Appendix 2-4

JPL-EW-01, JPL-EW-02
JPL-IW-01, JPL-IW-02
Development Logs

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Well Development

Location: JPL	Well No.: EW-1	Date: 3/15/04	Project No.: G486009	Page 1 of 3

Equipment:				Personnel:
HORIBA U 10	☐	HORIBA U22	■	David Conner
S/N:		S/N:		WDC-Jonathan
FID/PHOTO VAC	☐	ORION 290A	☐	EXPOSURE MONITORING / WELL CONDITION
INTERFACE PROBE	☐	OVA 128	☐	Background:_____PPM / Good ■
HORIBA ORP	☐	WATER LEVEL	☐	Reading:_____PPM / Fair ☐
Total Well Depth:	265’	Screen:	215’ to 265’	Poor ☐
Static Water Level:	185’	Depth to Product:		Pump Type: Peristaltic ☐ Submersible ■
Water Column:	80’	Product Layer:		Liquid Ring ☐ Bladder Pump ☐
Well Casing Diameter:	6”			Pump Rate: 66.48gpm
Borehole Diameter:	12.25”			Purge Start Time: 0855 HRS
Low Flow Method	☐			Purge Stop Time: 1600 HRS
Minimal Purge Sampling	☐			Total volume Purged: 16,082 Gal.

Criteria used to stop purging / development: Dry Well ☐ Parameter Stabilization ■

Time	Water Depth (btoc)	Volume Recovered (gal)	PH (units) +/- 0.2	Conductivity (mS/cm) +/- 5%	Turbidity (NTU) +/- 10%	Dissolved Oxygen (mg/l) +/- 0.2	Temp. (°C) +/- 3%	Salinity (%) -	ORP (mV) +/- 20	Comments
0938			6.97	0.443	306	12.44	20.0	0.0	206	Pump intake @ 235’
0941			7.36	0.411	626	8.88	20.0	0.0	185	
0944	180.4		7.39	0.395	783	8.27	20.0	0.0	181	
0947			7.40	0.443	449	8.55	20.0	0.0	178	
0953			7.42	0.387	354	7.93	20.0	0.0	168	
0956			7.43	0.397	133	7.98	20.0	0.0	169	
0959			7.44	0.409	122	8.02	20.1	0.0	168	
1002	180.58									Pump off for 15min

Field Team Leader Signature _____

1020	172.5									Tank Switch
1033			7.63	0.445	566	11.42	20.0	0.0	175	
1035										Stop
1050	172.43									Restart
1053			7.52	0.401	804	9.72	21.0	0.0	211	
1055	179.20									Stop
1110	172.40									Restart
1113			7.54	0.407	979	11.06	20.8	0.0	212	
1115	179.91									Stop
1130	172.40									Restart
1133			7.81	0.453	243	13.16	20.2	0.0	204	
1136			7.78	0.450	380	13.10	20.2	0.0	167	
1139			7.55	0.433	337	9.01	20.0	0.0	182	
1142			7.48	0.408	476	8.35	20.1	0.0	168	
1145			7.48	0.430	365	10.31	20.2	0.0	173	
1148			7.47	0.402	127	8.43	20.3	0.0	176	
1151			7.47	0.399	193	8.40	20.3	0.0	176	
1154			7.46	0.381	108	9.79	20.4	0.0	179	
1157			7.46	0.398	224	11.30	20.4	0.0	183	
1200			7.46	0.396	465	9.65	20.4	0.0	183	Stop
1230										Restart Surging 5min on 5min off
1345										Continuous pumping
1348										Stop Pump to move equipment
1355		7,629.6								Restart Pumping
1358			7.42	0.426	315	10.26	20.2	0.0	220	
1401			7.38	0.408	286	9.03	20.2	0.0	208	
1404			7.37	0.409	195	9.49	20.2	0.0	202	
1407			7.37	0.409	491	9.27	20.2	0.0	207	
1410			7.42	0.459	85	9.56	20.1	0.0	197	Cleaned Turbidity sensor
1413			7.39	0.452	80	10.12	20.1	0.0	192	
1416	178.95		7.38	0.438	57	10.58	20.1	0.0	190	
1419			7.37	0.426	154	10.57	20.1	0.0	191	

1422			7.37	0.425	203	10.59	20.1	0.0	190	
1425	178.95		7.37	0.415	213	10.34	20.1	0.0	189	
1428			7.38	0.396	238	10.49	20.1	0.0	189	
1431			7.39	0.418	113	10.34	20.2	0.0	193	
1434			7.40	0.408	92	10.76	20.2	0.0	193	
1437			7.41	0.397	122	9.94	20.3	0.0	193	
1440			7.41	0.402	177	10.83	20.3	0.0	192	
1443			7.42	0.395	186	11.0	20.2	0.0	192	
1446			7.43	0.396	110	10.72	20.2	0.0	192	
1449			7.43	0.396	108	10.91	20.2	0.0	191	
1452			7.43	0.391	147	11.00	20.3	0.0	190	
1455			7.44	0.394	200	10.74	20.3	0.0	190	
1458			7.45	0.385	272	11.22	20.3	0.0	190	
1501			7.45	0.402	374	11.10	20.2	0.0	190	
1504			7.46	0.401	483	10.64	20.2	0.0	189	
1507			7.46	0.406	576	10.60	20.2	0.0	188	
1510			7.49	0.384	999	11.64	19.9	0.0	179	
1513			7.47	0.388	999	12.22	19.9	0.0	179	
1521			7.69	0.479	348	9.50	20.2	0.0	184	
1524			7.54	0.460	999	9.49	20.1	0.0	177	
1527			7.51	0.455	999	9.47	20.1	0.0	175	
1533			6.89	0.444	713	11.50	20.1	0.0	268	
1536			7.10	0.417	120	11.33	20.1	0.0	248	
1539			7.13	0.414	92	11.46	20.1	0.0	240	
1542			7.16	0.410	166	11.42	20.1	0.0	230	
1545			7.15	0.409	54	11.56	20.1	0.0	226	
1548			7.19	0.409	66	11.51	20.0	0.0	221	
1551			7.21	0.393	449	11.32	20.0	0.0	215	
1554			7.22	0.408	139	11.34	20.0	0.0	213	
1557			7.23	0.403	190	11.27	20.1	0.0	216	
1600	179.43	16,082	7.23	0.419	57	11.11	20.1	0.0	219	

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Well Development

Location: JPL	Well No.: EW-2	Date: 03/09/04	Project No.: G486009	Page 1 of 3

Equipment:				Personnel:
HORIBA U 10	☐	HORIBA U22	■	Sam Serpa
S/N:		S/N:		
FID/PHOTO VAC	☐	ORION 290A	☐	EXPOSURE MONITORING / WELL CONDITION
INTERFACE PROBE	☐	OVA 128	☐	Background:_____PPM / Good ■
HORIBA ORP	☐	WATER LEVEL	☐	Reading:_____PPM / Fair ☐
Total Well Depth: 315'		Screen: 265' to 315'		Poor ☐
Static Water Level: 185'		Depth to Product:		Pump Type: Peristaltic ☐ Submersible ■
Water Column: 130'		Product Layer:		Liquid Ring ☐ Bladder Pump ☐
Well Casing Diameter: 6"				Pump Rate:
Borehole Diameter: 12.25"				Purge Start Time: HRS
Low Flow Method ☐				Purge Stop Time: HRS
Minimal Purge Sampling ☐				Total volume Purged: Gal.

Criteria used to stop purging / development: Dry Well ☐ Parameter Stabilization ☐

Time	Water Depth (btoc)	Volume Recovered (gal)	PH (units) +/- 0.2	Conductivity (mS/cm) +/- 5%	Turbidity (NTU) +/- 10%	Dissolved Oxygen (mg/l) +/- 0.2	Temp. (°C) +/- 3%	Salinity (%) -	ORP (mV) +/- 20	Comments
1230										Start bailing.
1400	179.10									450 gallons removed. Removed coarse sands and fines.
1500										550 gallons removed; coarse sands and fines still coming up.
1500										Start surging well for 1 hour.
1600										Start bailing; removed 6" sand.
1630										Bottom firm.

1655	181.40									TD: 316.20
1700										Complete for day
1111	172.55									March 10, 2004. Pump inlet at 288'.
1129	203.00									
1134										Stop Pump.
1137	195.00									Pump still off.
1138										Turn pump on.
1142										Water beginning to clear up.
1142										Pump stopped ran dry.
1146	187.00									
1148	178.00									
1152										Restart pump at 3.9 ft^3/min
1203			6.9	50	990	9.40	22.5	0.0	50	Totalizer= 330.50 ft^3
1205			6.9	45	990	9.48	22.4	0.0	57	
1207	177.50									Pump rate: 30 gpm
1210			6.8	49	990	9.93	22.4	0.0	67	
1212	177.50									
1214	178.50									Pump rate to 45 gpm.
1224	178.50		6.8	49	500					Water is clearing up.
1228	183.30									Pump rate to 81 gpm.
1231			6.8	49	660	12.78	21.6	0.0	66	
1234			6.9	48	620	12.64	21.7	0.0	74	
1236	183.20									Pump rate: 82 gpm
1240										Turn pump off to flush.
1255			6.9	48	860	13.27	21.6	0.0	73	
1258	173.98									Water level taken 18 minutes after pump shut off.
1308										Restart pump.
1313	183.28									Water cloudy at first, beginning to

										clear.
1314										Turn pump off (back flush).
1331	173.95									Restart pump.
1336	183.35									Turn pump off.
1343			6.9	47	260	12.90	21.5	0.0	61	
1353										Restart pump.
1355			6.9	45	200	14.40	21.5	0.0	63	
1359	183.12									Turn pump off.
1414	173.95									Restart pump.
1419	182.80									
1420										Turn pump off.
1435	173.95									Restart pump.
1453	182.70									
1505	182.74		6.9	44	180	16.09	21.4	0.0	65	
1520			6.9	46	150	19.99	21.3	0.0	62	
1521	182.89									
1522										Stop Pumping.

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Well Development

Location: JPL	Well No.: IW-1	Date: 3/23/04	Project No.: G486009	Page 1 of 3

Equipment:

HORIBA U 10	☐	HORIBA U22	■
S/N:		S/N:	
FID/PHOTO VAC	☐	ORION 290A	☐
INTERFACE PROBE	☐	OVA 128	☐
HORIBA ORP	☐	WATER LEVEL	☐

Personnel: David Conner
WDC- Jonathan

EXPOSURE MONITORING
Background:_____PPM
Reading:_____PPM

WELL CONDITION
Good ■
Fair ☐
Poor ☐

Total Well Depth:	315'	Screen:	215' to 315'
Static Water Level:	214'	Depth to Product:	
Water Column:	101'	Product Layer:	
Well Casing Diameter:	6"		
Borehole Diameter:	12.25"		
Low Flow Method	☐		
Minimal Purge Sampling	☐		

Pump Type: Peristaltic ☐ Submersible ■
Liquid Ring ☐ Bladder Pump ☐

Pump Rate:	65 gpm		
Purge Start Time:	HRS	1215	
Purge Stop Time:	HRS	1508	
Total volume Purged: 9873	Gal.		

Criteria used to stop purging / development: Dry Well ☐ Parameter Stabilization ■

Time	Water Depth (btoc)	Volume Recovered (gal)	PH (units) +/- 0.2	Conductivity (mS/cm) +/- 5%	Turbidity (NTU) +/- 10%	Dissolved Oxygen (mg/l) +/- 0.2	Temp. (°C) +/- 3%	Salinity (%) -	ORP (mV) +/- 20	Comments
1215										Start
1230			7.15	0.545	999	10.99	19.8	0.0	276	
1233			7.19	0.555	945	11.64	19.8	0.0	268	Water cloudy but relatively clear
1236			7.21	0.548	598	12.04	19.8	0.0	247	
1239			7.21	0.548	481	12.09	19.8	0.0	243	
1242			7.22	0.547	598	12.33	19.8	0.0	226	
1245			7.22	0.545	715	12.47	19.8	0.0	218	
1248			7.22	0.545	876	12.62	19.8	0.0	213	

Field Team Leader Signature _____

1251			7.23	0.542	661	12.73	19.8	0.0	208	
1254			7.23	0.544	368	12.85	19.8	0.0	202	
1257			7.23	0.542	537	12.92	19.8	0.0	198	
1300			7.23	0.542	439	12.97	19.8	0.0	195	
1303			7.23	0.540	416	13.00	19.8	0.0	193	
1306			7.23	0.542	388	13.08	19.8	0.0	191	
1309			7.23	0.542	433	13.11	19.8	0.0	189	
1312			7.23	0.541	354	13.19	19.8	0.0	188	7100 ft3
1315			7.22	0.534	329	13.27	19.8	0.0	187	
1318			7.23	0.538	396	13.32	19.8	0.0	186	
1334										1320 (Raised pump 21' to 278' bgs 1334 (start pump- 65gpm)
1345			7.24	0.533	331	13.46	19.8	0.0	196	
1348			7.25	0.544	146	12.55	19.8	0.0	192	
1351			7.23	0.542	210	12.93	19.8	0.0	188	
1354										
1357										
1400			7.23	0.540	125	12.02	19.8	0.0	181	
1403			7.23	0.540	168	8.73	19.8	0.0	180	
1406			7.22	0.537	125	13.16	19.8	0.0	178	
1409			7.22	0.541	52.8	13.21	19.8	0.0	179	
1412			7.22	0.538	66.4	13.21	19.8	0.0	178	
1415			7.22	0.538	50.2	13.31	19.8	0.0	178	
1418			7.22	0.540	85	13.37	19.8	0.0	176	
1428										Raised pump 21' to 257' bgs Total: 7590 DTW 214.95 (pump off)
1430										Start 65gpm
1445			7.22	0.539	244	12.27	19.8	0.0	198	221.85'
1448			7.23	0.538	174	13.94	19.8	0.0	188	
1451			7.22	0.538	134	13.99	19.8	0.0	183	
1454			7.22	0.538	94	14.05	19.8	0.0	181	
1457			7.22	0.538	78.3	14.06	19.8	0.0	179	

1500			7.22	0.537	84.6	14.07	19.8	0.0	179	

1506			7.22	0.537	70.2	14.03	19.8	0.0	178	
1508			7.22	0.537	81.4	14.02	19.8	0.0	179	
1508			7.22							Stop pumping: Parameter stabilized 222.33

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Well Development

Location: JPL	Well No.: IW-2	Date: 3/18/04	Project No.: G486009	Page 1 of 3

Equipment:		Personnel:	
HORIBA U 10 ☐	HORIBA U22 ■	David Conner	
S/N:	S/N:	WDC-Jonathan	
FID/PHOTO VAC ☐	ORION 290A ☐	EXPOSURE MONITORING	WELL CONDITION
INTERFACE PROBE ☐	OVA 128 ☐	Background:_____PPM	Good ■
HORIBA ORP ☐	WATER LEVEL ☐	Reading:_____PPM	Fair ☐
Total Well Depth: 315'	Screen: 215' to 315'		Poor ☐
Static Water Level: 223'	Depth to Product:	Pump Type: Peristaltic ☐	Submersible ■
Water Column: 92'	Product Layer:	Liquid Ring ☐	Bladder Pump ☐
Well Casing Diameter: 6"		Pump Rate: 65gpm	
Borehole Diameter: 12.25"		Purge Start Time:0815 HRS	
Low Flow Method ☐		Purge Stop Time:1107 HRS	
Minimal Purge Sampling ☐		Total volume Purged: 6550 Gal.	

Criteria used to stop purging / development: Dry Well ☐ Parameter Stabilization ■

Time	Water Depth (btoc)	Volume Recovered (gal)	PH (units) +/- 0.2	Conductivity (mS/cm) +/- 5%	Turbidity (NTU) +/- 10%	Dissolved Oxygen (mg/l) +/- 0.2	Temp. (°C) +/- 3%	Salinity (%) -	ORP (mV) +/- 20	Comments
0815	232.63									Pump set @ 257'bgs
0915			7.46	0.492	619	12.80	20.9	0.0	185	
0918			7.35	0.483	761	13.10	20.9	0.0	165	
0930			7.33	0.460	975	13.45	20.9	0.0	147	
0933			7.33	0.462	285	13.45	21.0	0.0	145	
0936			7.33	0.452	971	13.45	20.9	0.0	144	
0937										Begin Surging with pump 30min
1007										Continued pumping

Field Team Leader Signature _____

1010			7.40	0.489	999	13.84	21.4	0.0	203	
1013			7.36	0.482	437	13.50	21.0	0.0	172	
1016			7.34	0.470	265	13.14	21.0	0.0	149	
1019			7.34	0.476	84	13.11	21.0	0.0	145	
1022			7.33	0.469	83	13.18	21.0	0.0	139	
1025			7.36	0.494	175	11.00	21.0	0.0	150	
1028			7.35	0.478	519	12.60	21.0	0.0	145	
1030										Set pump @ 277'bgs
1051	225.65									
1052										Start pumping
1055			7.50	0.467	252	13.14	21.2	0.0	188	
1058			7.34	0.477	314	11.64	21.1	0.0	156	
1101			7.35	0.465	317	11.63	21.1	0.0	158	
1104			7.34	0.460	171.1	12.20	21.2	0.0	141	
1107			7.36	0.466	343	12.31	21.1	0.0	143	
1300		5060								Pull pump
1600										Bail, fine sands/silt in bailer
1630										15 min. surge (3 sections)
1715										End surging
1130										March 19, 2004 (started pumping) Pump intake 299' bgs
1140			6.91	0.499	722	10.03	21.1	0.0	228	
1143										
1146			7.14	0.486	886	10.04	21.0	0.0	208	
1149			7.17	0.485	973	10.22	21.0	0.0	202	
1152										
1155			7.20	0.480	999	10.11	21.0	0.0	192	
1158			7.20	0.480	999	9.56	21.0	0.0	191	
1201			7.20	0.477	999	10.76	21.0	0.0	191	
1204			7.20	0.476	999	10.89	21.0	0.0	187	
1207			7.26	0.484	315	11.22	21.4	0.0	192	Emptied flow-thru

1210			7.26	0.487	522	11.72	21.1	0.0	192	
1213			7.22	0.483	912	11.62	21.0	0.0	189	
1216			7.22	0.475	566	11.27	21.1	0.0	179	
1219			7.23	0.463	999	11.42	21.0	0.0	178	
1330			7.23	0.469	850	11.38	21.0	0.0	175	Turbidity meter readings wrong
1333	231.50		7.23	0.459	560	11.34	21.0	0.0	178	
1336			7.23	0.452	999	11.31	21.0	0.0	179	
1339			7.23	0.449	835	11.57	21.0	0.0	180	
1342			7.23	0.456	868	11.62	21.0	0.0	179	
1345			7.24	0.454	999	11.57	21.0	0.0	179	
										Move pump 21’ to 278’ bgs
1410										Begin pumping
1417			7.37	0.487	332	12.14	21.0	0.0	202	
1420			7.32	0.486	304	10.18	21.1	0.0	210	
1423			7.30	0.486	302	10.86	21.2	0.0	216	
1426			7.30	0.486	275	10.43	21.4	0.0	223	
1429			7.29	0.485	272	11.09	21.7	0.0	229	
1431			7.29	0.485	271	11.28	21.9	0.0	231	
1434			7.29	0.486	272	11.08	22.1	0.0	235	
1437			7.33	0.499	387	13.35	20.7	0.0	188	
1440			7.29	0.495	358	13.26	20.7	0.0	183	
1443			7.25	0.484	510	12.83	20.7	0.0	169	
1446			7.22	0.485	493	12.79	20.7	0.0	152	
1449			7.22	0.482	999	12.43	20.7	0.0	152	Water clear; see VOA
1452		6400	7.22	0.480	999	12.92	20.7	0.0	152	Water clear; see VOA
1500										Start at 257’
1510			7.38	0.500	247	12.23	21.6	0.0	198	
1513			7.24	0.497	137	12.66	20.8	0.0	174	
1516			7.24	0.499	240	12.63	20.8	0.0	173	
1519			7.24	0.494	137	12.65	20.7	0.0	170	
1520	233.15	6550								

Appendix 2-5

Aquifer Test Results

Date August 25, 2004

To Steve Slaten
Kimberly Gates

From Keith Fields
David Clexton

Subject Summary of OU-1 Aquifer Testing

Objective:

The objective of this technical memorandum is to provide a summary of the investigation of aquifer characteristics conducted as part of the OU-1 Expanded Treatability Study.

Summary:

The results of the investigation are summarized as follows:

- Hydraulic conductivity values estimated from the slug/bail aquifer tests correlate with those previously measured at the site.
- Hydraulic conductivity values estimated from the aquifer pumping test were slightly higher than those previously identified at the site.
- Increased hydraulic conductivity of the aquifer decreases the width of the OU-1 Expanded Treatability Study capture zone from 2,600 ft (hydraulic conductivity of 22 ft/d) to 2,100 ft (hydraulic conductivity of 60 ft/d).
- The geologic/hydrogeologic interpretation indicates that groundwater in the vicinity of the OU-1 Expanded Treatability Study exists under semi-confined to confined conditions.

Introduction:

As part of the OU-1 Expanded Treatability Study, two extraction (EW-1 and EW-2) and two injection (IW-1 and IW-2) wells were installed in the north central portion of the JPL Facility (Figure 1). The lithologic logs completed for these wells were used in conjunction with lithologic logs of existing wells (JPL monitoring wells and ARCADIS demonstration wells) to gain a better understanding of the geologic and hydrogeologic conditions beneath the site, primarily in the vicinity of the extraction wells. Spinner logging also was performed in the two extraction wells to evaluate vertical groundwater migration in the aquifer. The hydraulic characteristics of the aquifer in the vicinity of the study area were evaluated through a series of aquifer tests conducted in the newly installed injection and extraction wells. The goal was to collect data for estimating the transmissivity, hydraulic conductivity, and storativity of the aquifer material using two types of tests: slug/bail tests and a pumping test. A discussion of the geologic/ hydrogeologic interpretation and a summary of the results of the aquifer tests are provided in the following sections.

Geologic/Hydrogeologic Interpretation:

Methods. Two injection and two extraction wells were drilled using mud rotary drilling. After the extraction wells were drilled and prior to well construction, downhole geophysical logging was conducted within the boreholes using natural gamma radiation, electrical resistivity (R/SP), a sonic (acoustic)

method, and guard resistivity surveys. Based on the results of the surveys, the resistivity curves most accurately reflected downhole lithologies while the sonic log most accurately indicated the presence of saturated formation material (i.e., groundwater). The sections of the borehole that appear to have the best water-yielding capabilities appear to have the highest electrical resistivity. The character of the spontaneous potential (SP) log is normally subdued because of the fact that fresh water drilling muds were used in a fresh-water aquifer and the lack of significant clay beds present in the formation. The amount of natural-gamma radiation recorded is commonly the result of both the amount of clay present (high potassium content) and the amount of granitic material present (high potassium feldspar and biotite content) rendering lithology determinations from the natural gamma ray log at times non-descriptive. Attachment 1 provides the lithologic logs for the injection and extraction wells and the geophysical logs are presented in Attachment 2.

After the geophysical logging was complete, the wells were completed as listed in Table 1. Attachment 1 provides the well completion diagrams for the injection and extraction wells. The depth of the screened intervals was based on the vertical chemical distribution in adjacent monitoring wells (MW-24 and MW-7). After completion, the wells were developed by alternately surging and pumping from within the screened interval until the majority of fines were removed from the surrounding formation material. Spinner logging was subsequently performed in extraction wells EW-1 and EW-2 to evaluate equilibrium flow conditions within the well screened intervals (i.e., to determine the presence of vertical flow gradients). Spinner logging is a downhole logging technique that employs an impeller-type flowmeter which is raised or lowered within a well during either pumping or non-pumping conditions. The flowmeter measures the movement of water using a low-inertia impeller spinning on precision bearings. The impeller assembly typically incorporates an electromagnetic counting assembly in which magnetic field fluctuations caused by impeller rotation are electronically converted to pulses (counts) and transmitted to a surface recording system. Impeller speed in rotations per second can be calculated by dividing the measured counts per second by the number of counts per revolution. Impeller rotation is linearly related to fluid velocity within the well. The spinner logging tool is raised or lowered within a well at a constant rate, with impeller rotation induced from both the movement of the logging tool at a given line speed, and from the additional influence of fluid flow. The logging equipment records the counts per second measured by the impeller and counting assembly and produces a continuous chart or log (and/or saves data electronically) that is analyzed to determine zones where groundwater is entering or exiting the well. The spinner logs are presented in Attachment 3.

Results. The boring logs and well completion diagrams for the newly installed extraction and injection wells were used in conjunction with those of existing wells to construct a northeast/southwest geologic cross section in the vicinity of the OU-1 Expanded Treatability Study (Figures 1 and 2) and aid in lithologic characterization and stratigraphic correlation. In addition, information from the geophysical logging was used to further interpret the lithology in this area. When available, information obtained from the geophysical logs was given precedence over boring log data because the wells were completed using mud rotary drilling, and it was difficult to distinguish subtle changes in lithology because the cuttings were saturated with mud.

In general, the results of the logging indicate that the formational material surrounding both wells consists primarily of silty fine to coarse grained sands, gravels, and cobbles interbedded with minor layers of fine grained sediments such as silts and clays between the near surface and an elevation of between 950 and 980 ft above mean sea level (amsl). A fairly uniform 5- to 20-ft thick fine-grained unit (silty/clayey sand) was detected across the study area (Figure 1) below these interbedded units. This fine-grained zone is underlain by an approximately 40 foot thick layer of coarse grained material (e.g., sands, gravels, cobbles, and boulders) which is further underlain by interbedded silty sands, gravels, and sandy silts. It is within this coarse grained material that the results of the sonic log returned a strong indication of saturated sediments at a depth of approximately 240 ft below ground surface (bgs). However, subsequent

groundwater level measurements collected after the wells were constructed and developed indicated a static water level of approximately 160 ft bgs rather than 240 ft. This static water level is consistent with that observed in surrounding monitoring wells MW-24 and MW-7 (see Figure 1). Based on these results, it is interpreted that groundwater in the vicinity of the study area may exist under semi-confined to confined conditions due to the presence of the fine grained unit above the coarse material that results in an upgradient pressure head being applied to the groundwater present within the coarse grained material. The depth of the saturated zone identified during drilling also correlates with the base of the fine grained unit.

The results of the spinner logging were for the most part inconclusive regarding any significant inflows or outflows within the wells. However, there were subtle indications of groundwater inflow occurring in well EW-1 at a depth of approximately 240 ft bgs and outflow occurring at approximately 215 ft bgs. The above interpretation is based on changes in fluid resistivity and spinner results at the aforementioned depths.

Aquifer Testing:

The hydraulic characteristics of the aquifer beneath JPL in the vicinity of the study area were evaluated by performing aquifer tests at each injection and extraction well installed during the OU-1 Expanded Treatability Study. The goal was to collect data for estimating the transmissivity, hydraulic conductivity, and storativity of the aquifer material.

Pumping Test. An aquifer pumping test was conducted in the deep extraction well (EW-2) to determine well production capability, drawdown, and well efficiency relationships at the specified extraction rate. Data collected during this test was used to estimate aquifer transmissivity, hydraulic conductivity, and storativity in the area of influence. As noted in Table 1, EW-2 has a 50-ft screened interval and a design extraction rate of 125 gpm. A constant rate, 8-hour aquifer test was implemented at an extraction rate of 150 gpm. The extraction rate was increased to 200 gpm for the last 30 minutes of the test to evaluate whether the aquifer could handle the additional extraction volume. A recovery test was conducted immediately following cessation of the constant rate pumping test. The recover test was deemed complete once groundwater levels stabilized to pre-pumping (static) conditions.

The groundwater level (pressure) in the extraction well (EW-2) was monitored using a pressure transducer that was installed a sufficient distance beneath the pump intake. The transducer was set to collect readings at 0.5 second intervals during the first 10 minutes of the test, at 1 second intervals from 10 to 90 minutes after the start of the test, and at 10 second intervals from 90 minutes to the end of the test. During the pumping and recovery test, the groundwater level (pressure) in six nearby monitoring wells (MW-7, MW-8, MW-11 [screen 1], MW-13, MW-16, and MW-24 [screen 1], the shallow extraction well (EW-1), and the two injection wells (IW-1 and IW-2) also was continuously monitored for resulting changes (at 10 second intervals) using pressure transducers deployed in each well. Table 2 summarizes the spatial relationship of these wells with respect to EW-2. The resulting changes in the static groundwater level were used in conjunction with extraction well flow rates and groundwater levels to estimate aquifer parameters.

Approximately 72,000 gallons of purge water was generated during the aquifer test. The extracted groundwater was temporarily stored on-site in four 21,000 gallon Baker tanks prior to being reinjected back into EW-2 following completion of the aquifer recovery test.

The aquifer design and test software program AQTESOLV® (Gerraghty and Miller, 1991) was used to estimate aquifer parameter values using groundwater level and time data collected during the constant rate pumping test and the recovery test. This software contains a variety of different aquifer analysis methods

for different aquifer types, including confined, unconfined, and semi-confined (leaky) aquifers. Well response was analyzed in observation wells EW-1, MW-24, MW-7, IW-2, IW-1, MW-8, MW-16, MW-13, and MW-11. In addition, pumping well EW-2 was examined. The drawdown in each well as a result of groundwater extraction during the pumping test is presented in Table 2.

Groundwater levels in the extraction well dropped nearly 16 ft within the first 0.5 seconds after the pump was activated. Approximately 21 seconds into the test a maximum drawdown of 29 ft was observed, after which levels rebounded to 21 ft approximately 1.5 minutes into the test and stabilized at 19 ft after approximately 23 minutes. When the extraction rate was increased to 200 gpm, the drawdown stabilized at 26 ft. Groundwater level data in the pumping well could not be analyzed for aquifer parameters because there was no discernable pattern in the response curve due to oscillation in the initial portion of the test. Once the pump was turned off, the well recovered to static conditions very quickly (<15 seconds), and the transducer did not record enough data points for analysis. The majority of observation wells had less than 0.2 ft of water drawdown (see Table 2) and could not be used for analysis of aquifer parameters.

Aquifer test monitoring wells EW-1 and MW-24 provided the only reliable and usable data that could be analyzed. The data were imported into the AQTESOLV® software and response curves were generated. Response curve matching was performed using the available aquifer analysis methods. The response curves matched closely with that of the Moench (1993) solution for unconfined aquifers and with the Neuman-Witherspoon (1995) method for leaky aquifers. The saturated thickness was estimated at 145 ft for the layer 1 aquifer. Depth to the bottom of the aquifer was assumed to be approximately 315 ft bgs.

The best response curve was observed in EW-1, which was 12 ft from the pumping well. Data collected from this well exhibited a very good fit to the Moench type curve, showing the effects of delayed yield followed by radial flow. The transmissivity estimate was 13,480 ft^2/day for the pumping test and 11,410 ft^2/day for the recovery period, corresponding to hydraulic conductivity of 93 ft/day and 79 ft/day, respectively. The storativity estimate generated from EW-1 pumping and recovery test data was 0.015 and 0.012, respectively. The pumping response in well MW-24 showed a general solution corresponding to transmissivity of 9,400 ft^2/day (65 ft/day hydraulic conductivity), but did not seem to reach radial flow conditions in the monitoring time period. The graph suggests that pumping would have to be extended to several days to obtain the late response curve. The storativity estimate generated from MW-24 pumping test data was 0.009. Attachment 4 shows the response curves matched to the Moench method curve for EW-1 and MW-24.

The data also were analyzed using the Newman-Witherspoon method for leaky aquifers, and exhibited a strong fit to the type curve for this method. The transmissivity estimate was 9,793 ft^2/day for the pumping test and 10,770 ft^2/day for the recovery period, corresponding to a hydraulic conductivity of 67 ft/day and 75 ft/day, respectively. The storativity estimate generated from EW-1 pumping and recovery test data was 0.007 and 0.006, respectively. The pumping response in well MW-24 showed a general solution corresponding to transmissivity of 9,522 ft^2/day (66 ft/day hydraulic conductivity). The storativity estimate generated from MW-24 pumping test data was 0.006. Attachment 4 shows the response curves matched to the Newman-Witherspoon method curve for EW-1 and MW-24.

The Cooper Jacob (1946) distance drawdown method also was applied to the pump test data to estimate aquifer parameters. This method is designed for a confined aquifer and incorporates drawdown data from observation wells that are used to monitor groundwater level elevation changes associated with the pumping test. Because only two observation wells associated with the test (EW-1 and MW-24) exhibited an appreciable change in groundwater levels, results from the pumping well also were used in the analysis to constitute an additional data point. It should be noted that drawdown data from the pumping well is not typically included in the distance drawdown analysis due to inefficiencies associated with the accurate

calculation of drawdown in the pumped well. In defining the drawdown in the pumping well, the average hydraulic head change that was observed during the period between 10 and 1,000 seconds of the test (approximately 4 feet) was used. The transmissivity and storativity estimates were 9,192 ft^2/day and 0.00175, respectively. The transmissivity estimate corresponds to a hydraulic conductivity of 63 ft/d, which is similar to that obtained using the previously described methods. Attachment 4 shows the distance drawdown plot and associated transmissivity and storativity calculations.

Slug/Bail Tests. Three slug/bail tests were performed in each well by subsequently lowering and raising the 5-in diameter by 15-ft long slug into the water column once the water level had rebounded to static conditions. A pressure transducer located in the well collected water level readings at 0.5 second intervals throughout the duration of the test. The resulting data data were analyzed with the Bouwer and Rice (1976) solution for unconfined aquifers, which accounts for partially penetrating wells. Assumptions of the solution include the following:

- Aquifer is homogeneous, infinite, uniform thickness;
- Water table is horizontal over the area influenced by the test;
- Lower boundary is impermeable;
- Flow to well is steady state;
- Instantaneous change in water level due to withdrawal or addition of slug in well.

The well screen for IW-2 extended above the static groundwater level; therefore, the well casing radius for was corrected using the equation from Bouwer (1989):

$$r_{rc} = \sqrt{r^2{}_c + \left(r^2{}_w - r^2{}_{os}\right)S_y}$$

where r_{rc} = corrected well casing radius, r_c = casing radius, r_w = borehole radius, r_{os} = outside of well screen, and S_y = specific yield of the filter pack (assumed to be 0.05). Other parameters used in the solution were the same as in the pumping test.

Hydraulic conductivity estimates from the slug/bail tests are summarized in Table 3 and the response graphs are presented in Attachment 5. In general, the withdrawal (bail) tests showed better water level responses. The slug tests in well EW-2 were irregular and could not be analyzed. All other tests could be analyzed; however, some of the response curves had a poor fit using the Bouwer and Rice method. Several tests showed a dual-line effect where the first line reflected the sand pack and the later line reflected the aquifer surrounding the screen. Overall, the results of the usable slug/bail tests showed correlation within each well and for the overall population. The average hydraulic conductivity from all tests was 21.3 ft/day and the geometric mean was 20.4, which agree with previous measurements collected from aquifer testing (slug/bail and pumping tests) performed at JPL. The values are somewhat higher than the slug tests in JPL monitoring wells, many of which were 4-inch diameter wells with shorter screens that penetrated narrower sections of the aquifer.

Groundwater Modeling:

Because the hydraulic conductivity estimates generated during the aquifer test were slightly higher than those previously identified, groundwater modeling was conducted to determine the effects of variation in hydraulic conductivity on the size (width) of the treatment system capture zone. The OU-1 model, which was constructed using FEFLOW, was used to perform a sensitivity analysis on hydraulic conductivity by conducting forward and backward particle tracking to estimate the width of the capture zones. It was assumed that the Phase 1 and 2 system was in operation (four extraction wells and four injection wells), and that the extraction rate was 180 gpm per well. As expected, model results indicate that an increase in

hydraulic conductivity results in a decrease in the width of the capture zone. The base-case scenario (hydraulic conductivity of 22 ft/d) indicated the width of the capture zone is approximately 1,300 ft (Figure 3). Increasing the hydraulic conductivity to 60 and 120 ft/d yielded a decrease in the width of the capture zone to approximately 1,100 and 850 ft/d, respectively (Figures 4 and 5).

References:

Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

Bouwer, H., 1989. The Bouwer and Rice slug test--an update, Ground Water, vol. 27, no. 3, pp. 304-309.

Cooper, H.H. Jr. and C.E. Jacob. 1946. A generalized graphical method for evaluating formation constants and summarizing well-field history. Transactions, American Geophysical Union, vol. 27, pp. 526-34.

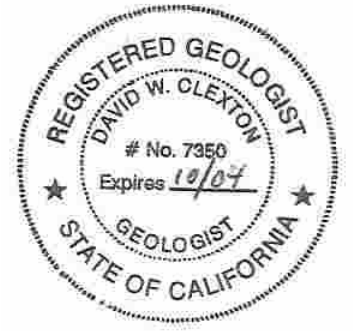
Gerraghty and Miller. 1991. *AQTESOLV®, Aquifer Test Design and Analysis Computer Software, Version 1.1*. Gerraghty and Miller, Inc. Modeling Group. Reston, VA.

Moench, A.F., 1997. Flow to a well of finite diameter in a homogeneous, anisotropic water table aquifer, Water Resources Research, vol. 33, no. 6, pp. 1397-1407.

8/25/04

Approved: _____

David Clexton, R.G. Date
Battelle Memorial Institute
Assistant Project Manager/Project Geologist



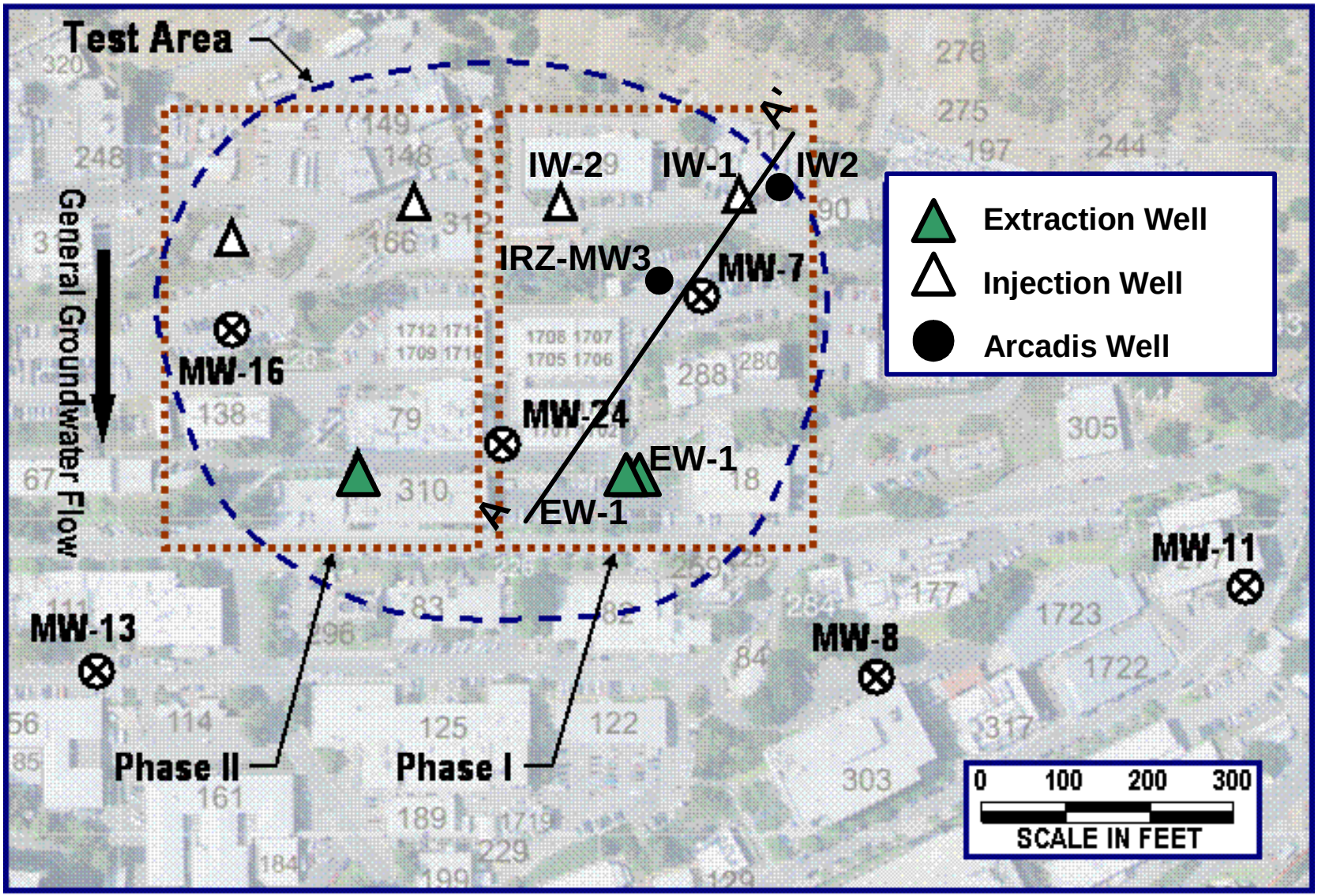


Figure 1. Site Map Showing Well Locations

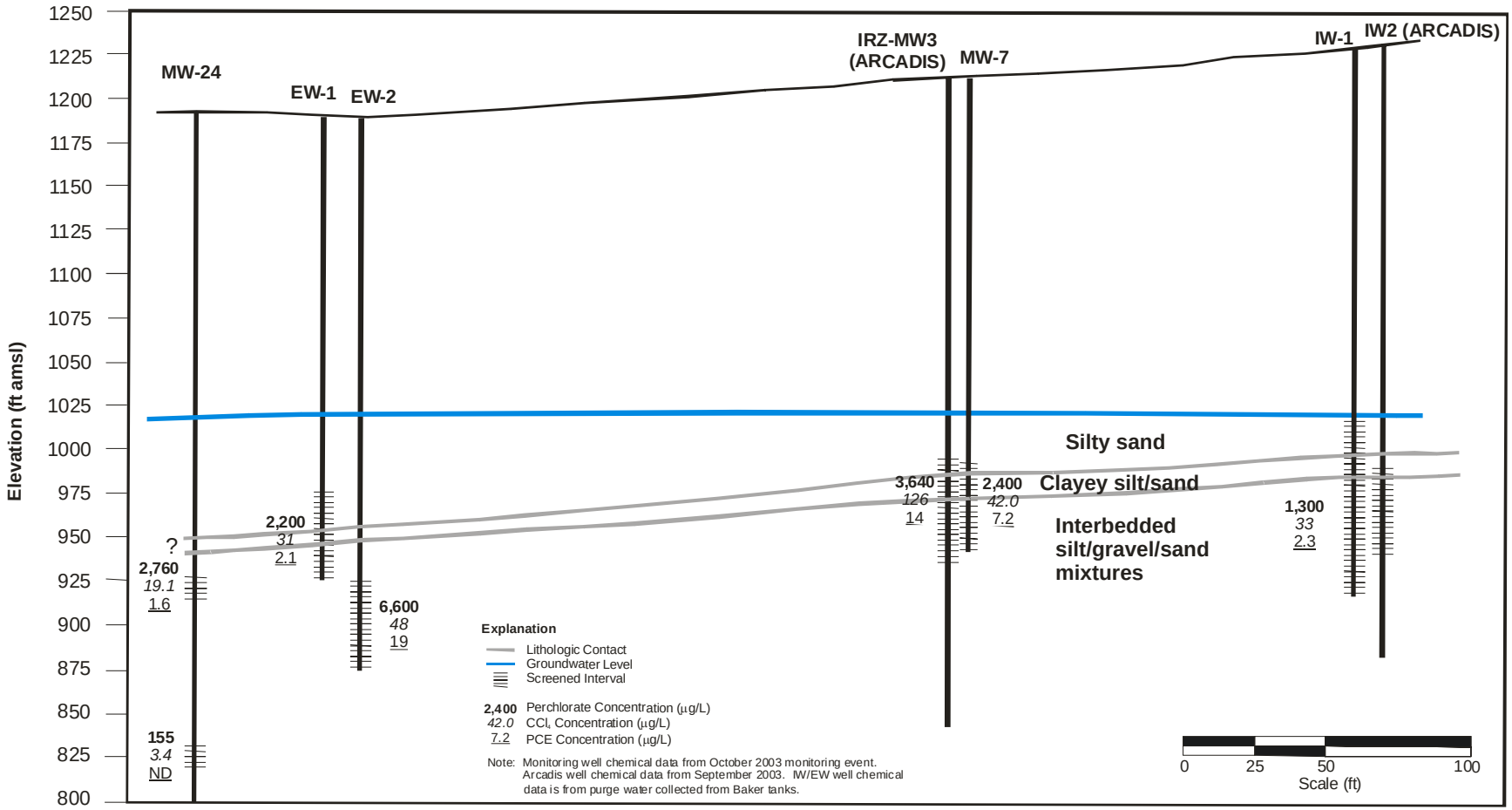


Figure 2. Cross Section A-A' Showing Lithology and Chemical Distribution

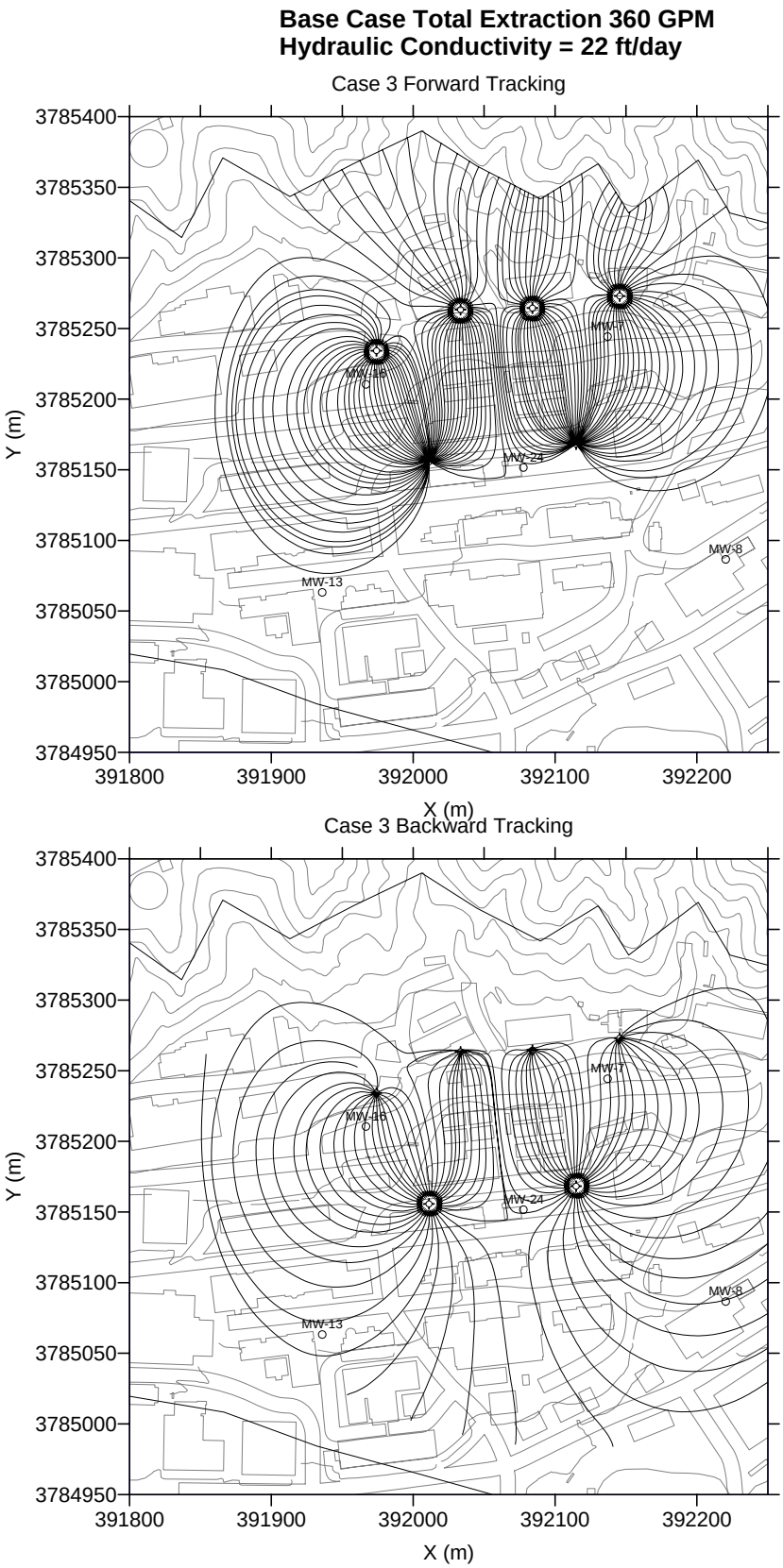


Figure 3. Extraction Well Capture Zones with Hydraulic Conductivity of 22 ft/d

Case A Total Extraction 360 GPM
Hydraulic Conductivity = 60 ft/day

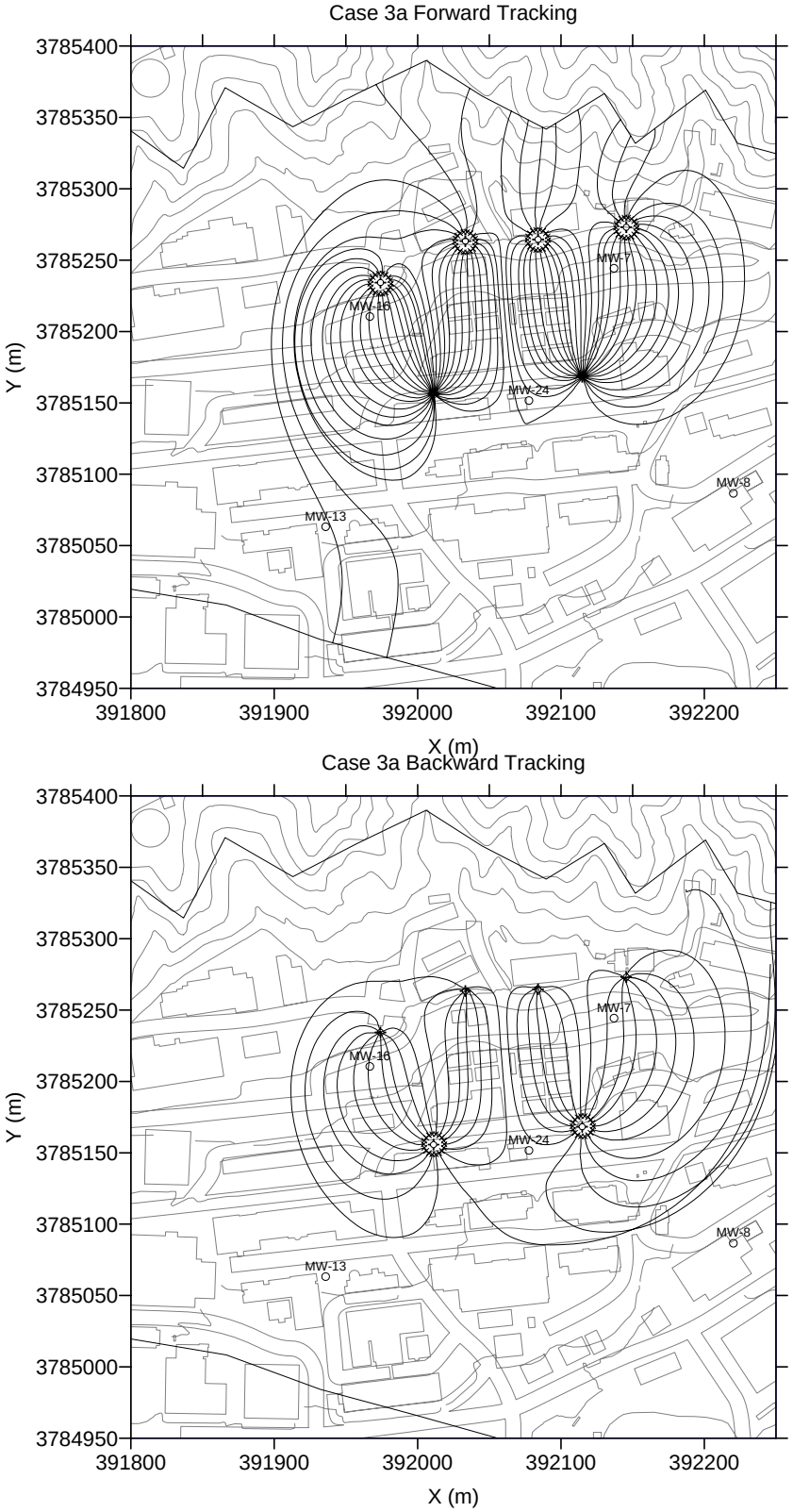


Figure 4. Extraction Well Capture Zones with Hydraulic Conductivity of 60 ft/d

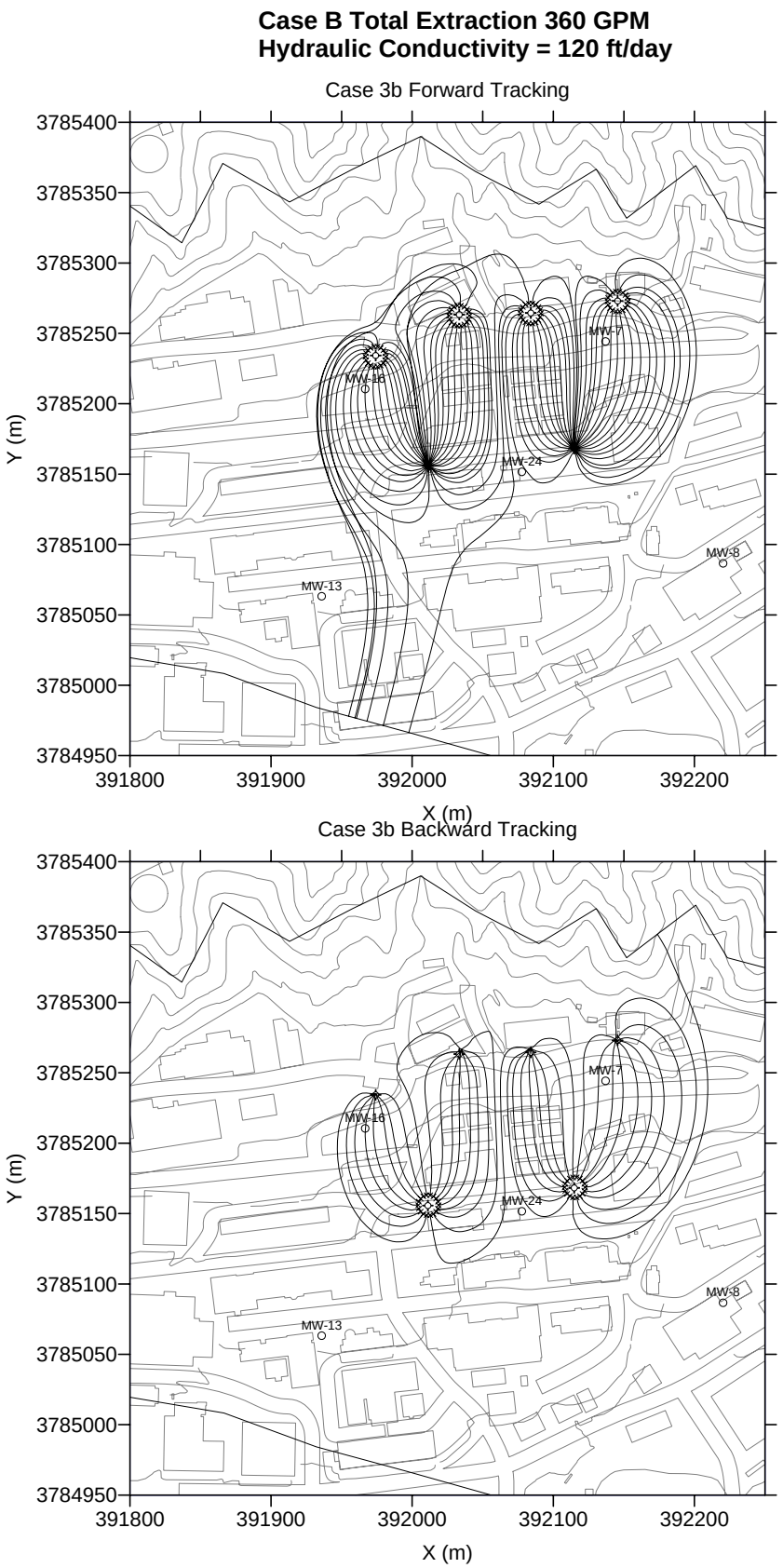


Figure 5. Extraction Well Capture Zones with Hydraulic Conductivity of 120 ft/d

Table 1. Well Construction Summary

Well	Depth (ft bgs)	Screen Depth (ft bgs)	Diameter (in)	Slot Size	Depth to Groundwater (ft bgs)	Design Extraction Rate (gpm)
EW-1 (shallow)	265	215-265	6	0.040	170	125
EW-2 (deep)	315	265-315	6	0.040	170	50
IW-1	315	215-315	6	0.050	214	NA
IW-2	315	215-315	6	0.050	221	NA

Table 2. Summary of Distance of Observation Wells from Extraction Wells and Drawdown in Extraction Wells During Pumping Test

Well ID	Approximate Distance from EW-2 (ft)	Drawdown Observed During Pumping Test (ft)
EW-2	NA	25
EW-1	12	1.6
MW-24	160	0.7
MW-7	240	<0.2
IW-2	345	<0.2
IW-1	365	<0.2
MW-8	370	<0.2
MW-16	513	<0.2
MW-13	670	<0.2
MW-11	738	<0.2

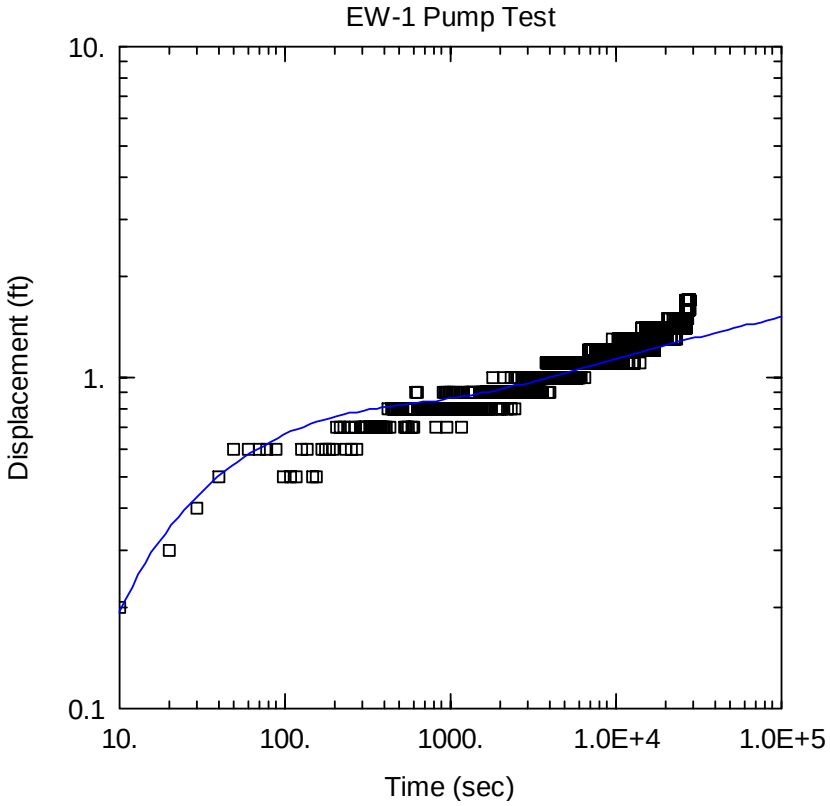
NA = not applicable.

Table 3. Summary of Slug Test Results.

Well	Test	K (ft/d)	Fit
EW-1	Bail #1	33.8	very good
	Bail #2	36.0	very good
	Bail #3	37.3	very good
	Slug #1	NA	none
	Slug #2	NA	none
	Slug #3	NA	none
EW-2	Bail #1	22.0	very]good
	Bail #2	21.2	very good
	Bail #3	22.9	very good
	Slug #1	20.7	poor
	Slug #2	22.2	marginal
	Slug #3	23.6	good
IW-1	Bail #1	14.0	poor
	Bail #2	21.8	good
	Bail #3	23.0	good
	Slug #1	18.4	poor
	Slug #2	20.1	poor
	Slug #3	22.2	poor
IW-2	Bail #1	12.7	very good
	Bail #2	13.2	good
	Bail #3	15.7	marginal
	Slug #1	14.2	marginal
	Slug #2	14.7	marginal
	Slug #3	18.5	poor
Average		***21.3***	
Geometric Mean		***20.4***	

Solution method: Bouwer-Rice for unconfined aquifers
Well casing for IW-2 corrected for screen above the water table (Bouwer, 1989)

ATTACHMENT 4

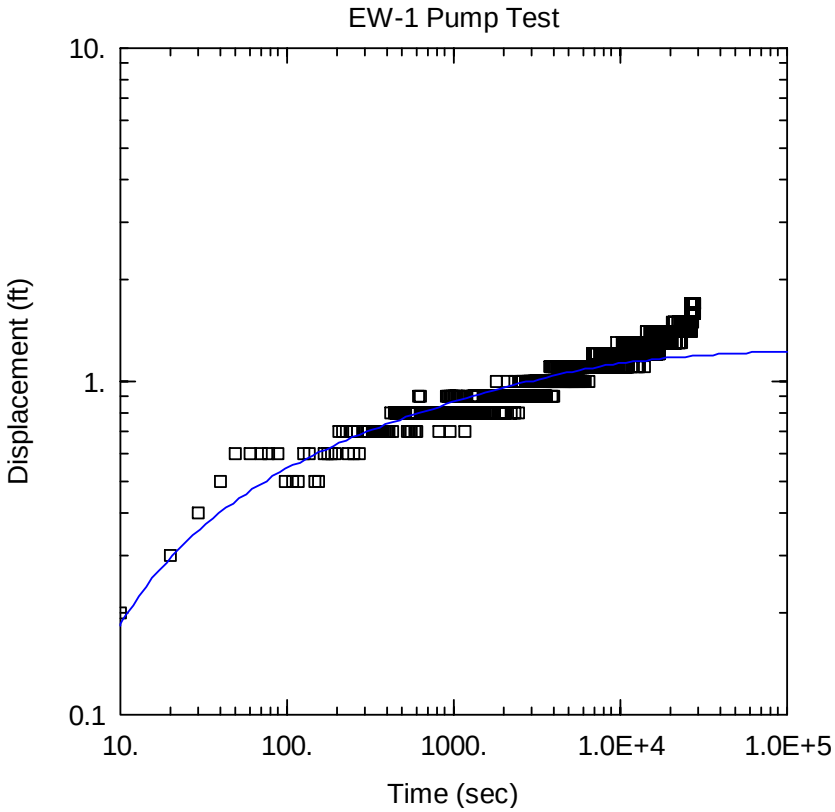


Obs. Wells
- EW-1

Aquifer Model
Unconfined

Solution
Moench

Parameters
T = 1.348E+4 ft^2/day
S = 0.01469
Sy = 0.1
ß = 0.03
Sw = 0.
r(w) = 1. ft
alpha = 1.0E+30 sec^{-1}

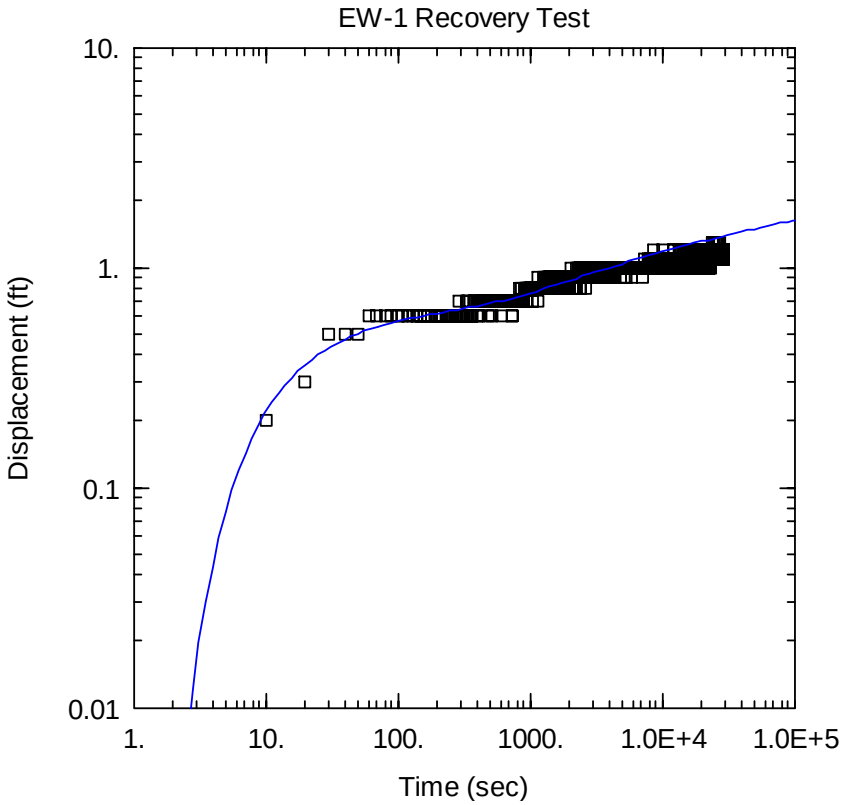


Obs. Wells
- EW-1

Aquifer Model
Leaky

Solution
Neuman-Witherspoon

Parameters
T = 9793.4 ft^2/day
S = 0.007457
r/B = 0.1
ß = 0.1
T' = 8.64E+4 ft^2/day
S' = 0.001

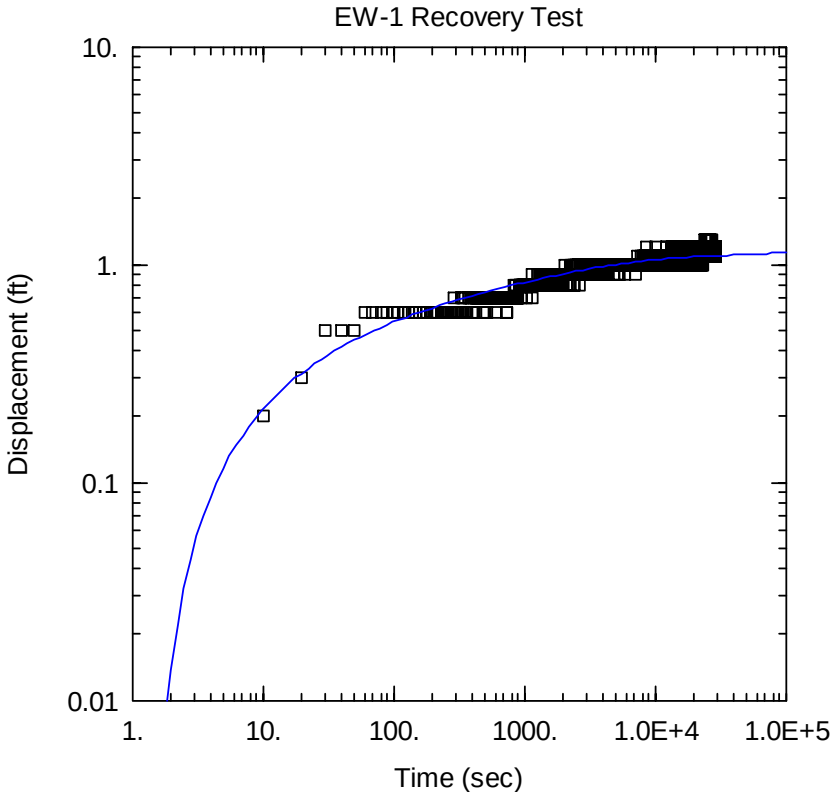


Obs. Wells
- EW-1

Aquifer Model
Unconfined

Solution
Moench

Parameters
T = 1.141E+4 ft^2/day
S = 0.01215
Sy = 0.1
ß = 0.06
Sw = 0.
r(w) = 1. ft
alpha = 1.0E+30 sec^{-1}

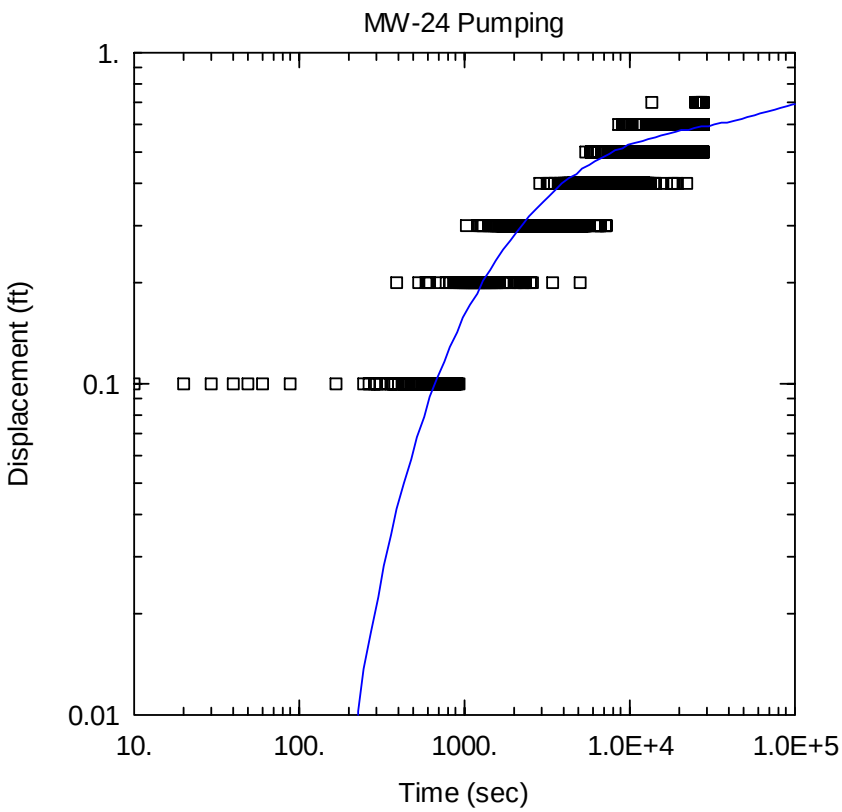


Obs. Wells
- EW-1

Aquifer Model
Leaky

Solution
Neuman-Witherspoon

Parameters
T = 1.077E+4 ft^2/day
S = 0.005674
r/B = 0.1
ß = 0.1
T' = 8.64E+4 ft^2/day
S' = 0.001

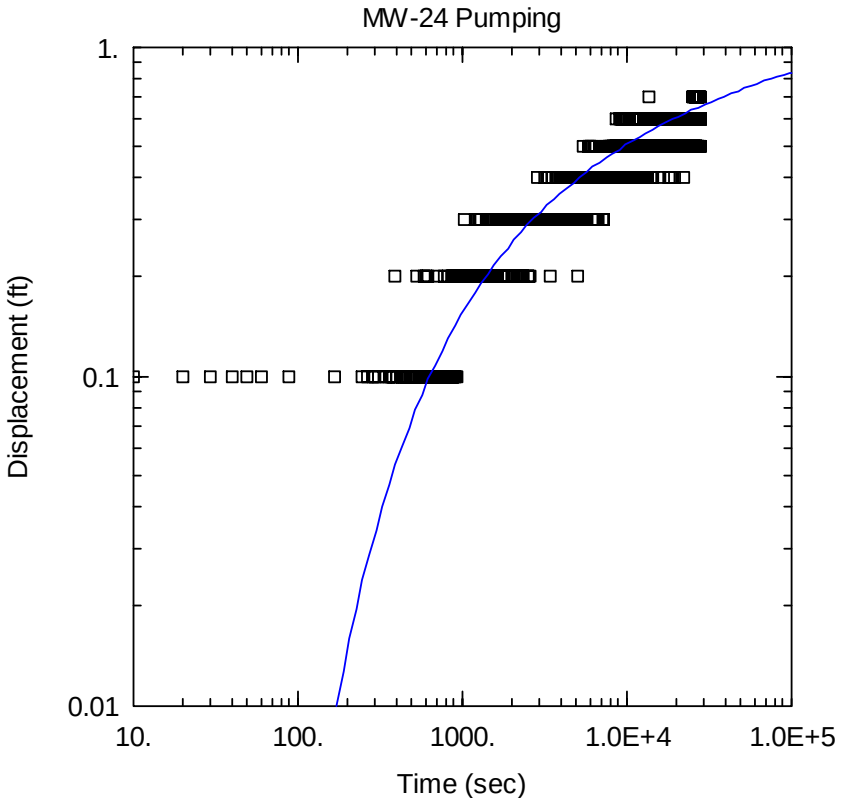


Obs. Wells
- MW-24

Aquifer Model
Unconfined

Solution
Moench

Parameters
T = 9400.8 ft^2/day
S = 0.008765
Sy = 0.1
ß = 0.1
Sw = 0.
r(w) = 1. ft
alpha = 1.0E+30 sec^{-1}



Obs. Wells
- MW-24

Aquifer Model
Leaky

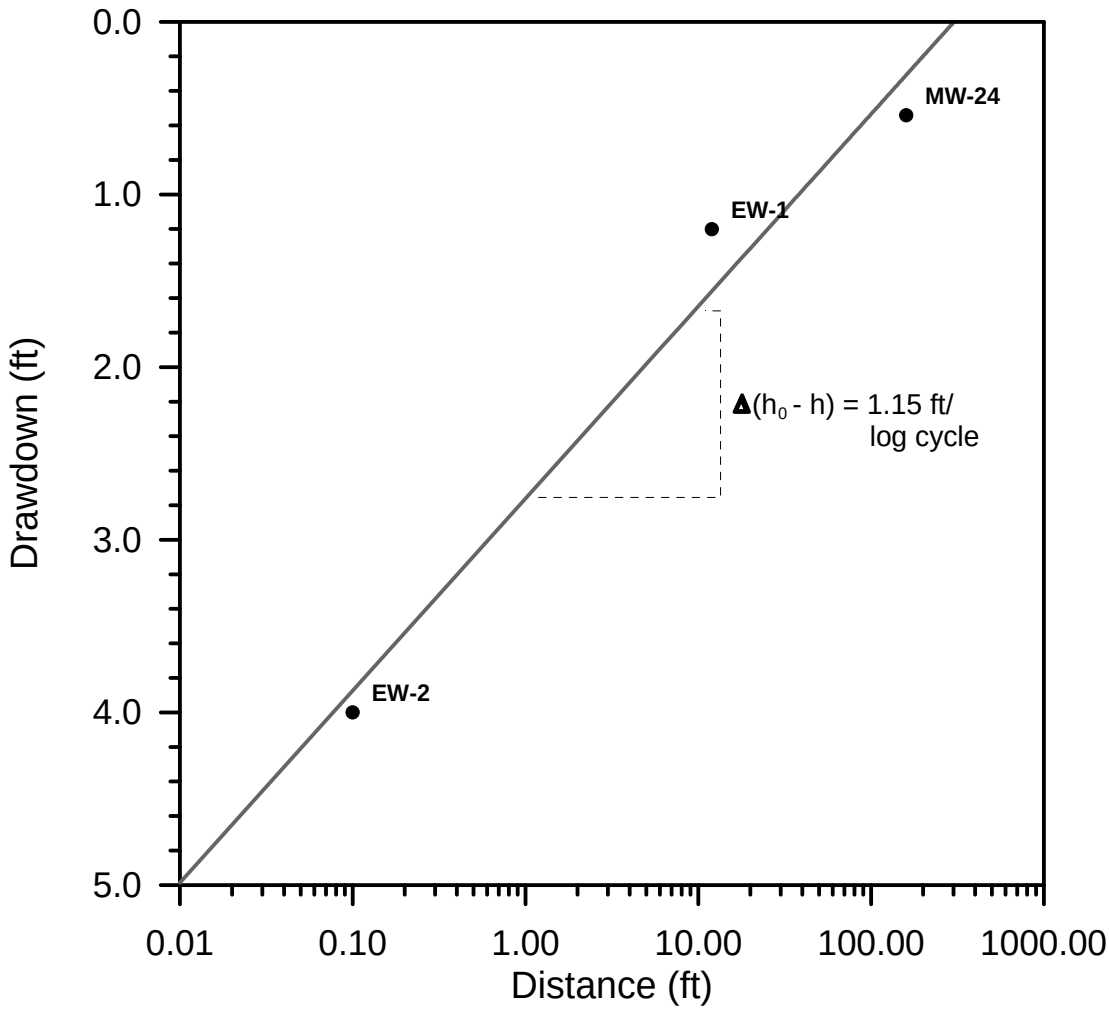
Solution
Neuman-Witherspoon

Parameters
T = 9521.8 ft^2/day
S = 0.005896
r/B = 0.1
ß = 0.1
T' = 8.64E+4 ft^2/day
S' = 0.001

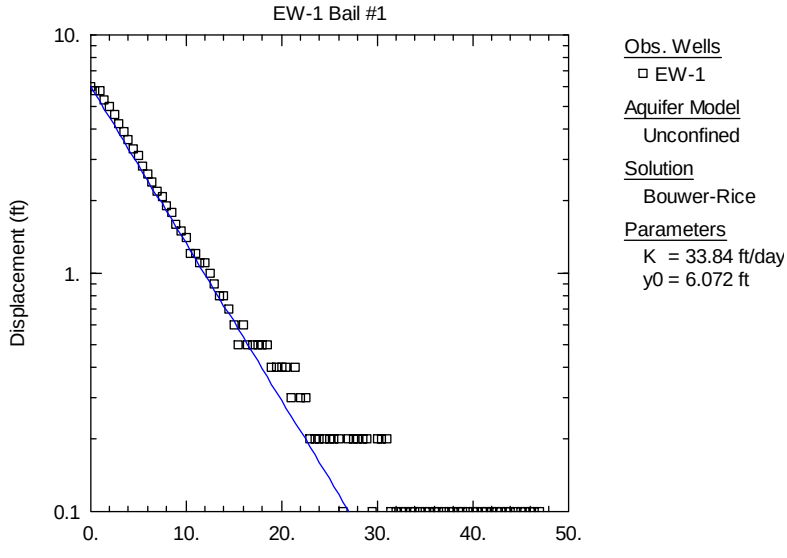
JPL OU-1 Pump Test: Distance Drawdown Method

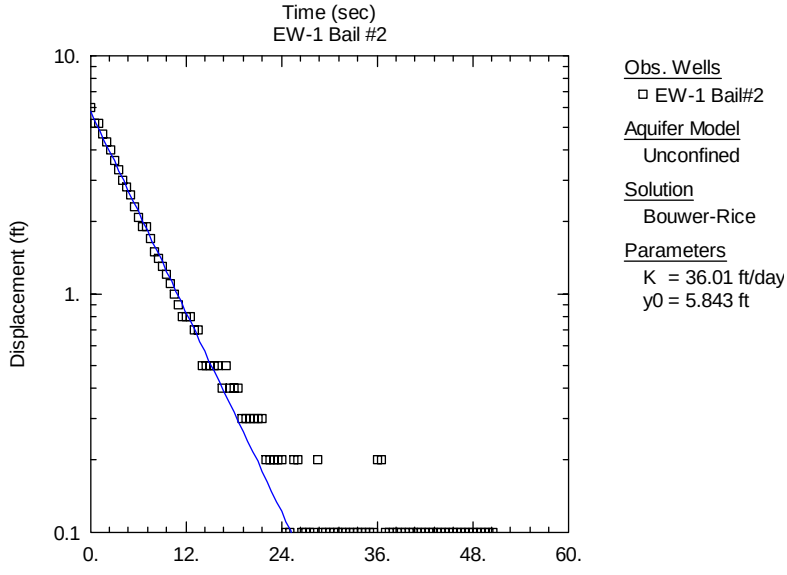
$$T = \frac{2.3\left(28{,}877\ ft^3 / d\right)}{2\pi(1.15\ ft)} = 9{,}192\ ft^2 / d$$

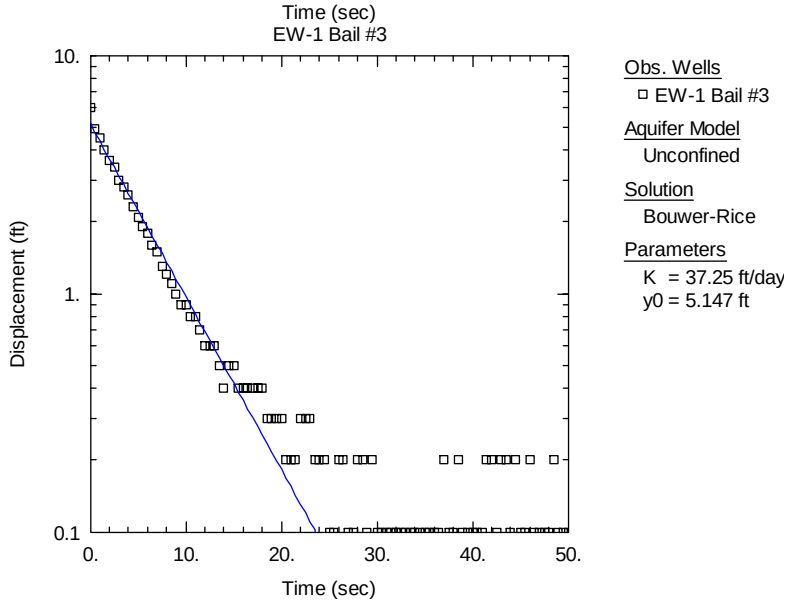
$$S = \frac{2.25\left(9192\ ft^2 / d\right)\left(0.116d\right)}{(1400\ ft)^2} = 0.00175$$

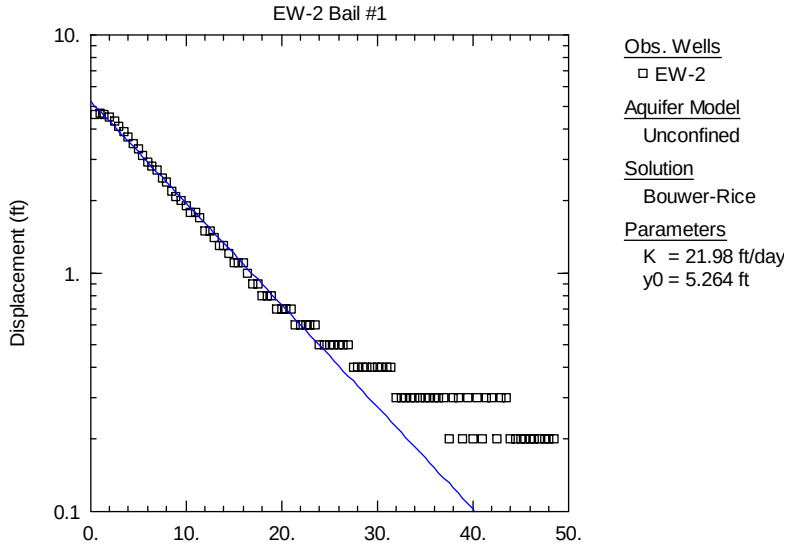


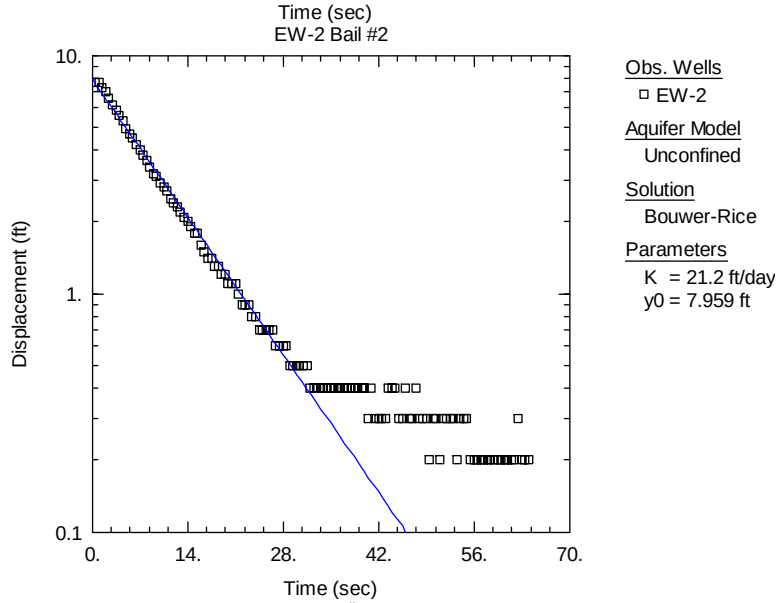
ATTACHMENT 5

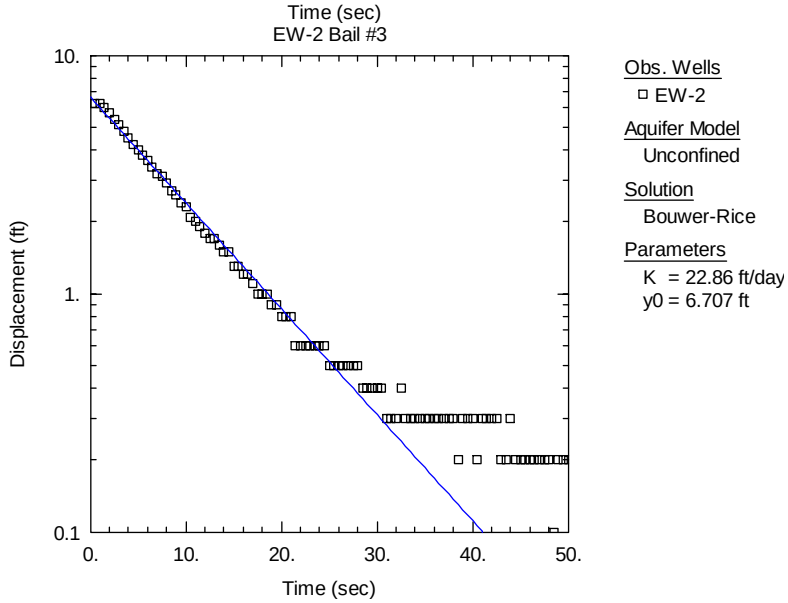

EW-1 Bail #1
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
EW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 33.84 ft/day
y0 = 6.072 ft

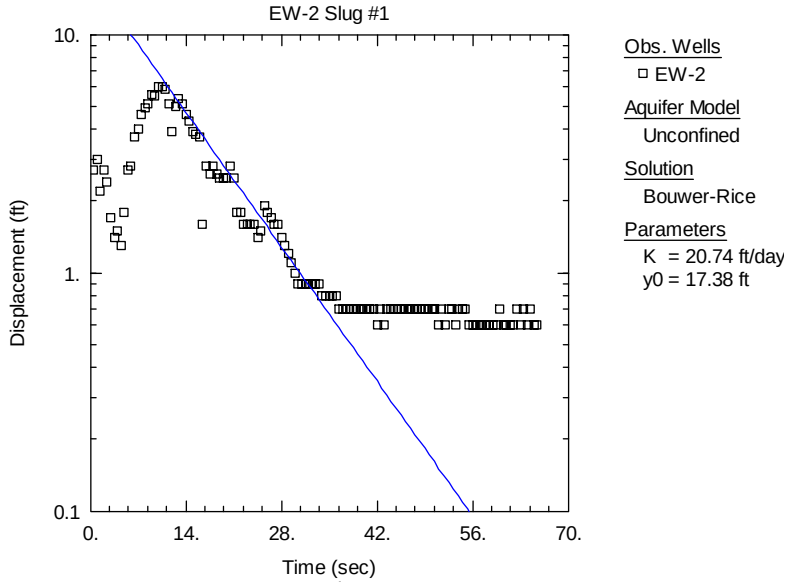

EW-1 Bail #2
Displacement (ft)
10.
1.
0.1
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
EW-1 Bail#2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 36.01 ft/day
y0 = 5.843 ft

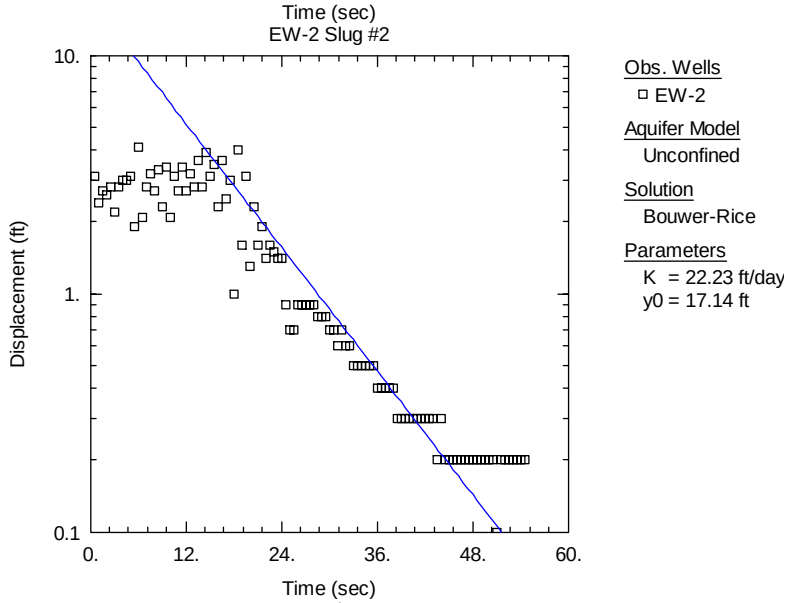

EW-1 Bail #3
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
EW-1 Bail #3
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 37.25 ft/day
y0 = 5.147 ft

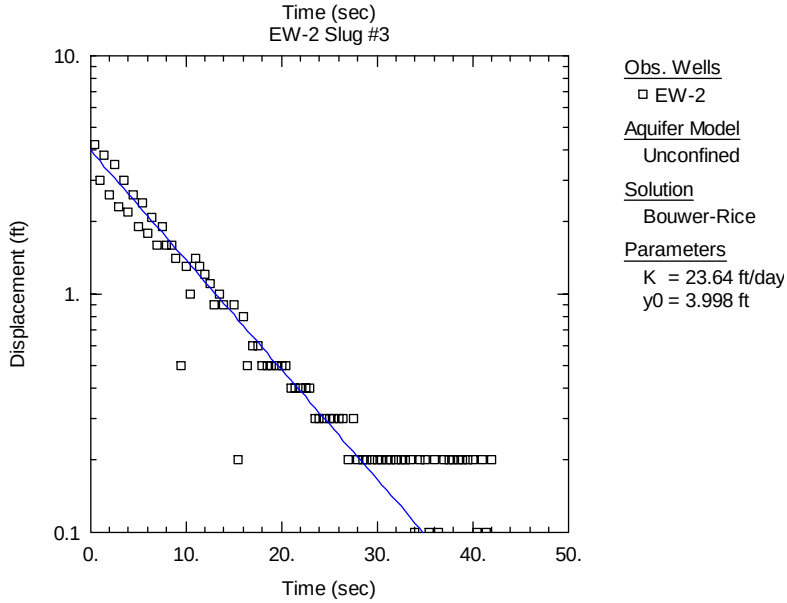

EW-2 Bail #1
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 21.98 ft/day
y0 = 5.264 ft

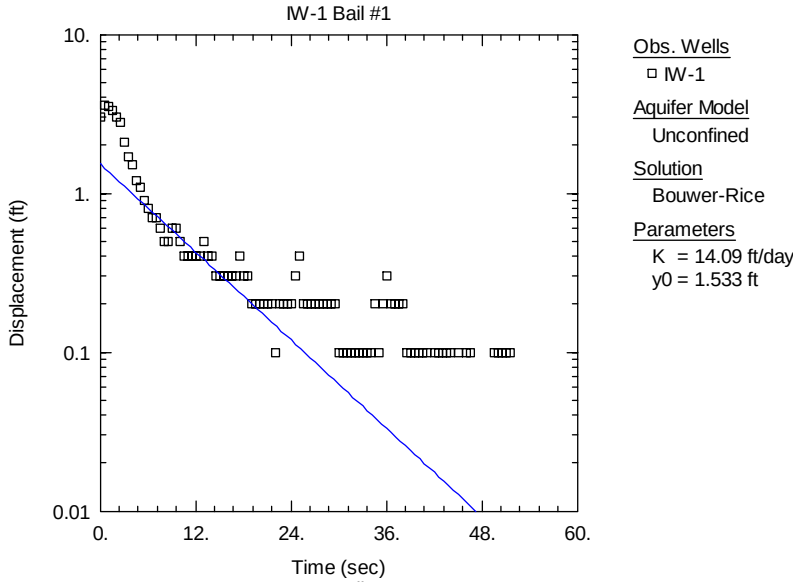

EW-2 Bail #2
Displacement (ft)
10.
1.
0.1
0.
14.
28.
42.
56.
70.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 21.2 ft/day
y0 = 7.959 ft

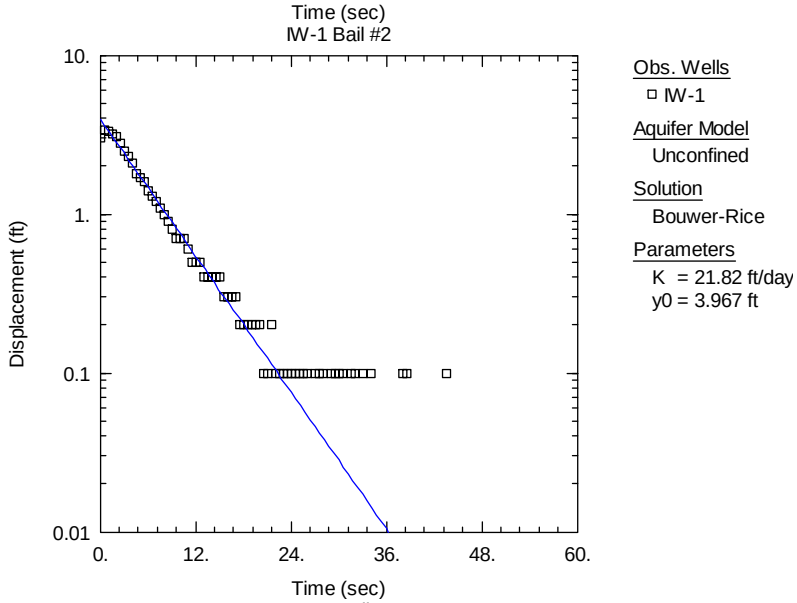

EW-2 Bail #3
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 22.86 ft/day
y0 = 6.707 ft

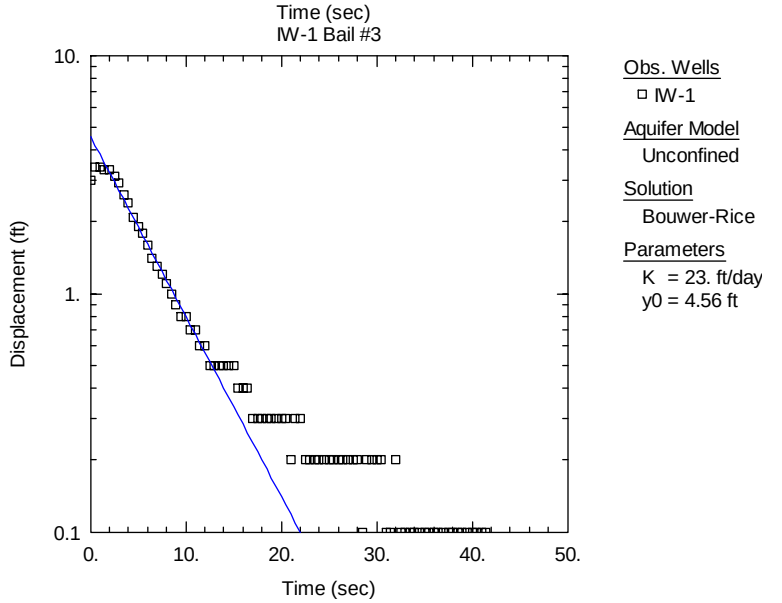

EW-2 Slug #1
10.
1.
0.1
Displacement (ft)
0.
14.
28.
42.
56.
70.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 20.74 ft/day
y0 = 17.38 ft

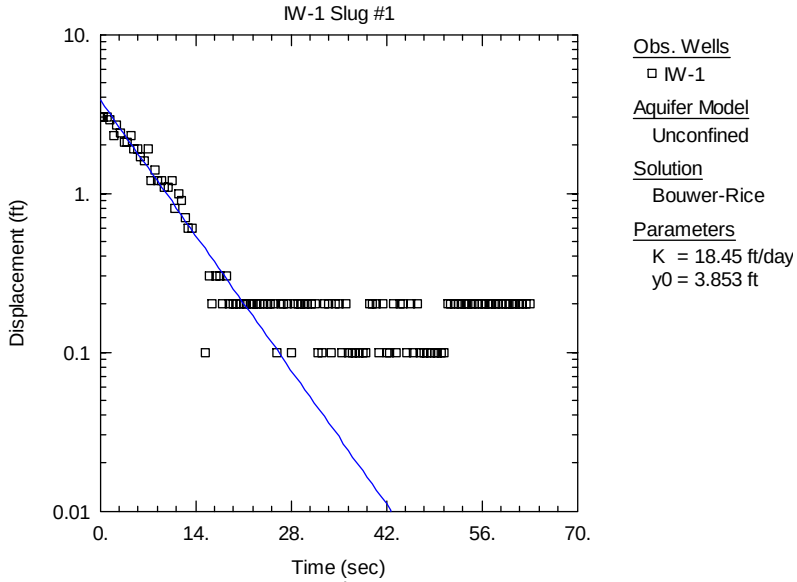

EW-2 Slug #2
10.
1.
0.1
Displacement (ft)
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 22.23 ft/day
y0 = 17.14 ft

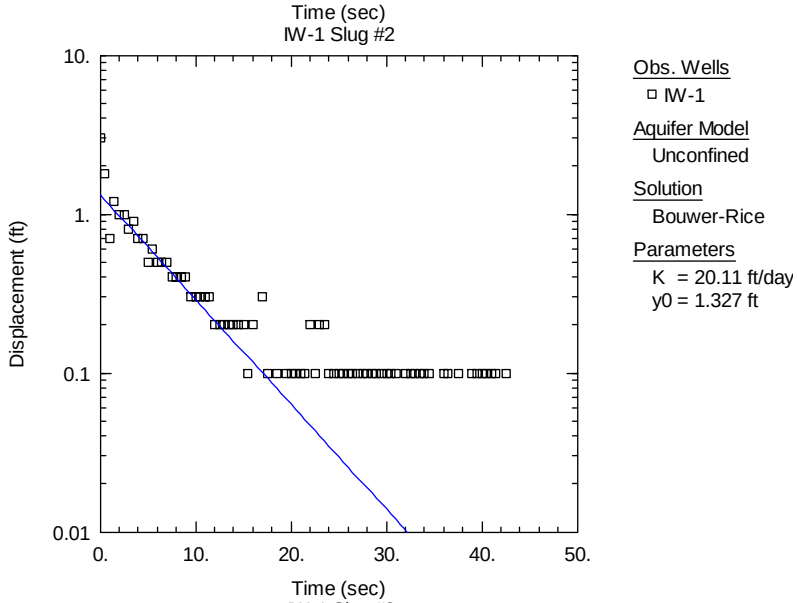

EW-2 Slug #3
10.
1.
0.1
Displacement (ft)
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
EW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 23.64 ft/day
y0 = 3.998 ft

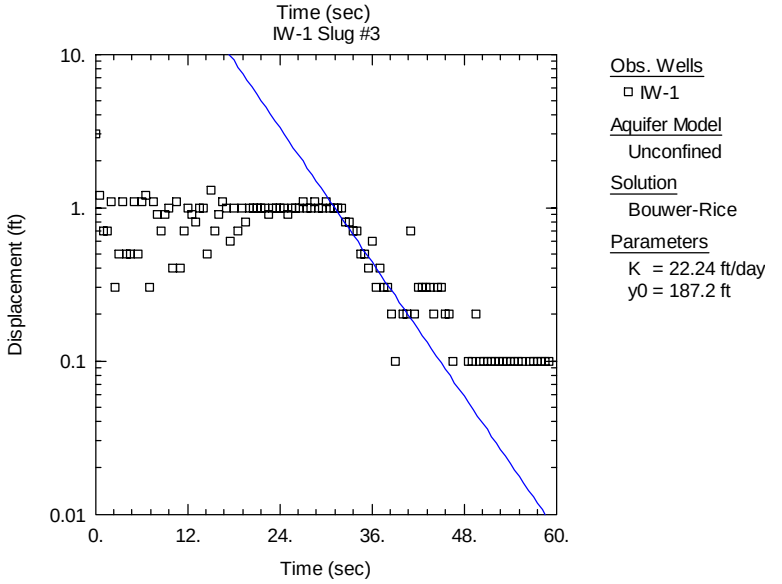

IW-1 Bail #1
Displacement (ft)
10.
1.
0.1
0.01
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 14.09 ft/day
y0 = 1.533 ft

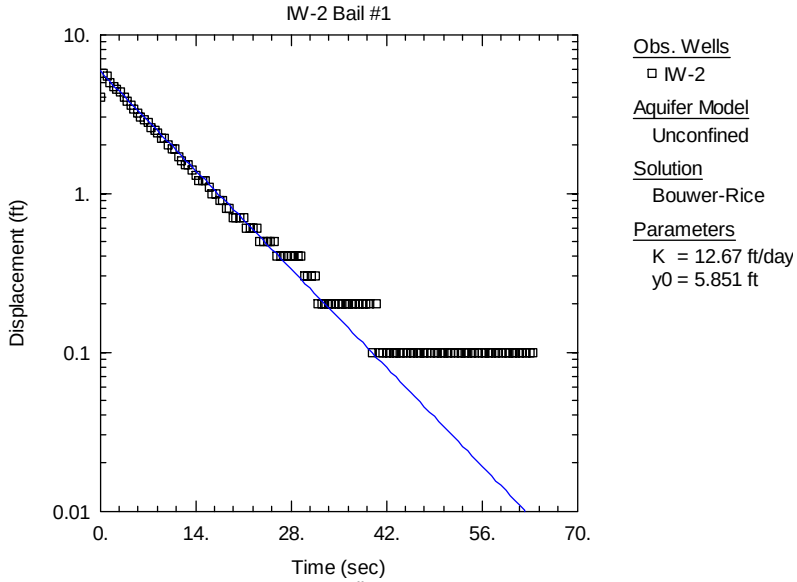

IW-1 Bail #2
Displacement (ft)
10.
1.
0.1
0.01
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 21.82 ft/day
y0 = 3.967 ft

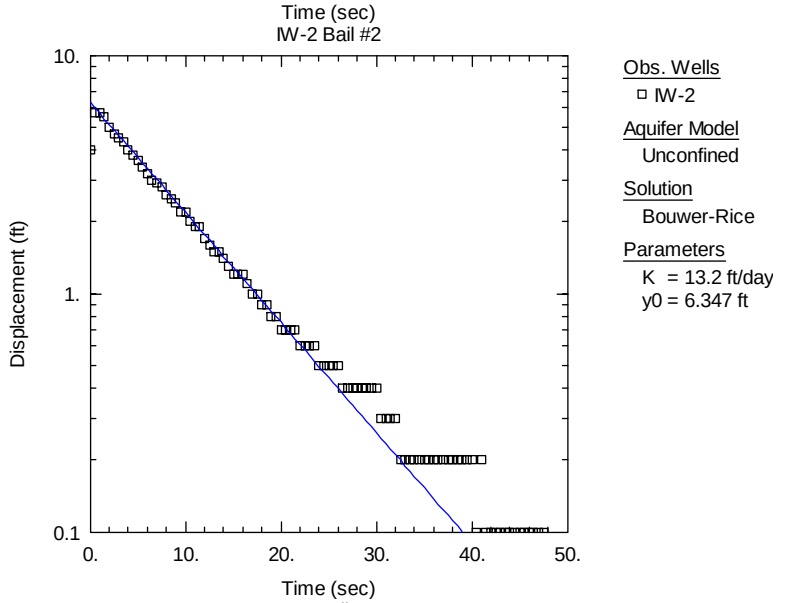

IW-1 Bail #3
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 23. ft/day
y0 = 4.56 ft

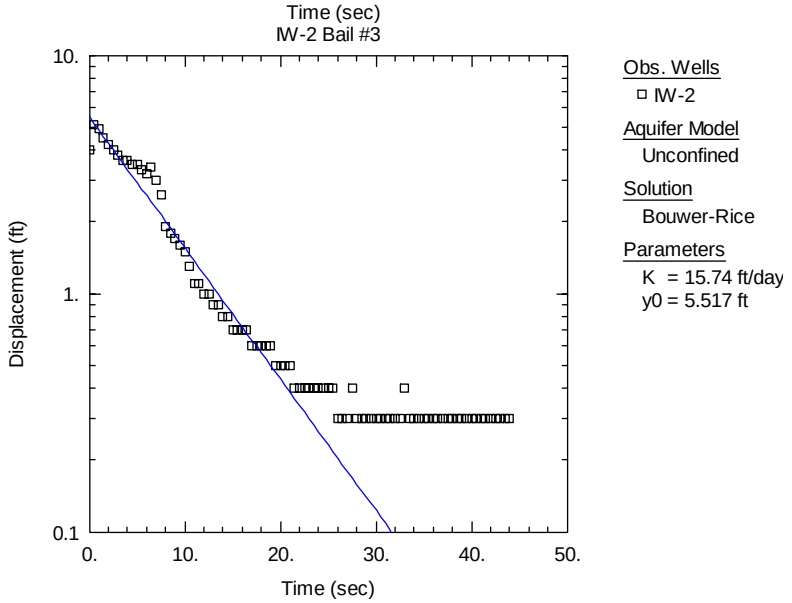

IW-1 Slug #1
Displacement (ft)
10.
1.
0.1
0.01
0.
14.
28.
42.
56.
70.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 18.45 ft/day
y0 = 3.853 ft

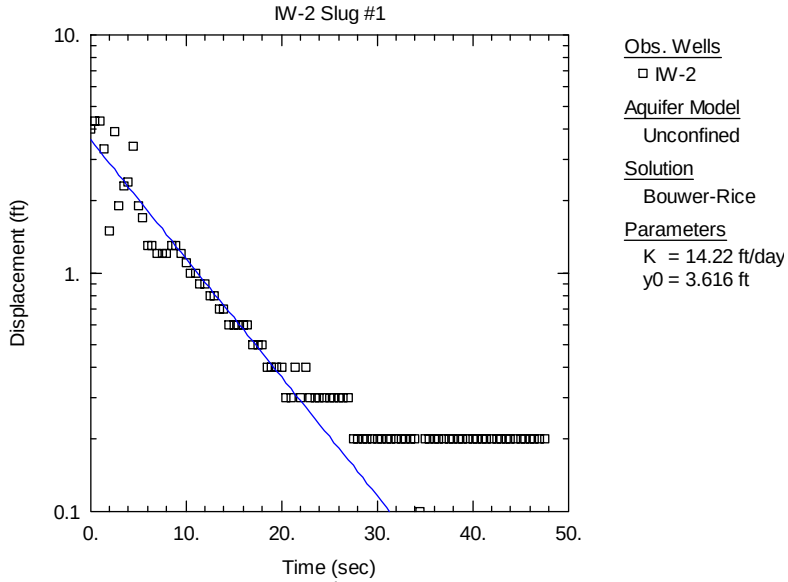

IW-1 Slug #2
Displacement (ft)
10.
1.
0.1
0.01
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 20.11 ft/day
y0 = 1.327 ft

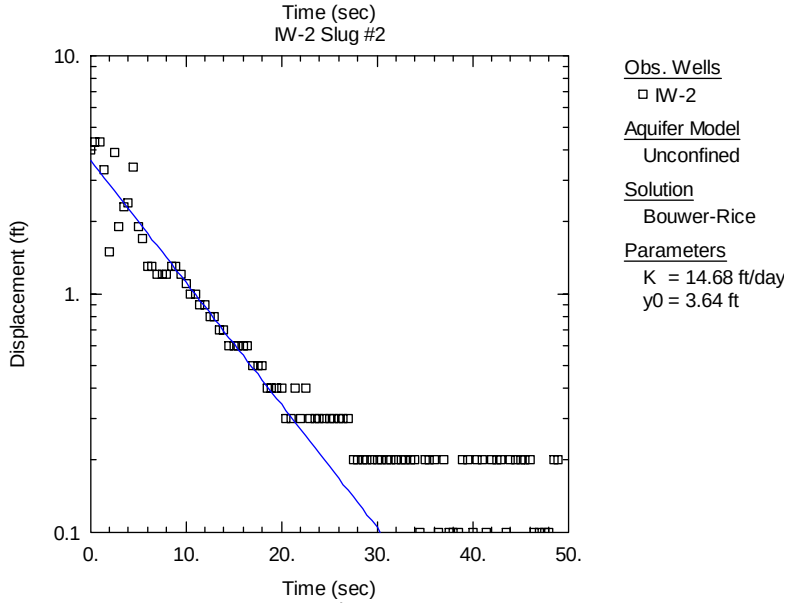

IW-1 Slug #3
Displacement (ft)
10.
1.
0.1
0.01
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 22.24 ft/day
y0 = 187.2 ft

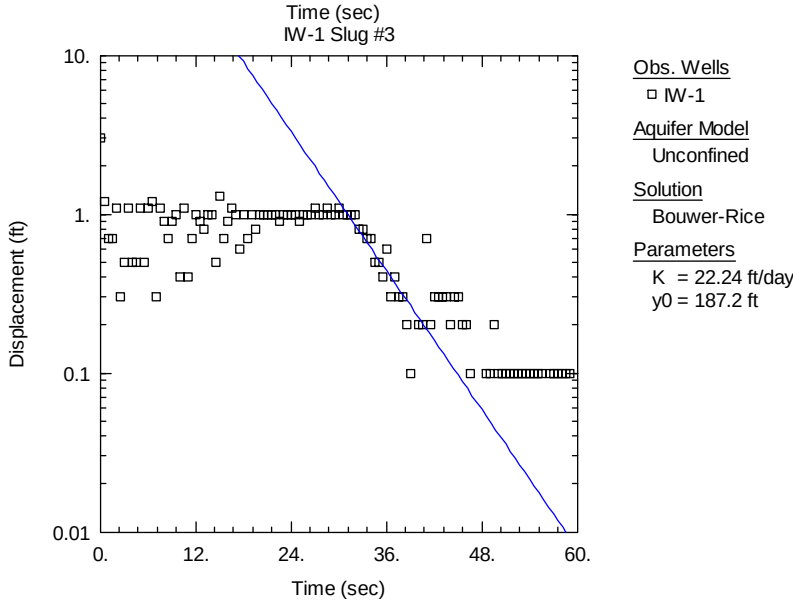

IW-2 Bail #1
Displacement (ft)
10.
1.
0.1
0.01
0.
14.
28.
42.
56.
70.
Time (sec)
Obs. Wells
IW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 12.67 ft/day
y0 = 5.851 ft


IW-2 Bail #2
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 13.2 ft/day
y0 = 6.347 ft

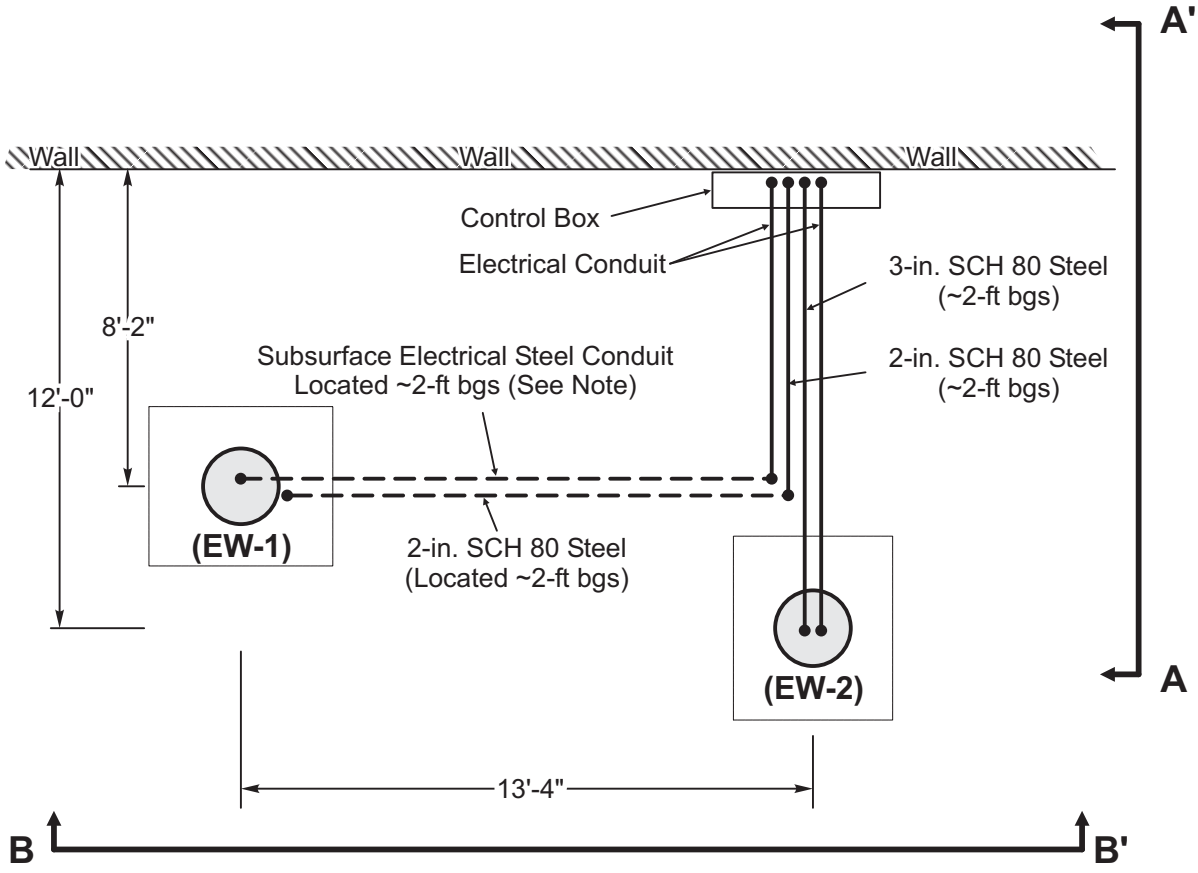

IW-2 Bail #3
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 15.74 ft/day
y0 = 5.517 ft


IW-2 Slug #1
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 14.22 ft/day
y0 = 3.616 ft


IW-2 Slug #2
Displacement (ft)
10.
1.
0.1
0.
10.
20.
30.
40.
50.
Time (sec)
Obs. Wells
IW-2
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 14.68 ft/day
y0 = 3.64 ft


IW-1 Slug #3
Displacement (ft)
10.
1.
0.1
0.01
0.
12.
24.
36.
48.
60.
Time (sec)
Obs. Wells
IW-1
Aquifer Model
Unconfined
Solution
Bouwer-Rice
Parameters
K = 22.24 ft/day
y0 = 187.2 ft

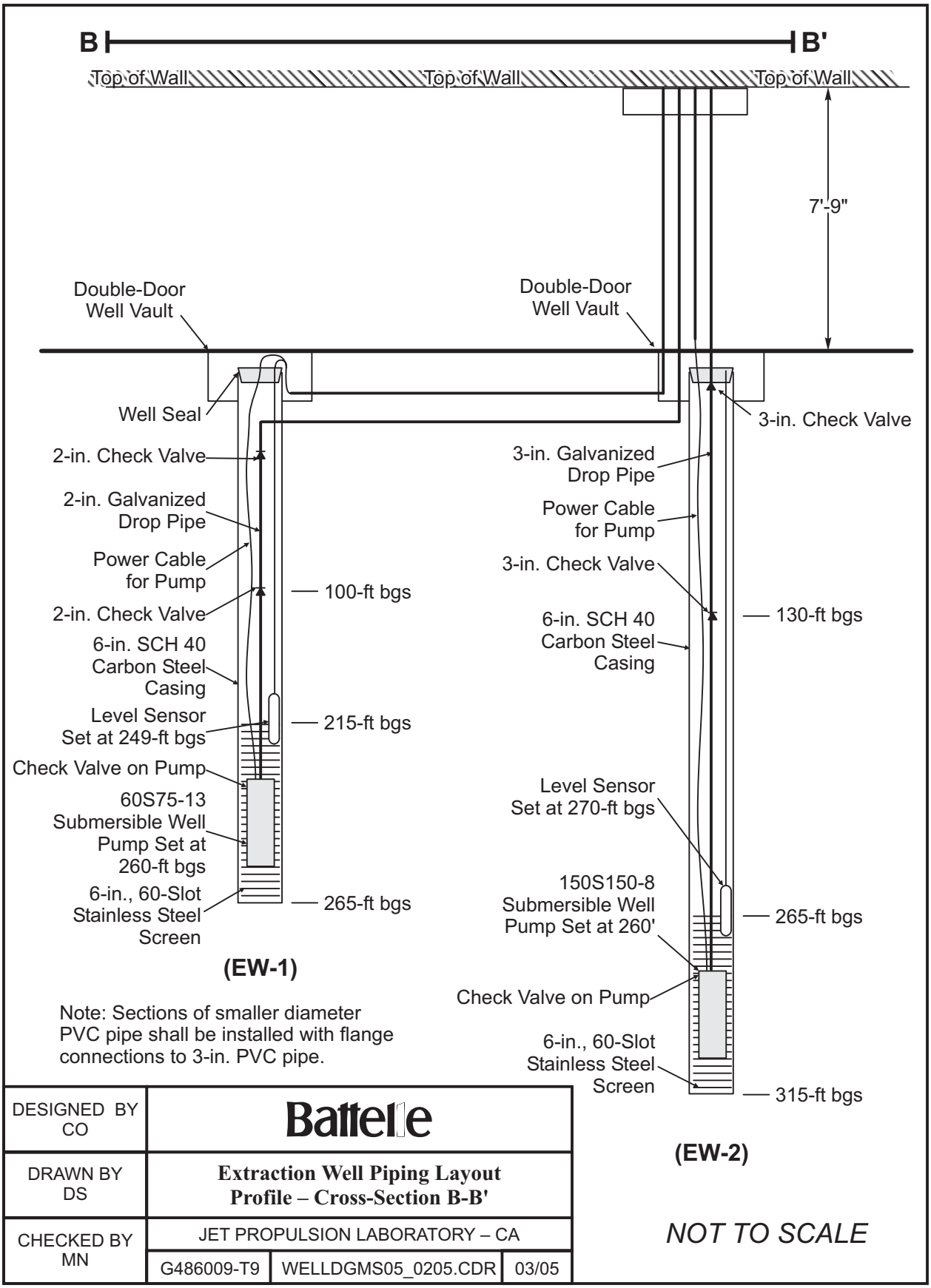
Extraction Well Piping Layout
PLAN VIEW



Note: Electrical conduit and PVC discharge pipe to be located in same trench with 0.5-ft vertical and 1.0-ft horizontal separation

NOT TO SCALE

DESIGNED BY CO	Battelle		
DRAWN BY DS	**Plan View of Extraction Well Layout**		
CHECKED BY MN	JET PROPULSION LABORATORY – CA		
	G486009-T9	WELLDGMS05_0205.CDR	04/04



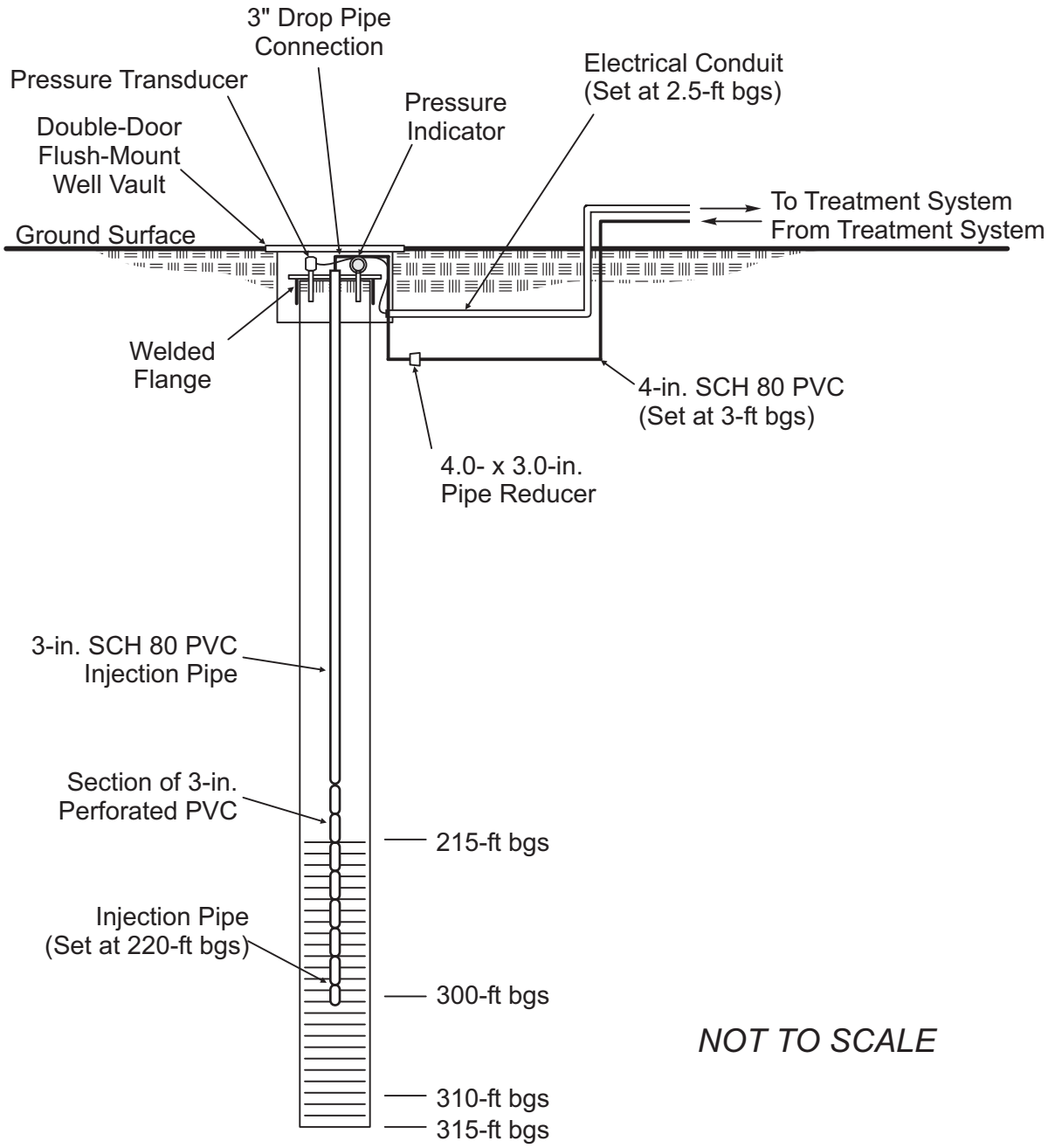
Note: Sections of smaller diameter PVC pipe shall be installed with flange connections to 3-in. PVC pipe.

DESIGNED BY CO	Battelle		
DRAWN BY DS	**Extraction Well Piping Layout Profile – Cross-Section B-B'**		
CHECKED BY MN	JET PROPULSION LABORATORY – CA		
	G486009-T9	WELLDGMS05_0205.CDR	03/05

NOT TO SCALE

Injection Wells 1 and 2

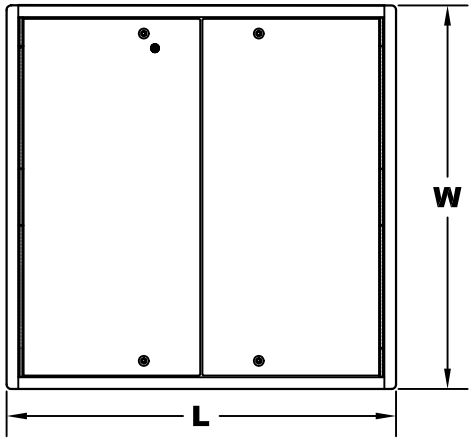
CROSS-SECTION

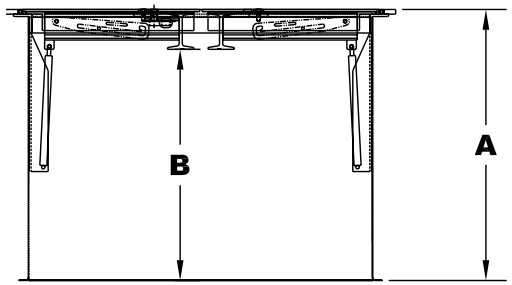


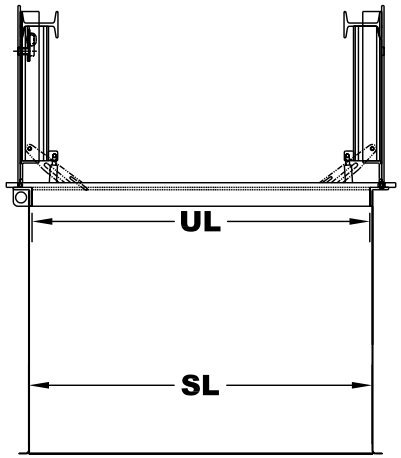
NOT TO SCALE

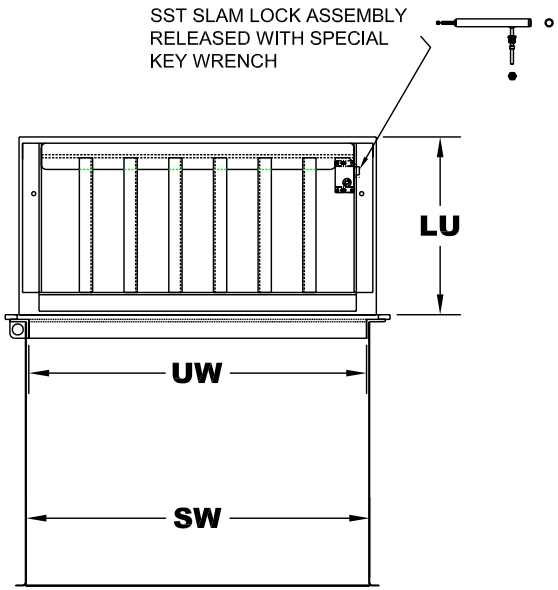
(IW-1)

DESIGNED BY CO	Battelle		
DRAWN BY DS	**Diagram of Injection Wells 1 and 2**		
CHECKED BY MN	JET PROPULSION LABORATORY – CA		
	G486009-T9	WELLDGMS05_0205.CDR	02/05









	DOUBLE DOOR H-20 MODELS				
	HRB 24 X 36	HRB 30 X 30	HRB 36 X 36	HRB 36 X 48	HRB 48 X 48
RATED	H-20	H-20	H-20	H-20	H-20
A	29.0	29.0	29.0	29.0	29.0
B	24.0	24.0	24.0	24.0	24.0
W	29.0	35.0	41.0	41.0	53.0
L	42.0	36.0	42.0	53.0	54.0
UW	24.0	30.0	36.0	36.0	48.0
UL	36.0	30.0	36.0	48.0	48.0
SW	24.5	30.5	36.5	48.5	48.5
SL	36.5	30.5	36.5	36.5	48.5
LU	19.0	16.0	19.0	25.0	25.0
SAFETY ARM	YES	YES	YES	YES	YES
GAS SPRING	YES	NO	YES	YES	YES
LID LIFTING FORCE	42#	55#	58#	49#	49#
BOLT DOWN LID	YES	YES	YES	YES	YES
SST SLAM LOCK	YES	YES	YES	YES	YES
GASKET	YES	YES	YES	YES	YES
PRIMED IN & OUT	YES	YES	YES	YES	YES
HINGED LID	YES	YES	YES	YES	YES
SHIPPING WEIGHT	295#	350#	525#	675#	764#

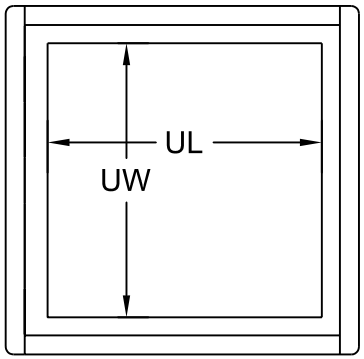
ALL DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

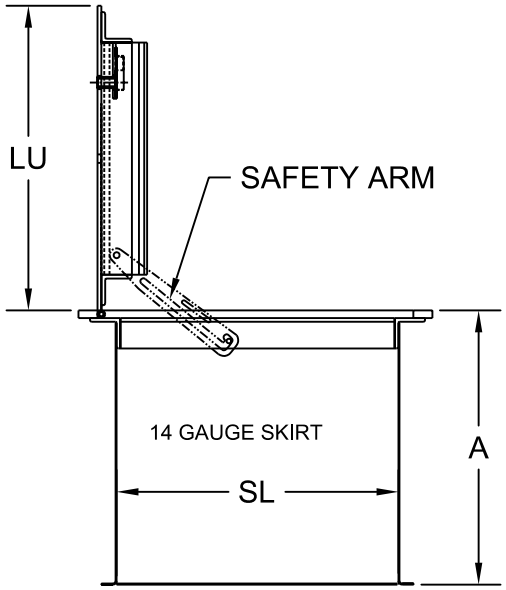
EXTENSIONS AVAILABLE - CONTACT FACTORY FOR DETAILS

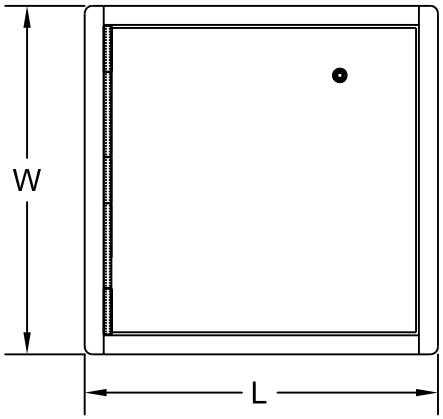
DOUBLE LID H-20 RATED VAULTS

GLOBAL DRILLING SUPPLIERS, INC.
12101 CENTRON PLACE
CINCINNATI, OH 45246
(800) 356-6400

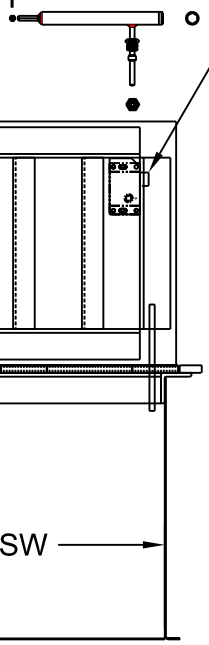
SIZE	FSCM NO.	DWG NO.	REV
		COMPOSITE	
SCALE NONE	DATE: 03-12-2003	SHEET	

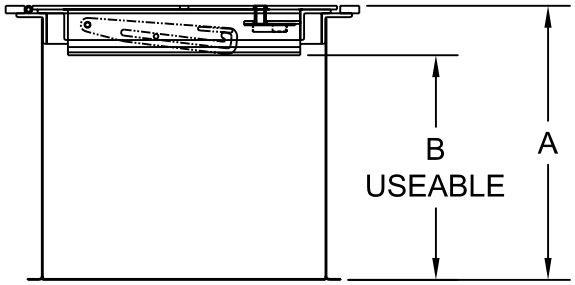






SST SLAM LOCK ASSEMBLY RELEASED WITH SPECIAL KEY WRENCH





	ECONO 14 x 14	ECONO 14 x 30	ECONO 18 x 18	ECONO 24 x 24	HRB 24 x 24	APB 24 x 24
RATED	H-20	H-20	H-20	H-20	H-20	55,000#
A	14.0	21.3	18.0	29.0	29.0	30.5
B	11.5	18.0	14.7	24.0	24.0	24.0
W	18.8	35.0	22.8	28.8	28.8	29.5
L	19.3	19.3	22.2	29.4	29.4	30.5
UW	14.0	14.0	18.0	24.0	24.0	24.0
UL	14.0	30.0	18.0	24.0	24.0	24.0
SW	14.5	30.5	18.5	24.5	24.5	24.5
SL	14.5	14.5	18.5	24.5	24.5	24.5
LU	16.0	16.0	20.0	26.0	26.0	27.2
SAFETY ARM	YES	YES	YES	YES	YES	YES
GAS SPRING	NO	NO	NO	NO	YES	YES
LID LIFTING FORCE	27#	48#	41#	76#	<50#	abt 50#
BOLT DOWN LID(1 BOLT)	YES	YES	YES	YES	YES	YES
SST SLAM LOCK	YES	YES	YES	YES	YES	YES
GASKET	YES	YES	YES	YES	YES	YES
PRIMED IN & OUT	YES	YES	YES	YES	YES	YES
HINGED LID	YES	YES	YES	YES	YES	YES
SHIPPING WEIGHT	80#	170#	140#	270#	275#	425#

ALL DIMENSIONS SUBJECT TO CHANGE WITHOUT NOTICE.

SINGLE LID H-20 RATED VAULTS

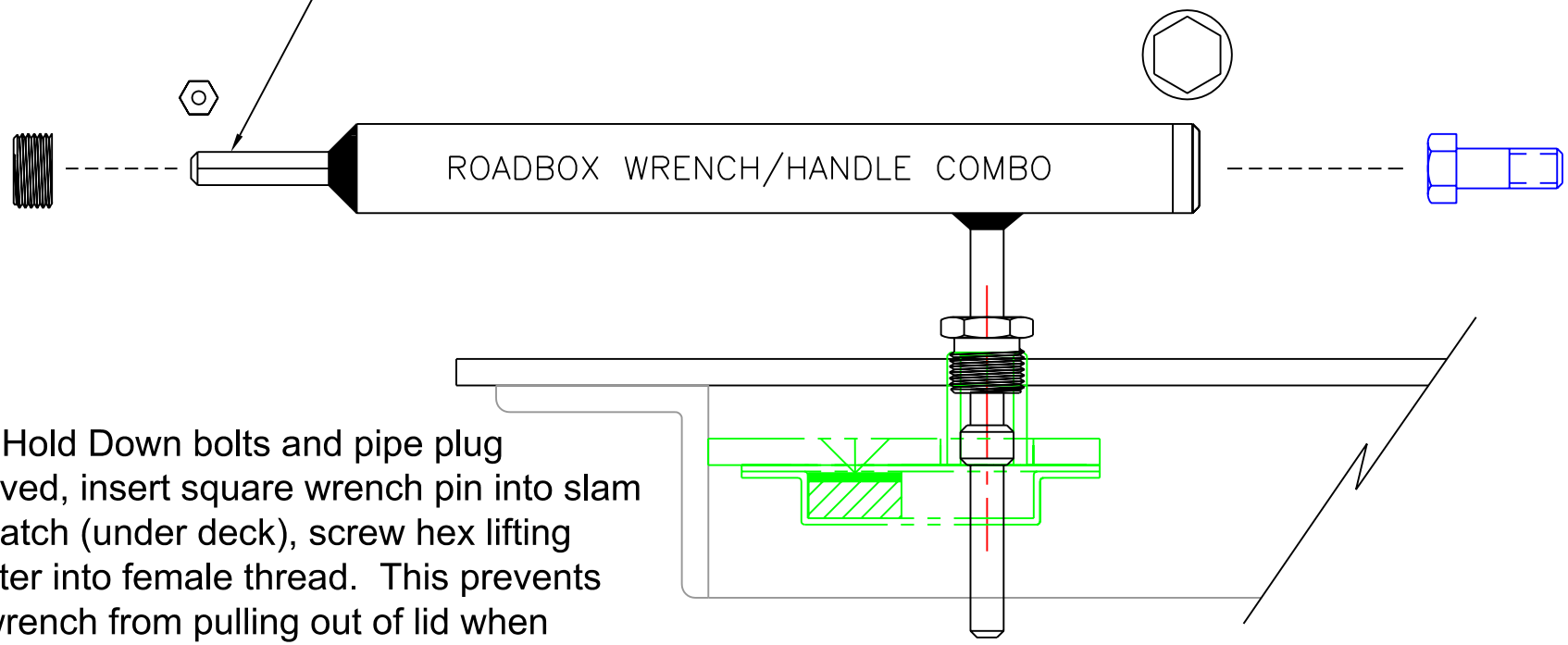
GLOBAL DRILLING SUPPLIERS, INC.
12101 CENTRON PLACE
CINCINNATI, OH 45246
(800) 356-6400

SIZE	FSCM NO.	DWG NO.	REV
		COMPOSITE	
SCALE NONE	DATE: 04-24-2000	SHEET	

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

Hex Pin is used to remove Stainless Steel Pipe Plug allowing access to Slam Lock.

9/16" Hex Box is used to remove Stainless Steel Lid Hold Down Bolts.



With Hold Down bolts and pipe plug removed, insert square wrench pin into slam lock latch (under deck), screw hex lifting adapter into female thread. This prevents the wrench from pulling out of lid when lifting.

Note:
Adapter must be tightened by hand, be sure several threads have been engaged.

Postion handle for best leverage when lifting lid. Rotate to release underdeck lock them lift vertical until SAFETY ARM LATCHES.

Opening Global Road Boxes

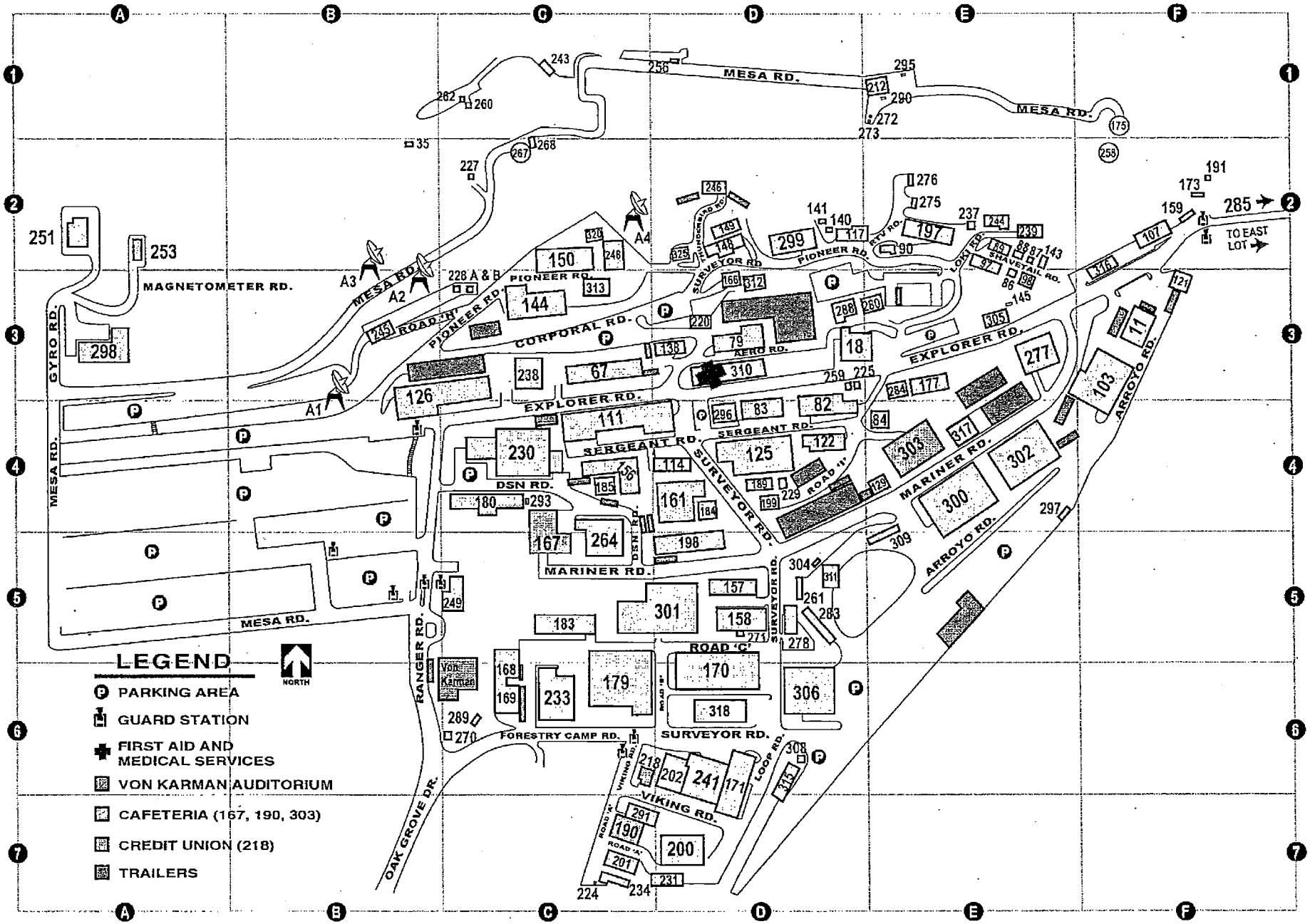
GLOBAL DRILLING SUPPLIERS, INC.
12101 CENTRON PLACE
CINCINNATI, OH 45246 (800) 356-6400

SIZE	FSCM NO.	DWG NO.	REV
		Instructions	

SCALE	DATE: 02-04-98	SHEET

Appendix 3-1

JPL Overview Map
Results


MESA RD.
MAGNETOMETER RD.
GYRO RD.
PIONEER RD.
ROAD 'H'
CORPORAL RD.
EXPLORER RD.
SERGEANT RD.
SURVEYOR RD.
DSN RD.
MARINER RD.
ROAD 'I'
ROAD 'C'
RANGER RD.
OAK GROVE DR.
FORESTRY CAMP RD.
VIKING RD.
LOOP RD.
ARROYO RD.
TO EAST LOT
Von Karman
LEGEND
NORTH
PARKING AREA
GUARD STATION
FIRST AID AND MEDICAL SERVICES
VON KARMAN AUDITORIUM
CAFETERIA (167, 190, 303)
CREDIT UNION (218)
TRAILERS