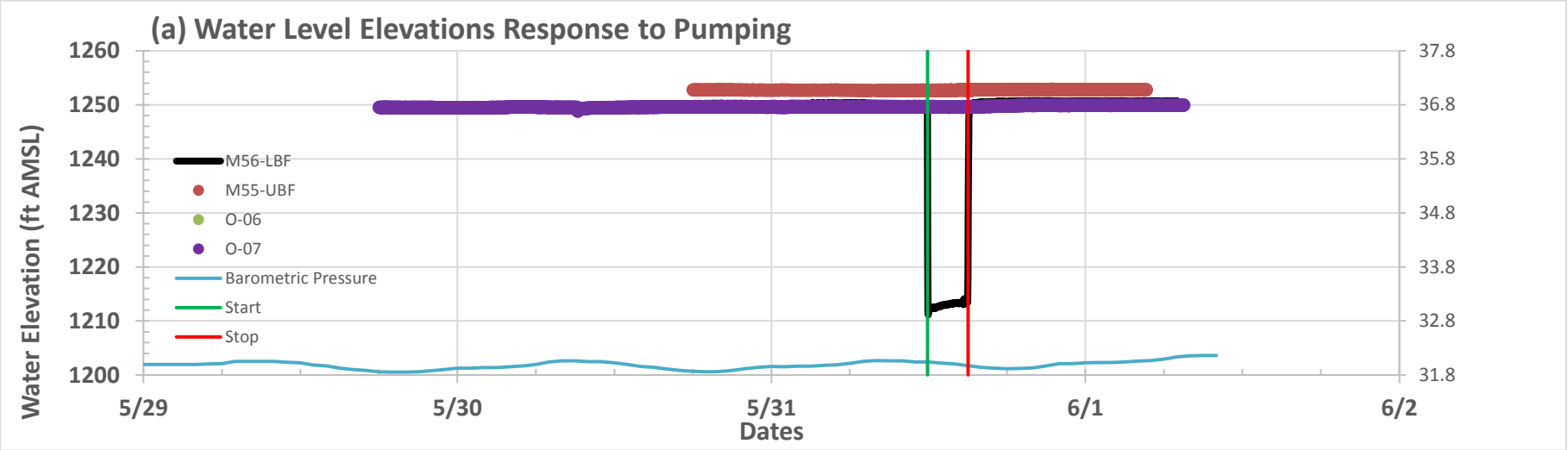
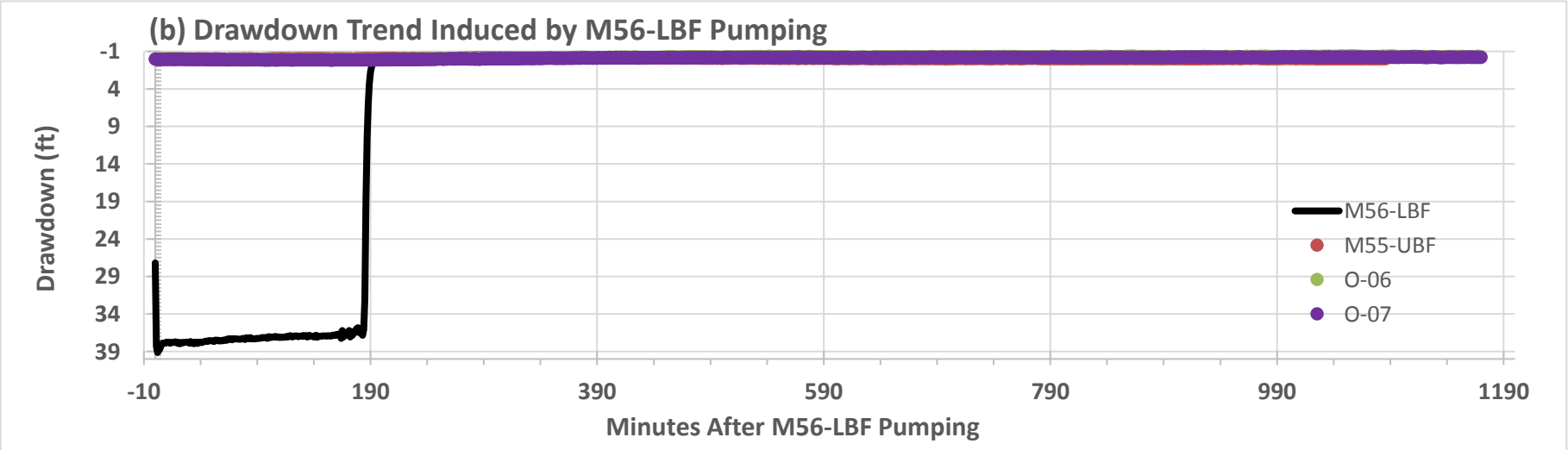
M55-UBF PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

JULY 2018

FIGURE 10

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 10_M55-UBF





NOTES

1. Transducer data are based on compensated values.
2. The magnitude of barometric pressure fluctuation is very small in comparison with the magnitude of drawdown; therefore, correction to the drawdown values is not needed.

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M56-LBF PUMPING TEST
HYDROGRAPHS AND DRAWDOWN TRENDS

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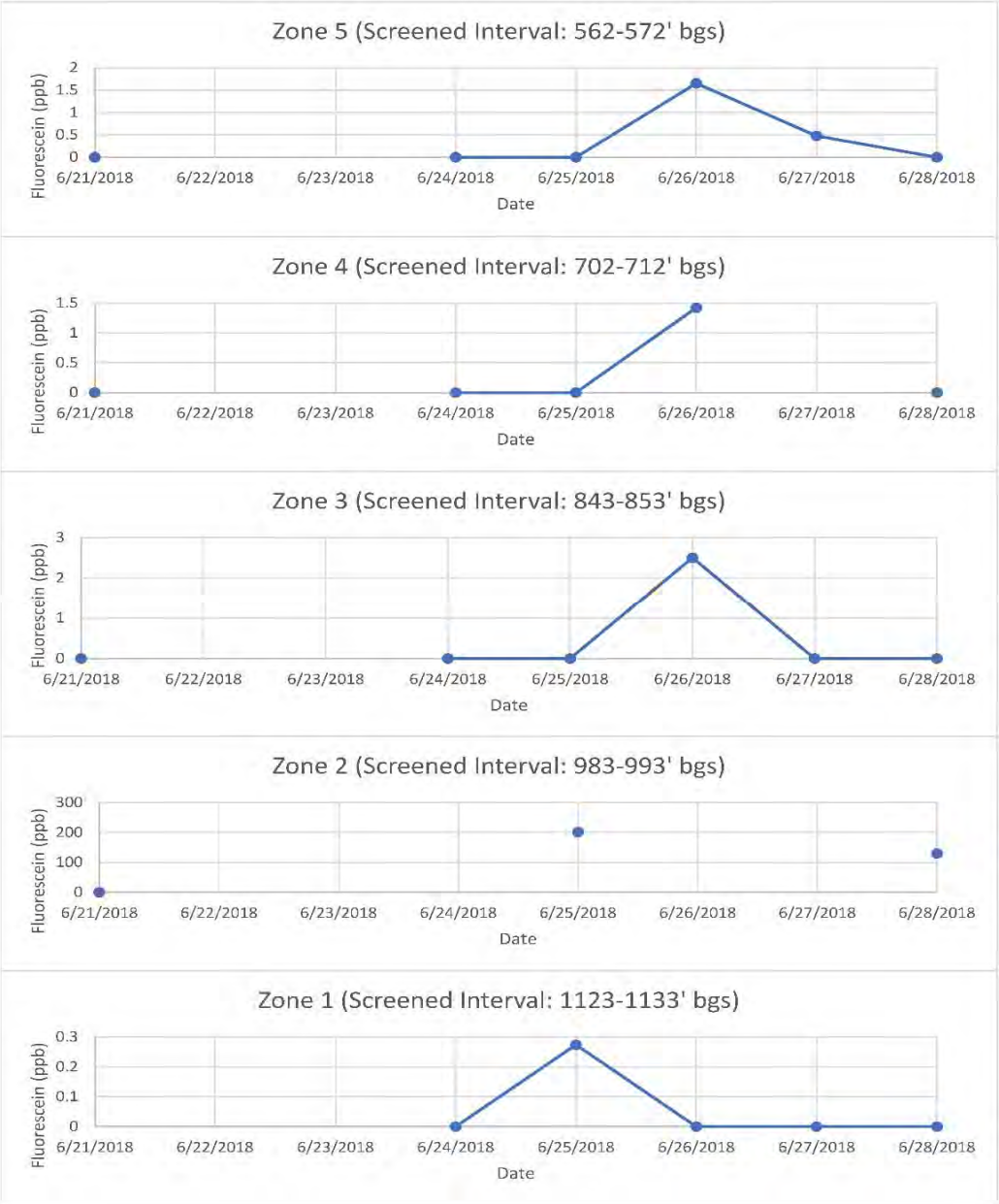
FIGURE 11

G:\Projects\Florence Copper\129687 PTF Well Drilling\Deliverables\Formation Testing Report\Figures\[Figure 11_M56-LBF.



NOTES

ppb = parts per billion (or µg/L)
bgs = below ground surface

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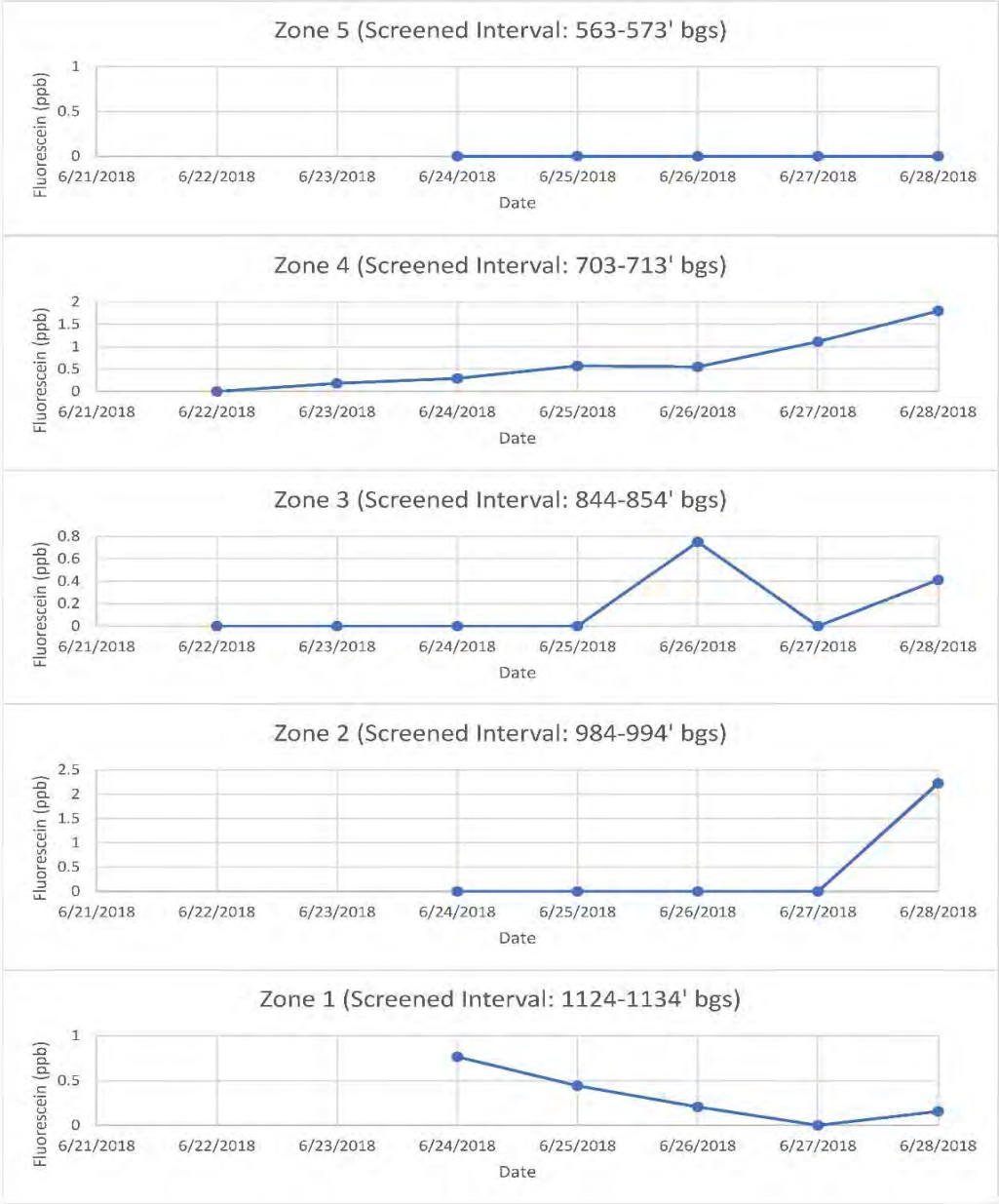
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

TRACER BREAKTHROUGH AT WB-01

JULY 2018

FIGURE 12

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\Project Data\Field Data\Aquifer



NOTES

ppb = parts per billion (or ug/L)
bgs = below ground surface

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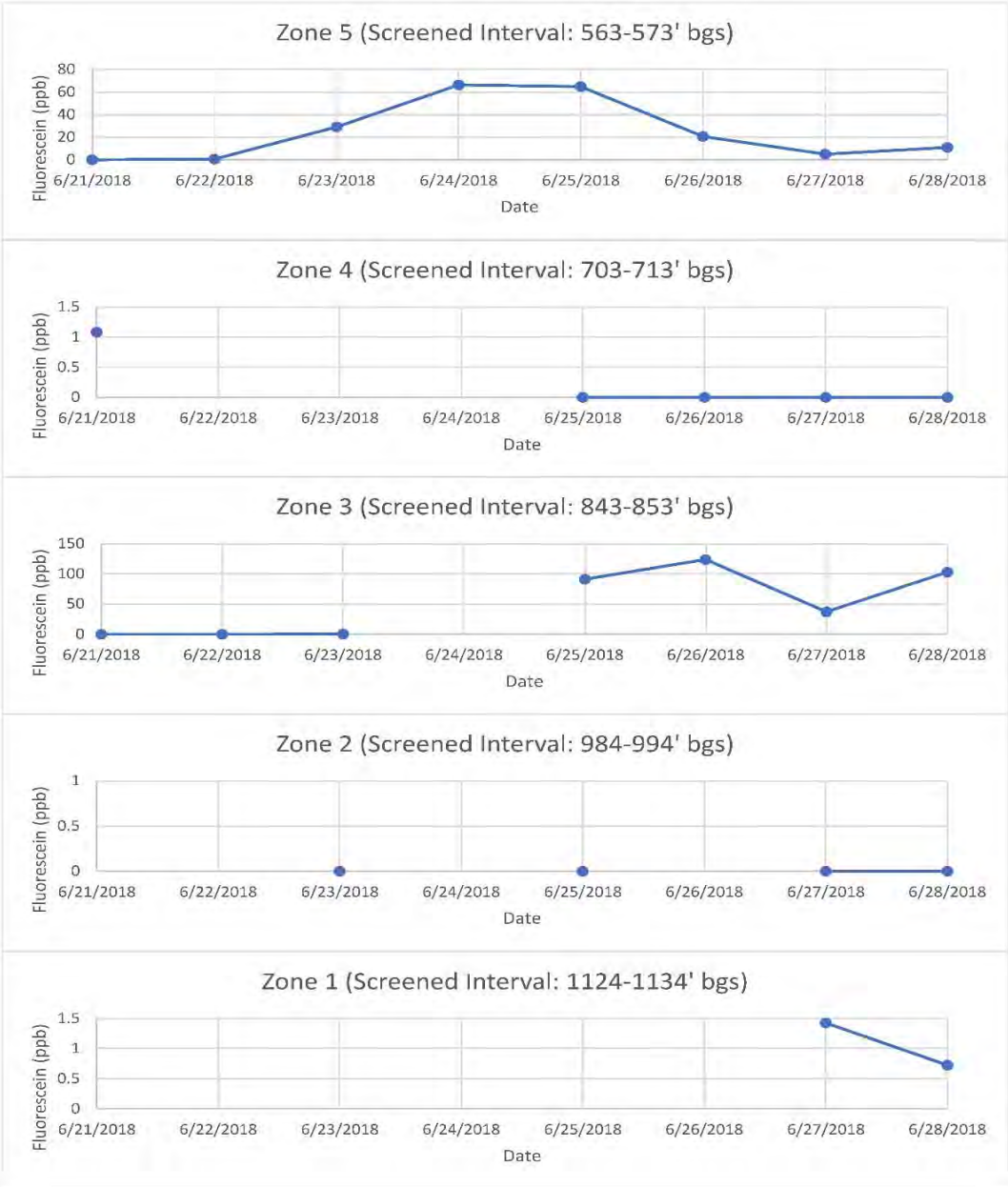
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

TRACER BREAKTHROUGH AT WB-02

JULY 2018

FIGURE 13

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\Project Data\Field Data\Aquifer



NOTES

ppb = parts per billion (or ug/L)
bgs = below ground surface

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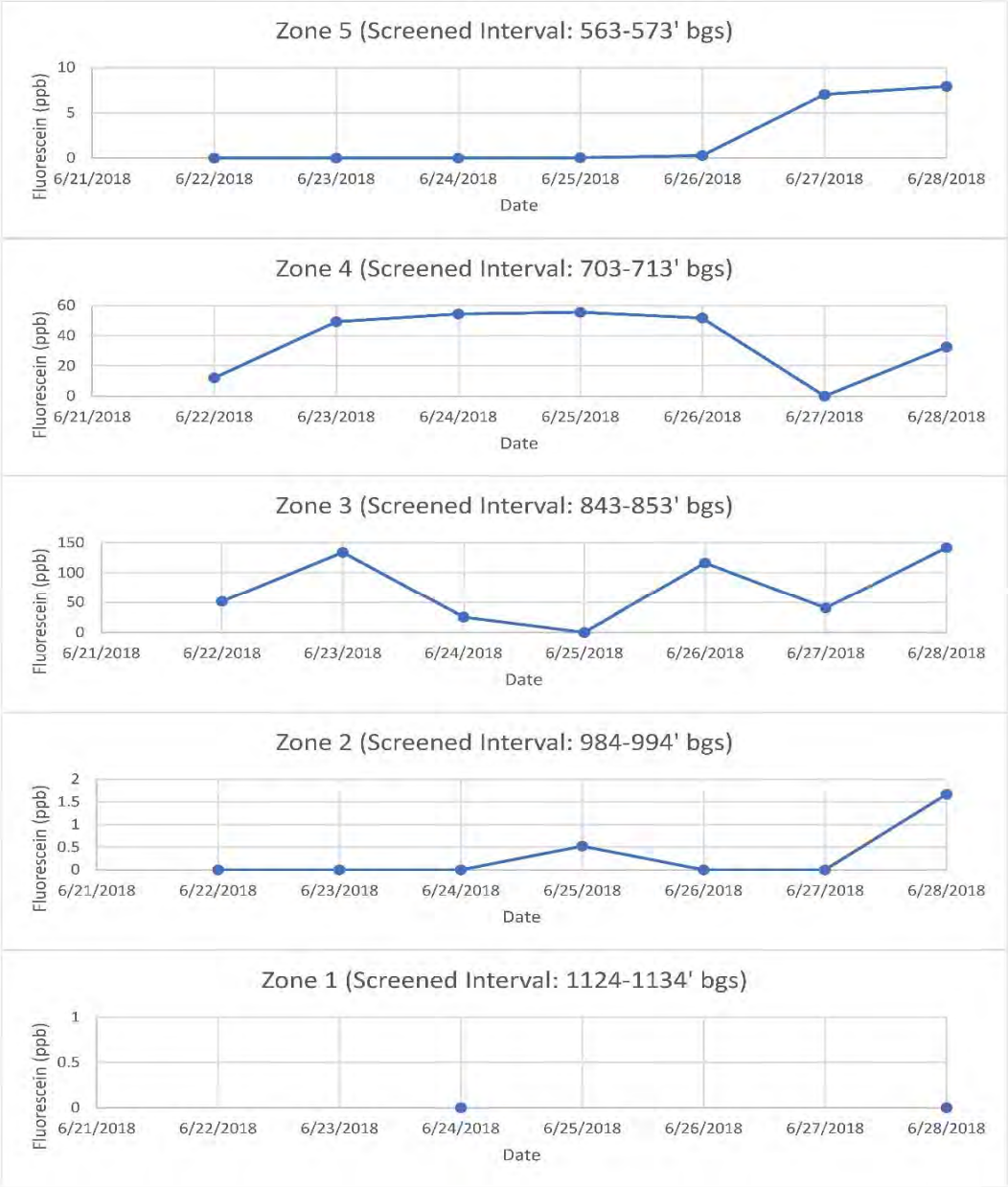
FLORENCE COPPER PROJECT
FLORENCE, ARIZONA

TRACER BREAKTHROUGH AT WB-03

JULY 2018

FIGURE 14

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\Project Data\Field Data\Aquifer



NOTES

ppb = parts per billion (or ug/L)
bgs = below ground surface

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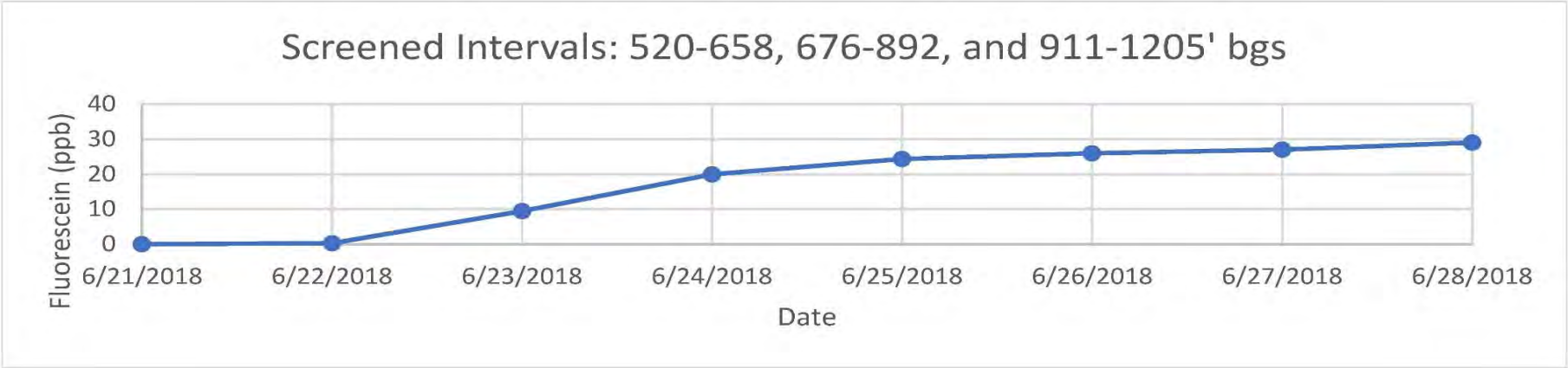
FLORENCE, ARIZONA

TRACER BREAKTHROUGH AT WB-04

JULY 2018

FIGURE 15

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\Project Data\Field Data\Aquifer



NOTES

ppb = parts per billion (or µg/L)
bgs = below ground surface

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FLORENCE, ARIZONA

TRACER BREAKTHROUGH AT R-09

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FIGURE 16

\\haleyaldrich.com\share\phx_common\Projects\Florence Copper\129687 PTF Well Drilling\Project Data\Field Data\Aquifer