OBG

Hydrogeologic Monitoring Plan

Havana East Ash Pond (Cells 1, 2, 3, and 4)
CCR Unit ID 701

Havana Power Station

Dynegy Midwest Generation, LLC

October 17, 2017

Natural Resource Technology
AN OBG COMPANY

OCTOBER 17, 2017 | PROJECT #2285

Hydrogeologic Monitoring Plan

Havana East Ash Pond (Cells 1, 2, 3, and 4)
CCR Unit ID 701

Havana Power Station
Havana, Illinois

Prepared for:
Dynegy Midwest Generation, LLC

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
CCR	coal combustion residual
CFR	Code of Federal Regulations
DMG	Dynegy Midwest Generation, LLC
cm/s	centimeters per second
ft	feet
HMP	Hydrogeologic Monitoring Plan
ID	Identification Number
MSL	mean sea level
NRT	Natural Resource Technology, an OBG Company
RCRA	Resource Conservation and Recovery Act
SAP	Sampling and Analysis Plan
STMI	Science & Technology Management, Inc.
USEPA	United States Environmental Protection Agency

1 INTRODUCTION

1.1 OVERVIEW

This Hydrogeologic Monitoring Plan (HMP) has been prepared by Natural Resource Technology, an OBG Company (NRT) to provide background information necessary to support the groundwater monitoring system established to comply with Part 257.91 of the United States Environmental Protection Agency (USEPA) Final Rule to regulate the disposal of Coal Combustion Residual (CCR) as solid waste under Subtitle D of the Resource Conservation and Recovery Act (RCRA) [40 CFR 257 Subpart D; published in 80 FR 21302-21501, April 17, 2015] for the Havana Power Station, Havana, Illinois. The Havana Power Station is owned by Dynegy Midwest Generation, LLC (DMG). This HMP will apply specifically to the following CCR Unit, Havana East Ash Pond (Cells 1, 2, 3, and 4), CCR Unit ID 701, as defined further below.

1.2 PREVIOUS INVESTIGATIONS AND REPORTS

Several hydrogeologic investigations have been performed concerning ash impoundments south of the Havana East Ash Pond (Cells 1, 2, 3, and 4) CCR Unit located at the Havana Power Station. The information presented in this HMP includes data collected in support of the monitoring well network established for development of the Sampling and Analysis Plan (SAP) and supplements comprehensive data collection and evaluations from prior hydrogeologic investigation reports (recent to oldest), including, but not limited to, the following:

- ***Atlantic Environmental Services Inc., March 1994, Ash Impoundment Closure Study.*** An investigation to characterize the hydrogeology of the ash impoundments south of the Havana East Ash Pond (Cells 1, 2, 3, and 4) and determine the nature, and distribution of subsurface material below the ash impoundments.
- ***Science & Technology Management, Inc. (STMI), March 1994, Investigation of Site Closure Options at Illinois Power Company's Havana South Ash Impoundment.*** An investigation to characterize hydrogeology and water quality, evaluate cap performance alternatives and determine viability of downgradient groundwater monitoring systems at ash impoundments south of Havana East Ash Pond (Cells 1, 2, 3, and 4).
- ***Illinois State Water Survey, August 1982, Groundwater Monitoring at the Havana Power Station's Ash Disposal Ponds and Treatment Lagoon.*** An investigation designed to implement a groundwater monitoring system for determining the impact from ash disposal methods on the groundwater system at ash impoundments south of Havana East Ash Pond (Cells 1, 2, 3, and 4).

This HMP provides a summary of data collected at Havana East Ash Pond (Cells 1, 2, 3, and 4) since the submittal of the previous reports concerning ash impoundments to the south of this site. The HMP also supports the monitoring well network established for development of the SAP through providing the following background information:

- Site Geology and Hydrogeology
- Aquifer Properties
- Monitoring Network Placement and Rationale

1.3 SITE LOCATION AND DESCRIPTION

Havana Power Station is located in the northeast quarter of Section 14, Township 21 North, Range 9 West of Mason County, Illinois and one mile south of the Village of Havana. The CCR Unit is bounded by the Illinois River to the west, agricultural and residential land to the south, agricultural land to the east, and industrial or residential land to the north.

1.4 DESCRIPTION OF CCR UNIT

The CCR Unit at the Havana Power Station consists of four existing surface impoundments - Havana East Ash Pond Cells 1, 2, 3, and 4 (CCR Unit ID 701) (Figure 1). The CCR Unit located at Havana Power Station will

hereafter be referred to as the 'Site'. The Site is located to the east of the power plant across Highway 78 and approximately 2,000 feet east of the Illinois River. The Site has an area of approximately 99.2 acres (Figure 1).

1.4.1 Havana East Ash Pond (Cells 1, 2, 3, and 4) – CCR Unit ID 701

The Site is a lined CCR surface impoundment and is bounded by the Highway 78 to the west, agricultural land to the south and east, and industrial or residential land use to the north.

2 GEOLOGY AND HYDROGEOLOGY

The site characterization activities performed at Havana Power Station since the Ash Impoundment Closure Study (AES, March 1994) have included the following:

- Geotechnical Data Package for Dynegy Havana Station; East Ash Pond CCR Unit (AECOM, January 2016)
- CCR monitoring network well installation and borehole logging (NRT, June 2015)

The results of these supplemental site investigations, as well as a summary of background information found in the above mentioned previous investigations and reports are discussed below.

2.1 GEOLOGY

Geologic units present in the vicinity of Havana Power Station include fill, unlithified wind-worked dune and ridge deposits, unlithified alluvial sediments, unlithified glacial outwash deposits (i.e. Wisconsinan Glaciation), sand and gravel basal deposits (i.e., pre-Illinoisan Sankoty Sand), and Mississippian-age shale and limestone bedrock (i.e., Salem Formation).

2.1.1 Regional Setting

The Site is located adjacent to and south to southeast of the Illinois River in an area known as the Havana Lowlands, which occur at the confluence of the Illinois River Valley and the Mahomet Bedrock Valley systems. The Havana Lowlands are characterized by unlithified deposits of sand and gravel ranging in thickness from 80 to 90 feet. The unlithified deposits of the Havana Lowlands are underlain by Salem Formation bedrock (i.e., uppermost bedrock) consisting of Mississippian-age shale and limestone. The Mississippian-age bedrock has a southeastern regional dip.

2.1.2 Site Geology

Based on previous investigations and reports, the vicinity of the Havana Power Station is underlain by well-sorted wind-worked sand and loess deposits that range in thickness from 8 to 49 feet followed by alluvial terrace deposits of poorly-sorted sand and gravel. Supplemental site investigations provide additional details on the geology and subsurface conditions at the Site.

AECOM completed a geotechnical investigation (AECOM, 2016) that included additional borings that were reported in the Geotechnical Data Package for Dynegy Havana Station, East Ash Pond CCR Unit (AECOM, 2016). This geotechnical exploratory program included 11 auger borings and 8 cone penetrometer tests at the Site. The geotechnical exploration locations are shown in Appendix A. Soil samples were collected during the AECOM geotechnical exploratory program and submitted by AECOM to Alpha-Omega Geotech, Inc. in Kansas City, Kansas. A summary of AECOM's geotechnical laboratory test results are found in Appendix B. Boring logs and other geotechnical testing data are available in the AECOM data package (2016).

NRT completed the CCR monitoring network well installation and borehole logging at four locations at the Site in June 2015. Borings were completed to a depth of 35 feet below ground surface (ft bgs) at locations HAMW-39, HAMW-40 and HAMW-41 and 44 ft bgs at location HAMW-42. All four NRT boring locations were completed with groundwater monitoring wells as part of the CCR groundwater monitoring program. Cross sections A-A', B-B' and C-C' (Figures 2 and 3) demonstrate the variability of fill and native geologic materials with depth across the Site. Materials encountered in the NRT (2015) borings included topsoil and surficial silts and clays with varying amounts of sand from 0.5 to 8.6 feet thick underlain by well-sorted fine-grained sand that extended to the boring termination depth. Occasional clay nodules, silty sand seams, medium to coarse-grained sand seams, and fine gravel seams were also observed within the mostly fine-grained sand unit. The boring logs, well construction forms, and other related monitoring well forms are available in the Operating Records as required by Title 40 CFR Part 257 Section 257.91 for each monitored CCR Unit or Unit.

2.2 HYDROGEOLOGY

The hydrogeology of the ash impoundments to the south of the Site was comprehensively addressed in the report, Groundwater Monitoring at the Havana Power Station's Ash Disposal Ponds and Treatment Lagoon (Illinois State Water Survey, 1982). No previous hydrogeologic characterization was completed in the vicinity of the East Ash Pond. As part of the NRT (2015) CCR monitoring network well installation, falling/rising head tests were completed and the results of the tests are summarized below.

2.2.1 Uppermost Aquifer

Previous investigations identified the approximately 80 to 90 foot thick unlithified sand and gravel deposits of the Havana Lowlands present at the Site as a single hydrogeologically connected and high yield unconfined aquifer. The uppermost aquifer in the vicinity of the Site extends from the top of the water table to the top of underlying Mississippian-age bedrock. A search of the Illinois State Geological Survey database, ILWATER, indicates numerous water supply wells located near the Site screened in the unlithified materials, confirming the local use of the sand and gravel aquifer as a groundwater resource.

2.2.2 Lower Limit of Aquifer

The lower limit of the uppermost aquifer is the top of the uppermost bedrock (i.e., Mississippian-aged shale and limestone). This formation in the vicinity of the Site is generally considered a hydrogeologic confining unit (STMI, 1994).

2.2.3 Hydraulic Conductivity

Falling/rising head tests were completed within the uppermost aquifer near the ash impoundments to the south of the Site as part of the 1982 Illinois State Water Survey (ISWS) report. Based on reported values in the ISWS (1982) report, median hydraulic conductivity values range from 4.7×10^{-3} to 1.1×10^{-1} centimeters per second (cm/s) with a geometric mean of the median conductivity values of 5.1×10^{-2} cm/s (tests performed at well locations M-1 through M-12; a well location figure and detailed results are located in Appendix C). As part of the NRT (2015) CCR monitoring network well installation, falling/rising head tests were also completed at eight well locations within the uppermost aquifer in the vicinity of the Site. The resulting hydraulic conductivity values ranged from 5.5×10^{-3} to 2.7×10^{-1} cm/s with a geometric mean of 3.5×10^{-2} cm/s. NRT (2015) falling/rising head test results are summarized in Table 1 and further detail of the analysis is provided in Appendix D. A hydraulic conductivity on the order of 10^{-2} cm/s for the uppermost aquifer as determined by ISWS (1982) and NRT (2015) falls within the typical range of conductivities for unlithified sand (Maidment, 1993). According to the ISWS (1982), an effective porosity of 35 percent is representative of the uppermost aquifer, which is typical for unlithified sand (Maidment 1993).

2.2.4 Groundwater Elevations, Flow Direction and Velocity

Groundwater elevations at the Site averaged approximately 447.1 feet above mean sea level (MSL) (NAVD88) with groundwater highs (i.e., <5% occurrence) at 458.5 feet MSL to the southeast of the unit (HAMW31 and HAMW38) and 446.2 feet MSL to the northwest of the unit (HAMW32 and HAMW33) from 1992 to 2013.

Groundwater elevations typically vary by 10 to 15 feet across the Site. Generally, higher groundwater elevations can be found to the east or southeast of the unit (upgradient) and lowest groundwater elevations are on the west or northwest of the unit (downgradient). Groundwater at the Site generally flows southeast to northwest toward the Illinois River, which is the primary discharge area in the vicinity of the Site (Figures 4, 5).

Groundwater elevations are primarily controlled by the river stage of the Illinois River, which is adjacent to the Havana Power Station to the west and northwest (ISWS, 1982). Generally, when the Illinois River stage rises the magnitude of the hydraulic gradient is reduced as surface water from the river moves into the stream banks and the floodplain. Alternatively, when Illinois River stage lowers the magnitude of the hydraulic gradient is increased. Seasonal variation of groundwater levels and flow direction in the vicinity of the CCR Unit is indicated in the groundwater elevation contour maps (Figures 4 and 5). Comparisons among groundwater elevations upgradient and downgradient of the CCR Unit (1992-2013) have not indicated any flow reversals at the Site.

Horizontal hydraulic gradient ranged from 0.003 to 0.005 foot per foot (ft/ft) in November 2015 and February 2016 as groundwater flowed from southeast to northwest across the Site (Table 2). During November 2015 and February 2016 there was little variation across the Site in horizontal hydraulic gradient; in general, gradient was only 0.001 ft/ft greater near the central area of the Site (i.e, between HAMW-31 and HAMW-32) than in the southern area of the Site (i.e., between HAMW-30 to HAMW-40). There was also little seasonal variation in horizontal hydraulic gradient at the Site; horizontal gradients in February 2016 were only 0.001 ft/ft less than in November 2015.

Groundwater flow velocity ranged from 0.5 to 2.6 feet per day (ft/day) as groundwater flowed from southeast to northwest at the Site in November 2015 and February 2016 (Table 2). Variation in groundwater flow velocity was 2 ft/day or lower when comparing the southern area of the Site (i.e., between HAMW-31 to HAMW-32) to the central area of the Site (i.e., between HAMW-30 and HAMW-40). Little seasonal variation in groundwater flow velocities were observed at the Site; groundwater flow velocity in November 2015 was less than 0.4 ft/day greater than in February 2016.

3 GROUNDWATER MONITORING

In June 2015, NRT began an assessment of the existing monitoring well network at Havana Power Station with respect to the existing CCR units. Included in the assessment was a review of the current placement and number of monitoring wells with respect to individual and contiguous CCR units as well as potential locations for new monitoring wells, as appropriate. The discussion below summarizes the results of the supplemental well installations.

3.1 CCR Monitoring Well Network

The 40 CFR Part 257 well network consists of seven monitoring wells installed in the uppermost aquifer and adjacent to the Site (HAMW-30, HAMW-31, HAMW-32, HAMW-39, HAMW-40, HAMW-41, HAMW-42). The Site utilizes the two upgradient monitoring wells (HAMW-31, HAMW-30) as part of their CCR Monitoring Well Network. The remaining five well locations (HAMW-32, HAMW-39, HAMW-40, HAMW-41 and HAMW-42) are utilized as downgradient monitoring wells. The boring logs, well construction forms, and other related monitoring well forms are available in the Operating Records as required by Title 40 CFR Part 257 Section 257.91. The 40 CFR Part 257 groundwater monitoring network well locations are shown on Figure 1. Details on the procedures and techniques used to fulfill the groundwater sampling and analysis program requirements are found in the SAP for the Site. The well depths, well screen intervals, depth to groundwater and monitored units at the 40 CFR Part 257 monitoring well network locations are summarized in Table 3 below:

Table 3: CCR Groundwater Monitoring Well Information

Well Number	Well Depth (ft bgs)	Well Screen Interval (ft bgs)	Depth to Water (ft bgs)	Unit Monitored	Screened Interval Lithology
HAMW-31	44.8	34.5 - 44.5	12.4	Upgradient Shallow Unlithified	Sand
HAMW-30	29.1	19.7 – 28.7	35.2	Upgradient Shallow Unlithified	Sand
HAMW-32	26.2	16.2 - 26.2	10.6	Downgradient Shallow Unlithified	Sand
HAMW-39	35.0	25.0 – 35.0	19.4	Downgradient Shallow Unlithified	Sand
HAMW-40	34.5	24.5 - 34.5	22.0	Downgradient Shallow Unlithified	Sand
HAMW-41	35.0	25.0 – 35.0	16.4	Downgradient Shallow Unlithified	Sand
HAMW-42	44.0	34.0 – 44.0	31.2	Downgradient Shallow Unlithified	Sand

Notes: Groundwater depth measurements were collected November 19, 2015

REFERENCES

AECOM, January 2016, *Geotechnical Data Package for Dynegy Havana Station; East Ash Pond CCR Unit.*

Atlantic Environmental Services Inc., March 1994, *Ash Impoundment Closure Study.*

Illinois State Water Survey, August 1982, *Groundwater Monitoring at the Havana Power Station's Ash Disposal Ponds and Treatment Lagoon.*

Maidment, February 22, 1993, *Handbook of Hydrogeology, McGraw Hill Publishing.*

Science & Technology Management, Inc., March 1994, *Investigation of Site Closure Options at Illinois Power Company's Havana South Ash Impoundment.*

USEPA, 2015, Disposal of Coal Combustion Residuals from Electric Utilities, Final Rule, 40 CFR Parts 257 and 261, Hazardous and Solid Waste Management System, April 2015.

Tables

Table 1. Falling/Rising Head Test Results Summary
Havana East Ash Pond (Cells 1, 2, 3, and 4)
November 2015 and February 2016
Hydrogeologic Monitoring Plan

Location	Test Type	Slug Type	Number	K (cm/sec)
HAMW30	Rising Head	Slug Out	1	2.67E-01
HAMW30	Rising Head	Slug Out	2	2.12E-01
HAMW30	Rising Head	Slug Out	3	3.19E-02
HAMW31	Falling Head	Slug In	1	5.54E-03
HAMW31	Falling Head	Slug In	4	7.52E-03
HAMW31	Rising Head	Slug Out	1	1.11E-02
HAMW31	Rising Head	Slug Out	2	6.94E-03
HAMW31	Rising Head	Slug Out	3	8.69E-03
HAMW31	Rising Head	Slug Out	4	1.01E-02
HAMW32	Rising Head	Slug Out	2	1.17E-01
HAMW32	Rising Head	Slug Out	3	1.39E-01
HAMW-37	Rising Head	Slug Out	1	8.55E-02
HAMW-37	Rising Head	Slug Out	2	9.26E-02
HAMW-37	Rising Head	Slug Out	3	8.15E-02
HAMW-39	Rising Head	Slug Out	1	2.05E-02
HAMW-39	Rising Head	Slug Out	2	2.47E-02
HAMW-39	Rising Head	Slug Out	3	3.73E-02
HAMW-39	Rising Head	Slug Out	4	3.73E-02
HAMW-40	Falling Head	Slug In	1	3.83E-02
HAMW-40	Rising Head	Slug Out	3	4.41E-02
HAMW-41	Falling Head	Slug In	2	3.67E-02
HAMW-41	Falling Head	Slug In	3	4.77E-02
HAMW-41	Rising Head	Slug Out	1	1.54E-02
HAMW-42	Rising Head	Slug Out	2	3.47E-02
HAMW-42	Rising Head	Slug Out	3	6.39E-02

O: 5/16 PMH, C: KJS 8/26/16

Table 2. Groundwater Flow Velocities
Havana East Ash Pond (Cells 1, 2, 3, and 4)
November 2015 and February 2016
Hydrogeologic Monitoring Plan

November 19, 2015				
	Geomean of Well Hydraulic Conductivities (cm/s)	Horizontal Hydraulic Gradient	Effective Porosity	Velocity (ft/day)
HAMW-30 to HAMW-40	7.9E-02	0.004	0.35	2.6
HAMW-31 to HAMW-32	1.6E-02	0.005	0.35	0.6

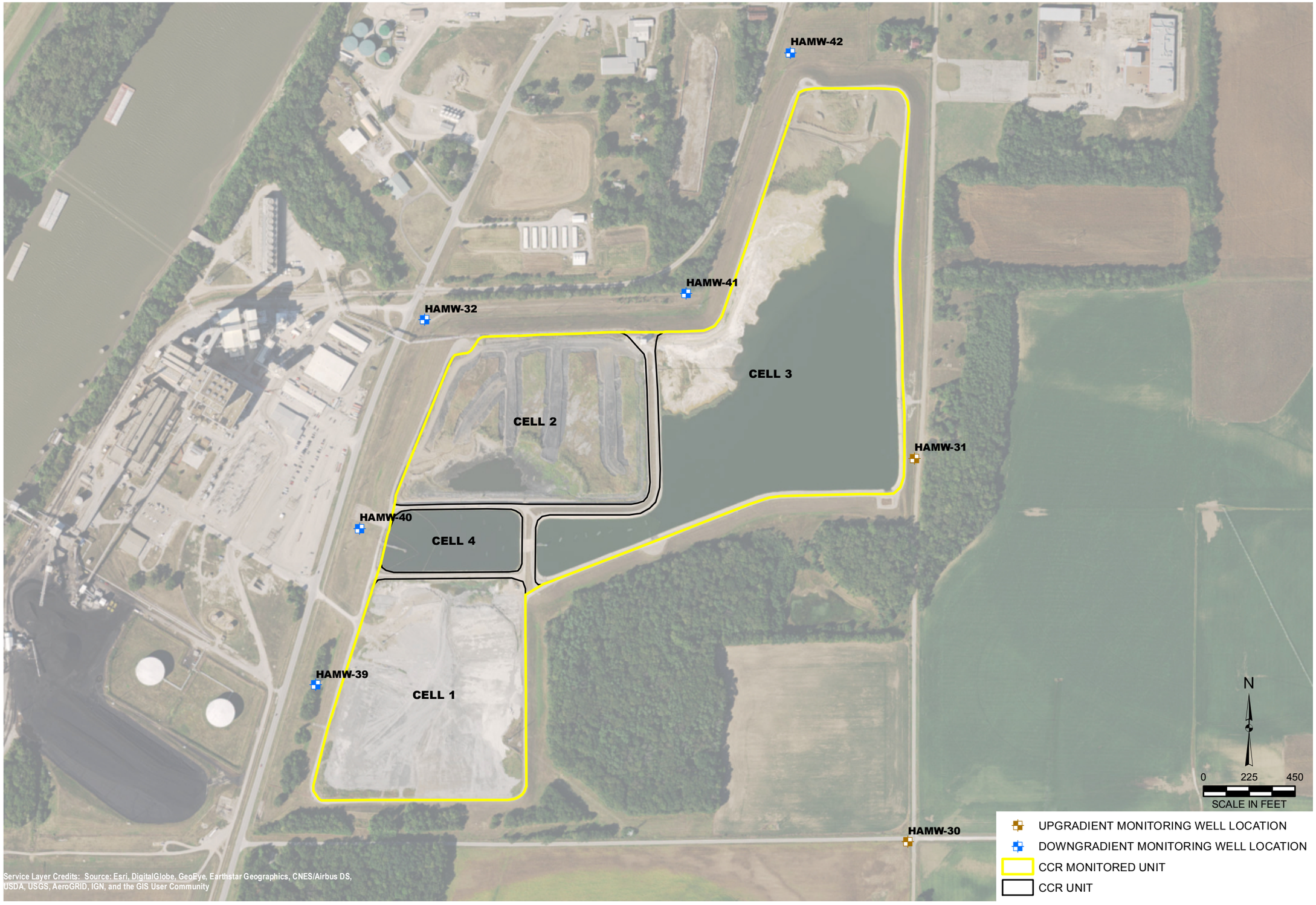
February 16, 2016				
	Geomean of Well Hydraulic Conductivities (cm/s)	Horizontal Hydraulic Gradient	Effective Porosity	Velocity (ft/day)
HAMW-30 to HAMW-40	7.9E-02	0.003	0.35	2.2
HAMW-31 to HAMW-32	1.6E-02	0.004	0.35	0.5

Note:

1) cm/sec x 2,835 = feet/day

2) Source of hydraulic conductivity values was NRT slug testing (NRT, August 2015)

Figures



SITE AND WELL LOCATION MAP
HAVANA EAST ASH POND CELLS 1, 2, 3, AND 4
UNIT ID: 701

HYDROGEOLOGIC MONITORING PLAN
DYNEGY CCR RULE GROUNDWATER MONITORING
HAVANA POWER STATION
HAVANA, ILLINOIS

DRAWN BY/DATE:
SDS 9/15/16
REVIEWED BY/DATE:
JJW 9/15/16
APPROVED BY/DATE:
SJC 9/21/17

PROJECT NO: 2285/2.3

FIGURE NO: 1

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SAND

SILTY SAND/ CLAYEY SAND

SAND

SILTY SAND / CLAYEY SAND

GEOLOGICAL CONTACT, DASHED WHERE INFERRED

SCREEN

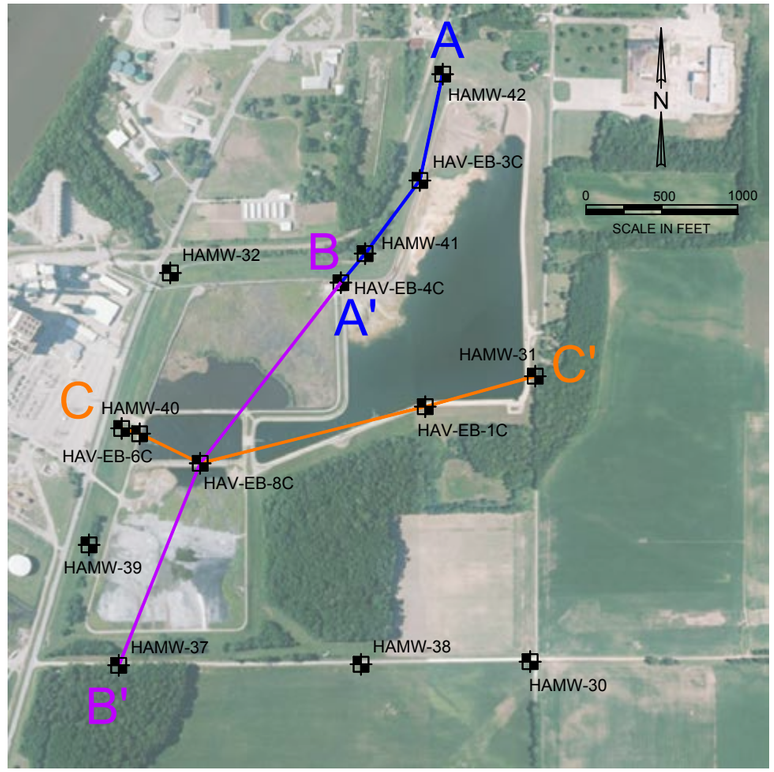
NOTES:

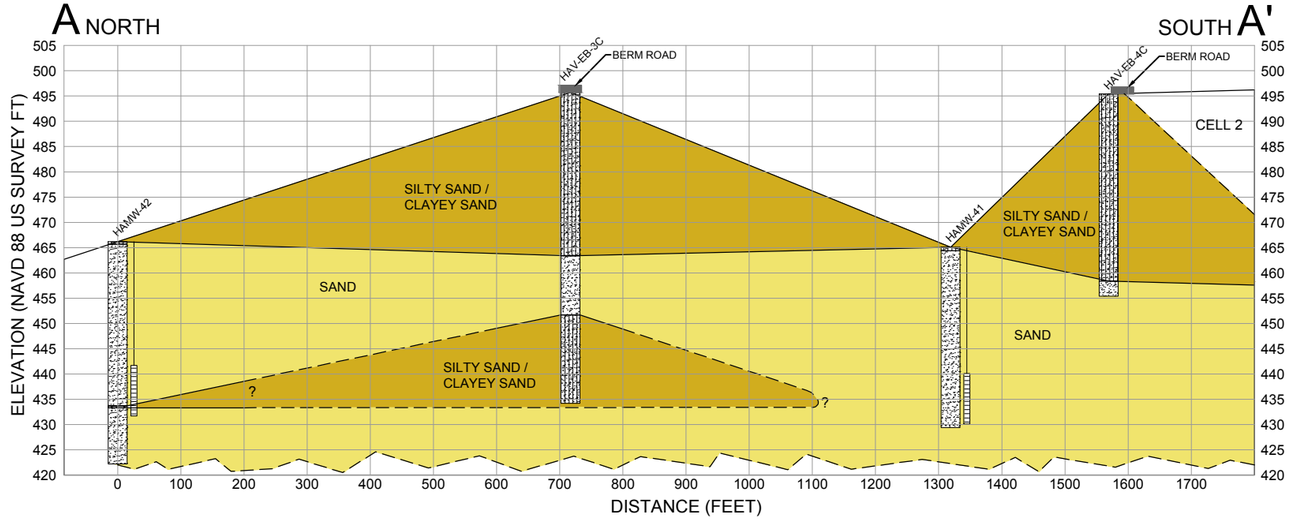
1. COORDINATE SYSTEM IS NAD 83 ILLINOIS STATE PLANE WEST, US SURVEY FOOT.
2. VERTICAL DATUM IS NAVD 88.
3. AERIAL PHOTOGRAPHY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

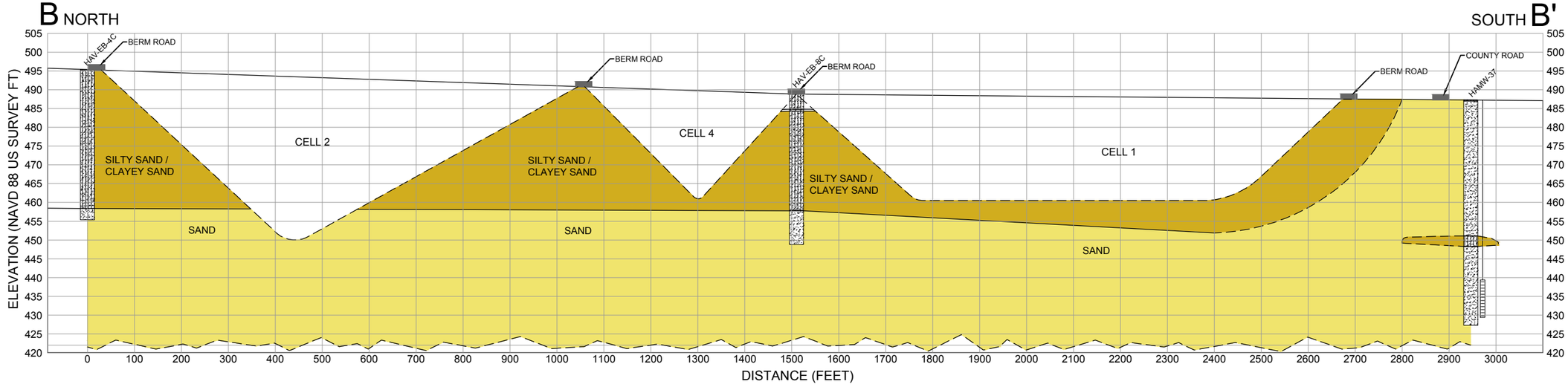
VERTICAL SCALE IN FEET: 30

HORIZONTAL SCALE IN FEET: 240

VERTICAL EXAGGERATION = 8







DRAWN BY:	RJB	DATE: 08/26/16
CHECKED BY:	YAD	DATE: 09/21/17
APPROVED BY:	SJC	DATE: 09/21/17

DRAWING NO: Fig 4A_Geol Xsects AA & BB

REFERENCE: SEE INFO BLOCK

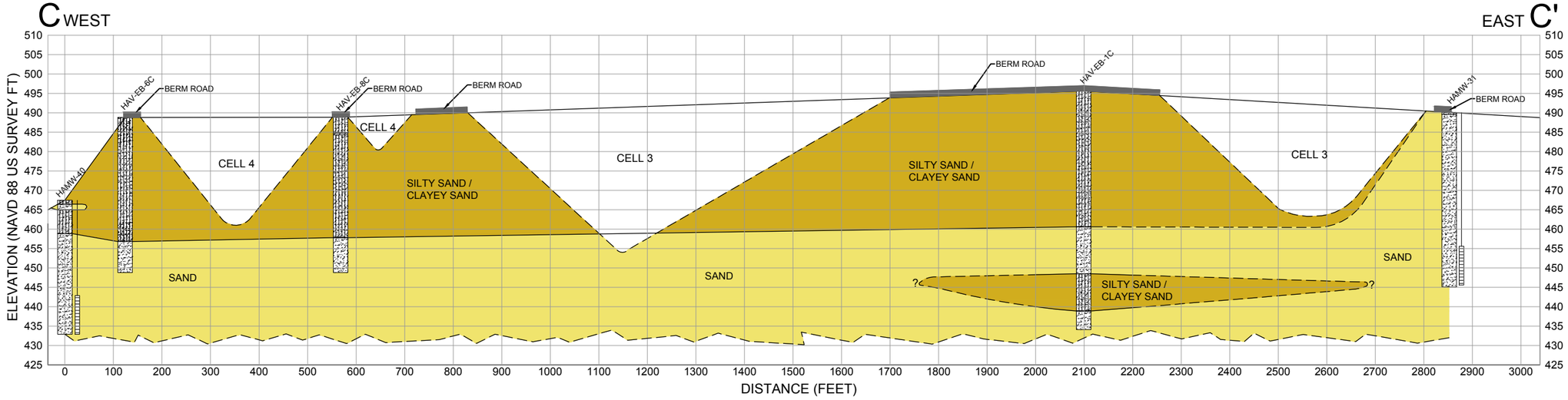
GEOLOGIC CROSS-SECTIONS A-A' AND B-B'

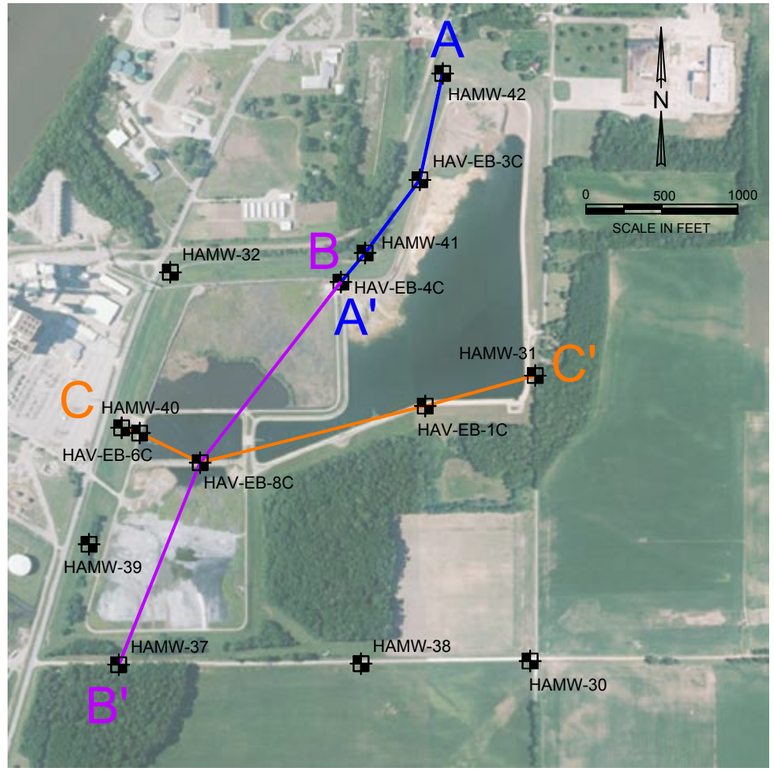
HAVANA HYDROGEOLOGIC MONITORING PLAN
HAVANA - DYNEGY 2285
HAVANA, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2285/1.6

FIGURE NO.
2





SAND
SILTY SAND/ CLAYEY SAND
SAND
SILTY SAND / CLAYEY SAND
GEOLOGICAL CONTACT, DASHED WHERE INFERRED
SCREEN

NOTES:

1. COORDINATE SYSTEM IS NAD 83 ILLINOIS STATE PLANE WEST, US SURVEY FOOT.
2. VERTICAL DATUM IS NAVD 88.
3. AERIAL PHOTOGRAPHY SOURCE: ESRI, DIGITALGLOBE, GEOEYE, I-CUBED, EARTHSTAR GEOGRAPHICS, CNES/AIRBUS DS, USDA, USGS, AEX, GETMAPPING, AEROGRID, IGN, IGP, SWISSTOPO, AND THE GIS USER COMMUNITY

VERTICAL SCALE IN FEET: 30
HORIZONTAL SCALE IN FEET: 240

VERTICAL EXAGGERATION = 8

DRAWN BY: RJB DATE: 08/26/16
CHECKED BY: YAD DATE: 09/21/17
APPROVED BY: SJC DATE: 09/21/17
DRAWING NO: Fig 4B_Geol Xsect CC
REFERENCE: SEE INFO BLOCK

GEOLOGIC CROSS-SECTION C-C'

HAVANA HYDROGEOLOGIC MONITORING PLAN
HAVANA - DYNEGY 2285
HAVANA, ILLINOIS

NATURAL RESOURCE TECHNOLOGY

PROJECT NO.
2285/1.6

FIGURE NO.
3

HAMW-42
448.00 ft

HAMW-41
448.72 ft

HAMW-32
443.15 ft

HAMW-31
454.96 ft

HAMW-40
445.41 ft

HAMW-39
446.78 ft

HAMW-37
448.85 ft

HAMW-38
454.05 ft

HAMW-30
457.86 ft

CELL 1

CELL 2

CELL 3

CELL 4

444 445 446 447 448 449 450 451 452 453 454 455 456 457

N

0 225 450
SCALE IN FEET

CCR RULE MONITORING WELL LOCATION
NON-CCR RULE MONITORING WELL
GROUNDWATER ELEVATION CONTOUR (1-FT INTERVAL, NAVD88)
INFERRED GROUNDWATER ELEVATION CONTOUR
GROUNDWATER FLOW DIRECTION
CCR MONITORED UNIT
CCR UNIT

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Y:\Mapping\Projects\2285_Havana\MXD\HGMP\Figure 4_R1_GW_Contours_201511.mxd Author: stolzsd Date/Time: 9/21/2017, 12:08:59 PM

HAVANA EAST ASH POND (CELLS 1, 2, 3, AND 4) UNIT ID: 701
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 1: NOVEMBER 19, 2015

HYDROGEOLOGICAL MONITORING PLAN
DYNEGY CCR RULE GROUNDWATER MONITORING
HAVANA POWER STATION
HAVANA, ILLINOIS

DRAWN BY/DATE:
SDS 8/24/16
REVIEWED BY/DATE:
JJW 8/24/16
APPROVED BY/DATE:
SJC 9/21/17

PROJECT NO: 2285/1.5

FIGURE NO: 4

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HAMW-42
450.81

HAMW-41
451.24

HAMW-32
446.30

HAMW-31
456.48

HAMW-40
448.27

HAMW-39
449.38

HAMW-37
450.95

HAMW-38
455.55

HAMW-30
459.03

CELL 1

CELL 2

CELL 3

CELL 4

447
448
449
450
451
452
453
454
455
456
457
458
459

N

0 225 450
SCALE IN FEET

UPPERMOST AQUIFER MONITORING WELL LOCATION

NON-CCR RULE MONITORING WELL LOCATION

GROUNDWATER ELEVATION CONTOUR (1-FT CONTOUR INTERVAL, NAVD 88)

INFERRED GROUNDWATER ELEVATION CONTOUR

GROUNDWATER FLOW DIRECTION

CCR UNIT

HAVANA EAST ASH POND (CELLS 1, 2, 3, AND 4) UNIT ID: 701
UPPERMOST AQUIFER UNIT
GROUNDWATER ELEVATION CONTOUR MAP
ROUND 2: FEBRUARY 16, 2016

HYDROGEOLOGICAL MONITORING PLAN
DYNEGY CCR RULE GROUNDWATER MONITORING
HAVANA POWER STATION (HAVANA EAST ASH POND CELLS 1,2,3 AND 4)
HAVANA, ILLINOIS

DRAWN BY/DATE:
SDS 3/9/16
REVIEWED BY/DATE:
NRK 3/9/16
APPROVED BY/DATE:
SJC 9/21/17

PROJECT NO: 2285/1.5

FIGURE NO: 5

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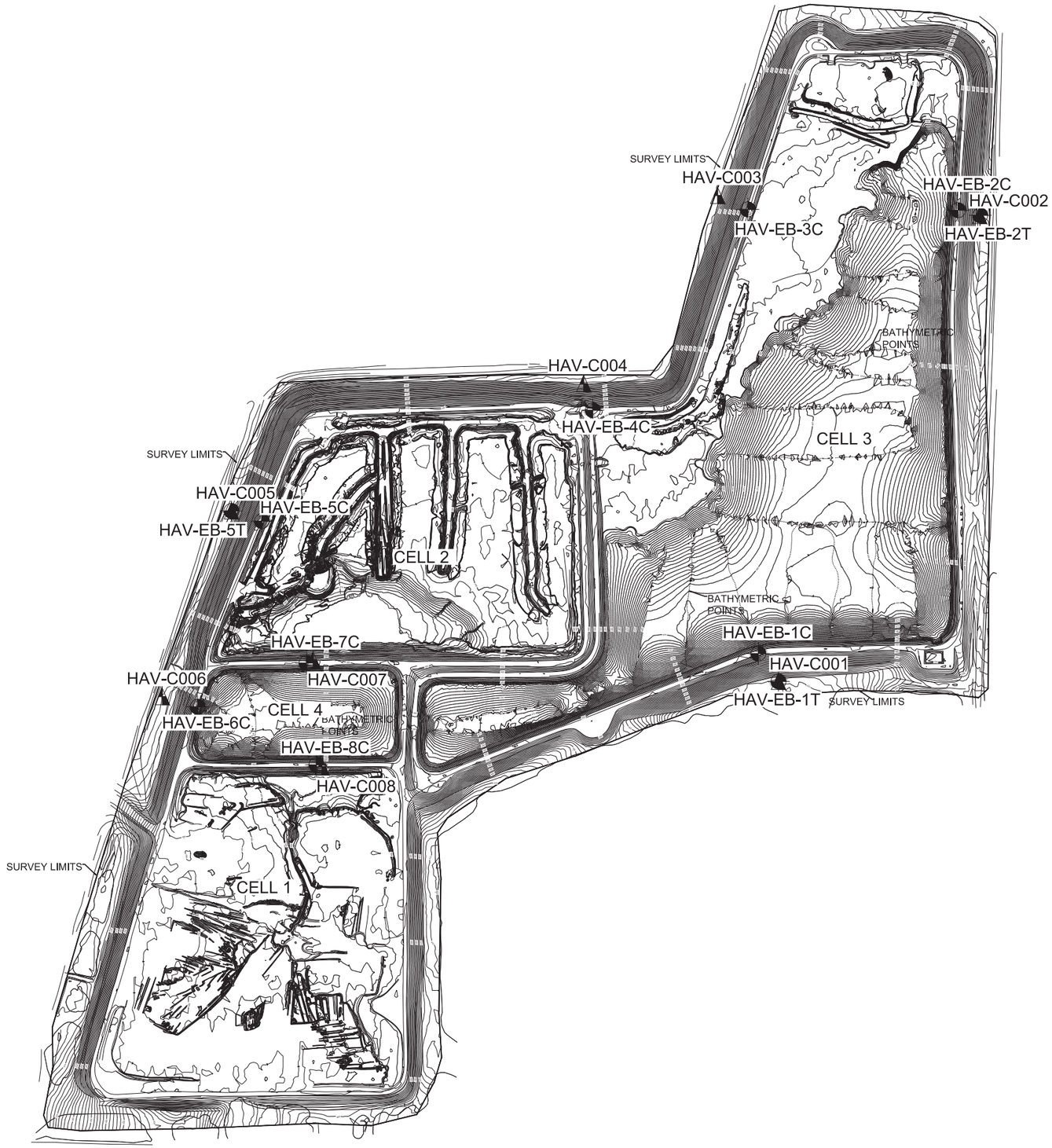
Appendix A

AECOM Drilling Locations



LEGEND:

HAV-EB-8C — BORING LOCATION AND NUMBER

HAV-C005 — CPT SOUNDING LOCATION AND NUMBER

NOTE

THE TOPOGRAPHY SHOWN IN THIS FIGURE IS FROM A BATHYMETRIC SURVEY BY OTHERS.

N

200 0 200

SCALE IN FEET

AECOM 8300 College Boulevard, Suite 200 Overland Park, Kansas 66210

CLIENT:	HAVANA STATION
LOCATION:	HAVANA, IL
TITLE:	**BORING AND CPT LOCATION PLAN HAVANA EAST ASH POND**

DRAWN BY	CHECKED BY	APPROVED BY
SMS	JAA	WDS
PROJECT NO.	DATE	FIGURE NO.
60439304	DEC. 2015	1

Appendix B

AECOM Geotechnical Laboratory Test Results Summary

Summary of Laboratory Testing

SLT 22205

Alpha-Omega Geotech, Inc.
1701 State Avenue
Kansas City, KS 66102
Office: (913) 371-0000 Fax: (913) 371-6710
Website: www.aogeotech.com

ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-1C	ST-1	6'-7.5'	Brown poorly graded sand with silt	7.2					SP-SM	7.8				ASTM D2488
EP-1C	SPT-1	11'-12.5'	Brown poorly graded sand with silt	5.8					SP-SM	9.2				ASTM D2488
EP-1C	ST-2	16'-17.5'	Brown poorly graded sand with silt	9.4					SP-SM	9.7				ASTM D2488
EP-1C	SPT-2	21'-22.5'	Brown poorly graded sand with silt	9.8					SP-SM	11.9				ASTM D2488
EP-1C	ST-3	26'-27.5'	Brown and dark brown silty sand	9.6		NV	NP	NP	SM	20.4				ASTM D2487
EP-1C	SPT-4	41'-42.5'	Brown poorly graded sand						SP	3.4				ASTM D2488
EP-1C	SPT-6	51'-52.5'	Brown silty sand						SM	30.8				ASTM D2488
EP-1C	SPT-7	56'-57.5'	Brown poorly graded sand						SP	5.7				ASTM D2488
EP-1T	SPT-1	3.5'-5'	Dark brown silty sand	9.6					SM	25.3				ASTM D2488
EP-1T	SPT-2	8.5'-10'	Brown silty sand	13.9					SM	16.3				ASTM D2488

Summary of Laboratory Testing

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PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-1T	SPT-3	13.5'-15'	Brown poorly graded sand	20.5					SP	2.0				ASTM D2488
EP-1T	SPT-5	23.5'-25'	Brown poorly graded sand						SP	6.3				ASTM D2488
EP-1T	SPT-7	33.5'-34.7'	Brown poorly graded sand with gravel						SP	4.8				ASTM D2488
EP-1T	SPT-8	38.5'-39.75'	Brown poorly graded sand						SP	5.0				ASTM D2488
EP-2C	ST-1	3.5'-5'	Brown poorly graded sand with silt	6.5		NV	NP	NP	SP-SM	7.4				ASTM D2487
EP-2C	SPT-1	8.5'-10'	Brown poorly graded sand with silt	7.6					SP-SM					ASTM D2488
EP-2C	ST-2	13.5'-15'	Brown poorly graded sand	5.3					SP	4.6				ASTM D2488
EP-2C	ST-3	23.5'-25'	Brown poorly graded sand	6.4					SP	2.8				ASTM D2488
EP-2C	ST-4	33.5'-35'	Brown poorly graded sand	5.2					SP	3.3				ASTM D2488
EP-2C	SPT-4	38.5'-40'	Light brown poorly graded sand						SP	4.6				ASTM D2488

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ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-2C	SPT-5	43.5'-45'	Light brown poorly graded sand						SP					ASTM D2488
EP-2C	SPT-6	48.5'-50'	Brown poorly graded sand with silt						SP-SM	8.0				ASTM D2488
EP-2C	SPT-8	55'-56'	Brown poorly graded sand						SP	4.5				ASTM D2488
EP-2T	SPT-1	6'-7.5'	Brown poorly graded sand with silt						SP-SM	6.3				ASTM D2488
EP-2T	SPT-2	11'-12.5'	Brown Clayey sand						SC	22.0				ASTM D2488
EP-2T	SPT-4	21'-22.5'	Brown poorly graded sand						SP	2.0				ASTM D2488
EP-2T	SPT-6	31'-32.5'	Brown poorly graded sand						SP	4.8				ASTM D2488
EP-2T	SPT-8	40'-41.5'	Brown poorly graded sand with gravel						SP	2.3				ASTM D2488

Summary of Laboratory Testing

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PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-3C	ST-1	6'-7.5'	Dark brown silty sand	8.7					SM	21.5				ASTM D2488
EP-3C	SPT-1	11'-12.5'	Brown silty sand	7.8		NV	NP	NP	SM	19.4				ASTM D2487
EP-3C	ST-2	16'-17.5'	Brown poorly graded sand with silt	6.5					SP-SM	6.8				ASTM D2488
EP-3C	ST-3	26'-27.5'	Reddish brown poorly graded sand with silt						SP-SM	10.7				ASTM D2488
EP-3C	ST-4	36'-37.5'	Brown poorly graded sand						SP	3.7				ASTM D2488
EP-3C	SPT-5	46'-47.5'	Brown silty sand						SM	20.2				ASTM D2488
EP-3C	SPT-7	56'-57.5'	Brown poorly graded sand with silt						SP-SM	5.4				ASTM D2488

Summary of Laboratory Testing

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ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-4C	ST-1	3.5'-5'	Brown poorly graded sand with silt						SP-SM	5.2				ASTM D2488
EP-4C	SPT-1	8.5'-10'	Brown silty sand						SM	13.8				ASTM D2488
EP-4C	ST-2	13.5'-15'	Brown poorly graded sand with silt						SP-SM	11.2				ASTM D2488
EP-4C	SPT-2	18.5'-20'	Brown, mottled dark brown silty sand						SM	13.6				ASTM D2488
EP-4C	ST-3	23.5'-25'	Gray, mottled light reddish brown poorly graded sand with silt						SP-SM	7.3				ASTM D2488
EP-4C	SPT-3	28.5'-30'	Brown silty sand						SM	12.9				ASTM D2488
EP-4C	ST-4	33.5'-34'	Dark brown silty sand			14	13	1	SM	28.6				ASTM D2487
EP-4C	SPT-4	38.5'-40'	Light brown poorly graded sand with silt						SP-SM					ASTM D2488

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ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-5C	ST-1	6'-7.5'	Reddish brown poorly graded sand with silt	9.1					SP-SM	10.1				ASTM D2488
EP-5C	SPT-1	11'-12.5'	Brown poorly graded sand with silt	7.2					SP-SM	9.2				ASTM D2488
EP-5C	ST-2	16'-17'	Brown poorly graded sand with silt	7.0					SP-SM	6.4				ASTM D2488
EP-5C	ST-3	26'-27.5'	Brown poorly graded sand with silt	8.0					SP-SM	5.8				ASTM D2488
EP-5C	ST-4	41'-42.5'	Brown poorly graded sand						SP	0.8				ASTM D2488
EP-5C	SPT-5	46'-47.5'	Brown poorly graded sand						SP	1.1				ASTM D2488
EP-5C	SPT-7	56'-57.5'	Brown poorly graded sand						SP	2.2				ASTM D2488

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PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-5T	SPT-1	3.5'-5'	Brown poorly graded sand with silt						SP-SM	8.0				ASTM D2488
EP-5T	SPT-2	8.5'-10'	Brown poorly graded sand						SP	4.6				ASTM D2488
EP-5T	SPT-3	13.5'-15'	Brown poorly graded sand with silt						SP-SM	5.8				ASTM D2488
EP-5T	SPT-4	18.5'-20'	Brown poorly graded sand						SP	4.0				ASTM D2488
EP-5T	SPT-5	23.5'-25'	Brown poorly graded sand						SP					ASTM D2488
EP-5T	SPT-6	28.5'-30'	Brown poorly graded sand with silt						SP-SM	5.3				ASTM D2488
EP-5T	SPT-7	33.5'-35'	Brown poorly graded sand						SP					ASTM D2488
EP-5T	SPT-8	38.5'-40'	Brown poorly graded sand						SP	2.2				ASTM D2488

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PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-6C	ST-1	3.5'-5'	Dark brown, mottled gray clayey sand	12.3		25	14	11	SC	43.1				ASTM D2487
EP-6C	SPT-1	8.5'-10'	Brown silty sand			14	13	1	SM	36.3				ASTM D2487
EP-6C	ST-2	13.5'-15'	Brown poorly graded sand with silt	9.3					SP-SM	10.0				ASTM D2488
EP-6C	ST-3	23.5'-24.25'	Brown and dark brown poorly graded sand with silt	12.1					SP-SM	6.4				ASTM D2488
EP-6C	SPT-3	28.5'-30'	Dark brown silty, clayey sand			18	13	5	SC-SM	37.7				ASTM D2487
EP-6C	ST-4	33.5'-35'	Brown poorly graded sand						SP	3.4				ASTM D2488
EP-6C	SPT-4	38.5'-40'	Brown poorly graded sand						SP	4.1				ASTM D2488

Summary of Laboratory Testing

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ALPHA-OMEGA GEOTECH

PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-7C	ST-1	6'-7.5'	Brown, mottled dark brown and gray silty sand	8.0					SM	21.8				ASTM D2488
EP-7C	SPT-1	11'-12.5'	Brown silty sand	4.6					SM	17.8				ASTM D2488
EP-7C	ST-2	16'-17.5'	Brown poorly graded sand with silt	7.9					SP-SM	11.7				ASTM D2488
EP-7C	SPT-2	21'.22.5'	Brown poorly graded sand with silt	8.2					SP-SM	10.6				ASTM D2488
EP-7C	SPT-4	31'-32.5'	Brown poorly graded sand with silt						SP-SM	10.0				ASTM D2488
EP-7C	SPT-6	41'-42.5'	Brown poorly graded sand with silt						SP-SM	8.7				ASTM D2488

Summary of Laboratory Testing

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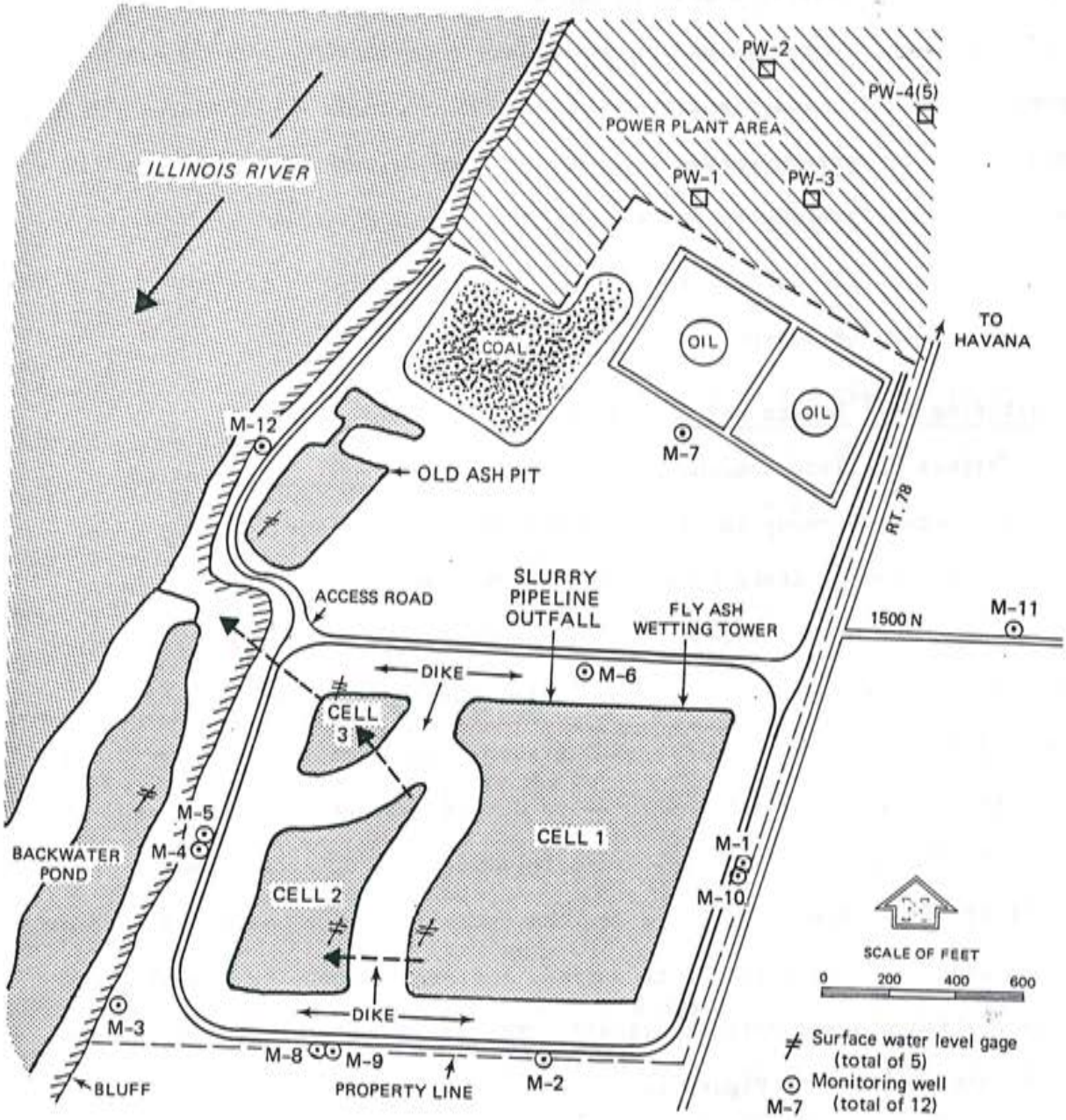
PROJECT NAME: Dynegy CCR Ph 3/7- Havana
PROJECT LOCATION: Havana, IL
PROJECT NUMBER: 15-391T
DATE: 9/28/2015

Boring Number	Sample Number	Depth or Elevation	Description	Natural Moisture (%)	Dry Unit Weight (pcf)	Atterberg Limits LL	PL	PI	USCS / Visual - Manual	% Passing No. 200	Unconfined Compression PSF	%e	% Swell	Material Description per Methodology
EP-8C	ST-1	3.5'-5' Upper Portion	Brown silty sand	17.4					SM	24.7				ASTM D2488
EP-8C	ST-1	3.5'-5' Middle Portion	Dark gray sandy LEAN CLAY	12.8		30	15	15	CL	60.8				ASTM D2487
EP-8C	ST-1	3.5'-5' Lower Portion	Brown silty sand	12.2					SM	17.6				ASTM D2488
EP-8C	SPT-1	8.5'-10'	Brown silty sand	9.1					SM	19.0				ASTM D2488
EP-8C	ST-2	13.5'-15'	Brown poorly graded sand with silt	6.9					SP-SM	6.7				ASTM D2488
EP-8C	SPT-2	18.5'-20'	Brown silty sand	9.5					SM	27.7				ASTM D2488
EP-8C	ST-3	23.5'-25' Upper Portion	Brown poorly graded sand with silt	11.5					SP-SM	8.5				ASTM D2488
EP-8C	ST-3	23.5'-25' Lower Portion	Dark brown silty sand	9.7					SM	26.7				ASTM D2488
EP-8C	ST-4	33.5'-35'	Brown poorly graded sand						SP	3.1				ASTM D2488
EP-8C	SPT-4	38.5'-40'	Brown poorly graded sand						SP	3.1				ASTM D2488

Appendix C

Illinois State Water Survey Well Location Map and Hydraulic Testing Results (1982)



ure 1. Site description and locations of groundwater monitoring wells and surface water level gages.

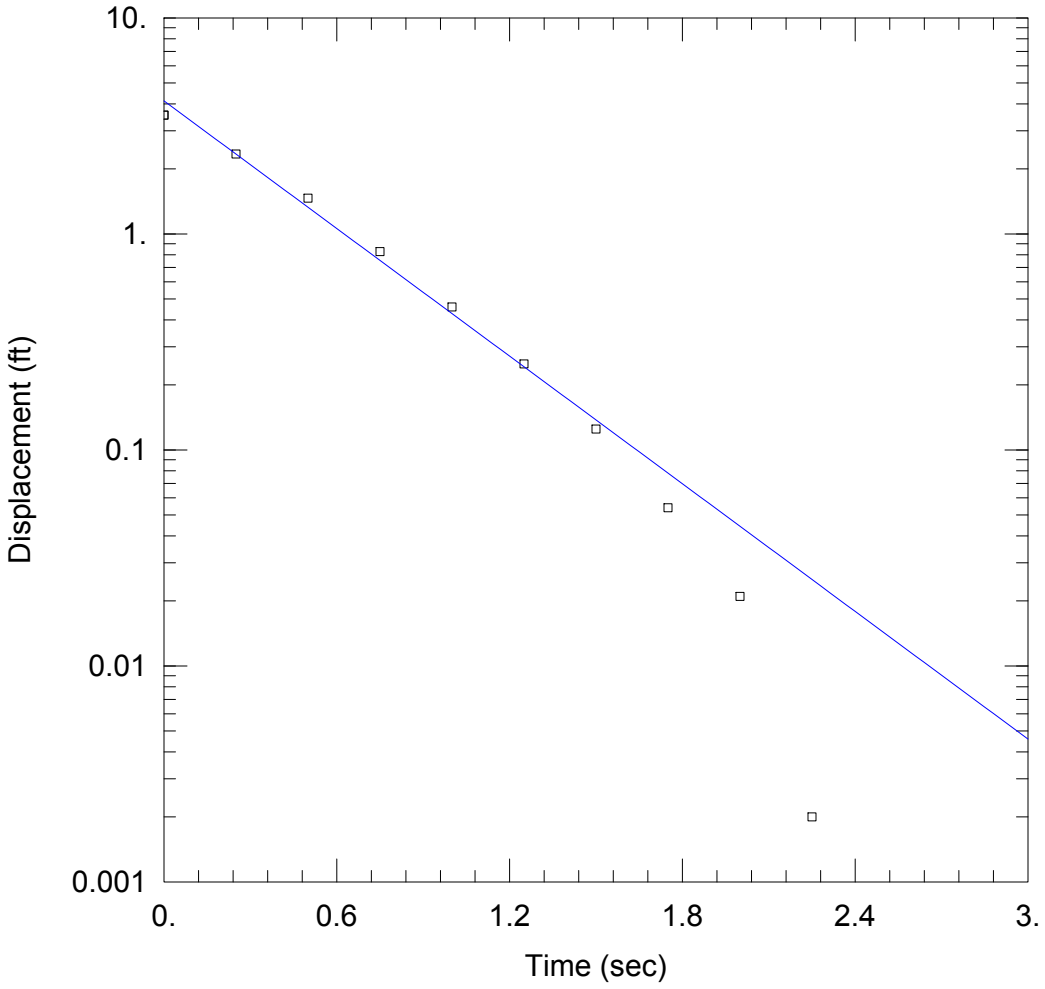
Table 1. Results of Hydraulic Conductivity Tests and Calculation of Local Groundwater Flow Rates

Well Number	Hydraulic conductivity (gpd/ft^2)	Hydraulic gradient (ft/ft)*	Assumed effective porosity	Calculated velocity (ft/day)
M-1	320-380	3.4×10^{-3}	0.30	0.6
M-2	1500-1900	4.8×10^{-3}	0.40	2.7
M-3	1100-1500	3.3×10^{-2}	0.30	19
M-4	1200-1600	4.9×10^{-2}	0.30	31
M-5	1600-2000	4.9×10^{-2}	0.35	34
M-6	90-110	6.2×10^{-3}	0.30	0.3
M-7	1800-2600	6.0×10^{-3}	0.40	4.4
M-8	1400-2000	6.0×10^{-3}	0.30	4.5
M-9	1700-2100	6.0×10^{-3}	0.30	5.1
M-10	1700-2100	3.4×10^{-3}	0.35	2.5
M-11	2100-2500	3.1×10^{-3}	0.40	2.4
M-12	420-500	7.3×10^{-2}	0.30	15

* Based on December 11, 1981 water table configuration

Appendix D

Falling/Rising Head Test Results



HAMW30 SLUG OUT 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO1.aqt
Date: 05/12/16 Time: 11:40:48

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW30)

Initial Displacement: 3.549 ft
Total Well Penetration Depth: 11.6 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16. ft
Screen Length: 9. ft
Well Radius: 0.34 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.008766 ft/sec
y0 = 4.128 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO1.aqt
Title: HAMW30 Slug Out 1
Date: 05/12/16
Time: 11:40:58

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW30

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.549 ft
Static Water Column Height: 16. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 9. ft
Total Well Penetration Depth: 11.6 ft
Corrected Casing Radius (Bouwer-Rice Method): 0.1821 ft
Gravel Pack Porosity: 0.25

No. of Observations: 10

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.549	1.25	0.25
0.25	2.343	1.5	0.125
0.5	1.463	1.75	0.054
0.75	0.828	2.	0.021
1.	0.459	2.25	0.002

SOLUTION

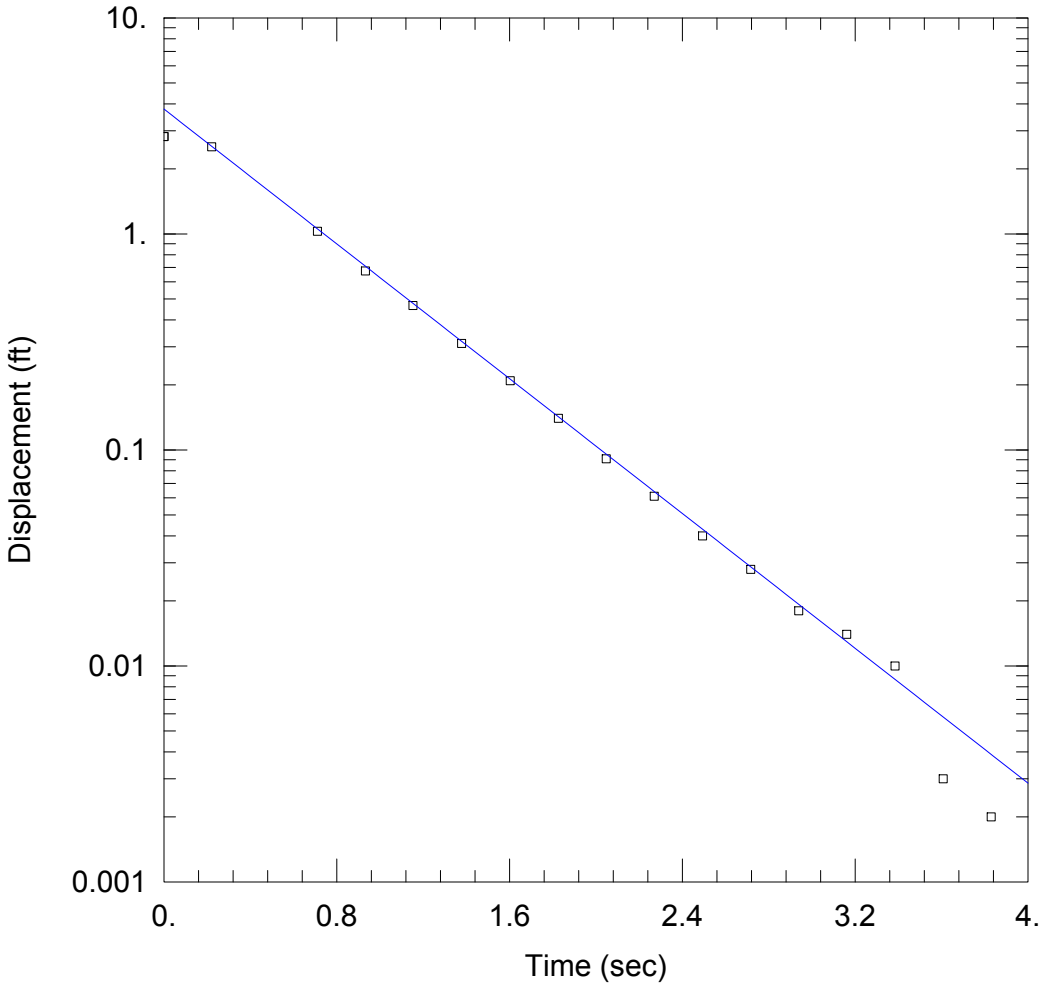
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.098

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.008766	ft/sec
y0	4.128	ft

K = 0.2672 cm/sec
T = K*b = 0.7451 ft²/sec (692.2 sq. cm/sec)



HAMW30 SLUG OUT 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO2.aqt
Date: 05/04/16 Time: 11:23:08

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW30)

Initial Displacement: 2.825 ft
Total Well Penetration Depth: 11.6 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16. ft
Screen Length: 9. ft
Well Radius: 0.34 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2117 cm/sec
y0 = 3.784 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO2.aqt
Title: HAMW30 Slug Out 2
Date: 05/04/16
Time: 11:23:17

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW30

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.825 ft
Static Water Column Height: 16. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 9. ft
Total Well Penetration Depth: 11.6 ft
Corrected Casing Radius (Bouwer-Rice Method): 0.1821 ft
Gravel Pack Porosity: 0.25

No. of Observations: 17

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.825	2.27	0.061
0.221	2.532	2.494	0.04
0.711	1.028	2.717	0.028
0.933	0.674	2.939	0.018
1.153	0.466	3.161	0.014
1.378	0.311	3.385	0.01
1.603	0.209	3.608	0.003
1.826	0.14	3.83	0.002
2.048	0.091		

SOLUTION

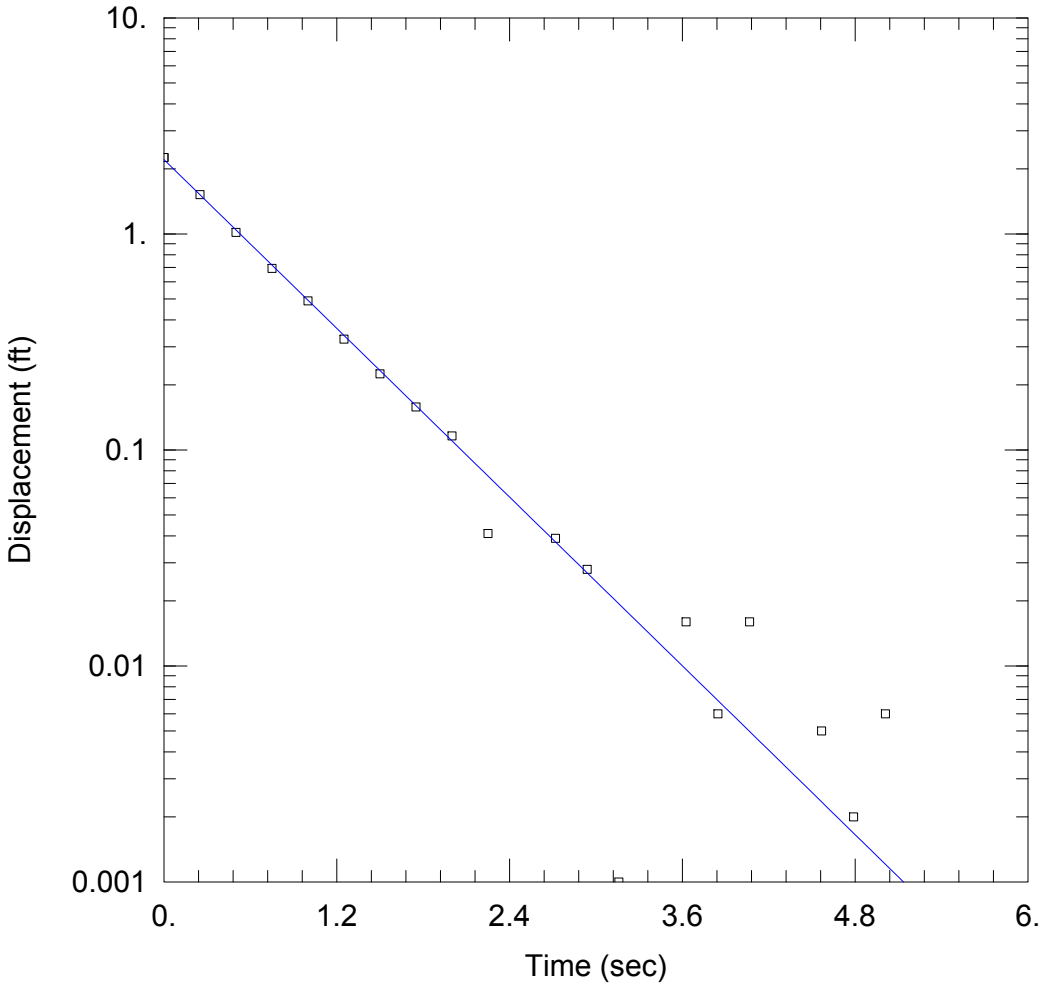
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.098

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.2117	cm/sec
y0	3.784	ft

T = K*b = 548.5 cm²/sec



HAMW30 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO3.aqt
Date: 05/04/16 Time: 11:23:48

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW30)

Initial Displacement: 2.257 ft
Total Well Penetration Depth: 11.6 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16. ft
Screen Length: 9. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0319 cm/sec
y0 = 2.208 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW30\HAMW30 SO3.aqt
Title: HAMW30 Slug Out 3
Date: 05/04/16
Time: 11:23:56

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW30

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW30

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.257 ft
Static Water Column Height: 16. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 9. ft
Total Well Penetration Depth: 11.6 ft

No. of Observations: 19

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.257	2.719	0.039
0.25	1.521	2.939	0.028
0.5	1.017	3.159	0.001
0.75	0.693	3.626	0.016
1.	0.49	3.847	0.006
1.25	0.326	4.067	0.016
1.5	0.225	4.567	0.005
1.75	0.158	4.789	0.002
2.	0.116	5.01	0.006
2.25	0.041		

SOLUTION

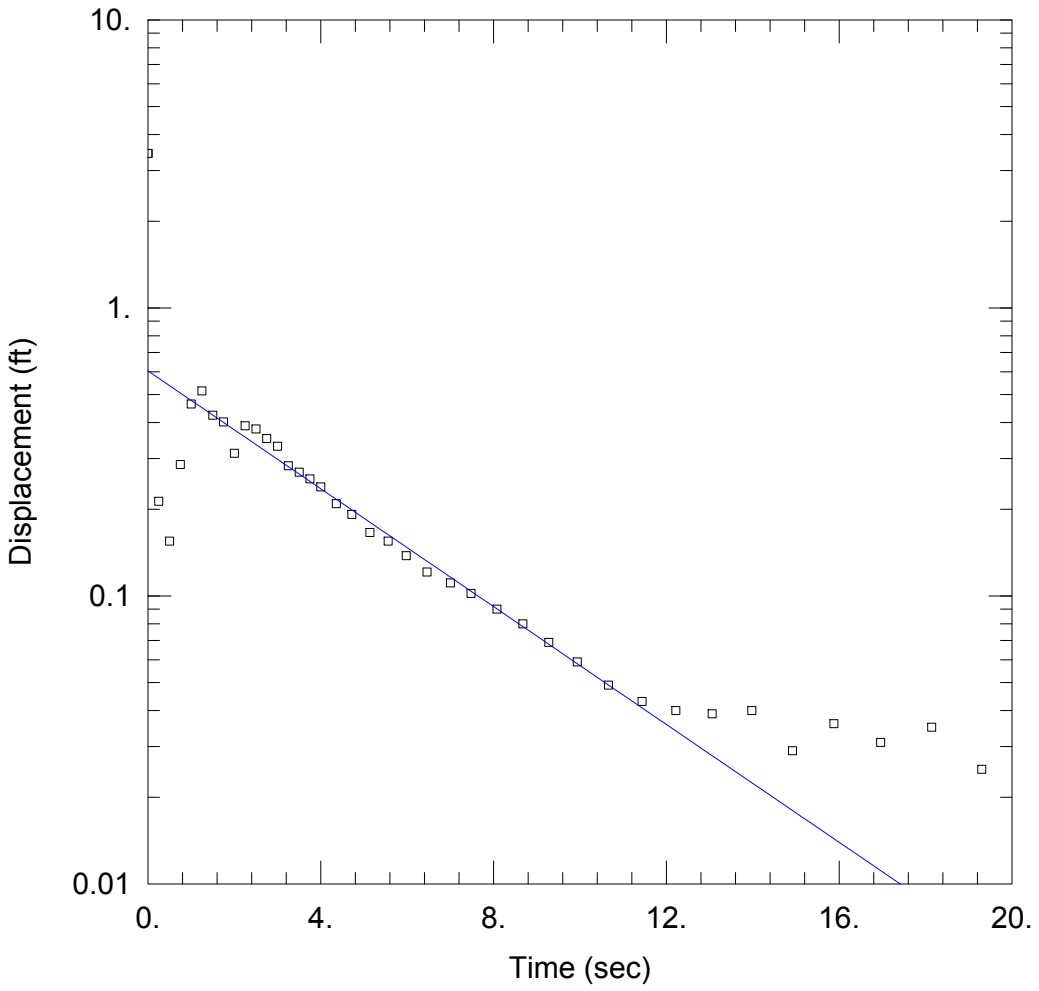
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.098

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0319	cm/sec
y0	2.208	ft

T = K*b = 82.64 cm²/sec



HAMW31 SLUG IN 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SI1.aqt
Date: 05/04/16 Time: 13:00:05

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 3.439 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.005535 cm/sec
y0 = 0.6041 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SI1.aqt
Title: HAMW31 Slug In 1
Date: 05/04/16
Time: 13:00:13

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.439 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 39

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.439	5.56	0.155
0.25	0.213	5.98	0.138
0.5	0.155	6.46	0.121
0.75	0.286	7.	0.111
1.	0.464	7.48	0.102
1.25	0.515	8.08	0.09
1.5	0.424	8.68	0.08
1.75	0.402	9.28	0.069
2.	0.313	9.94	0.059
2.25	0.39	10.66	0.049
2.5	0.38	11.44	0.043
2.75	0.352	12.22	0.04
3.	0.331	13.06	0.039
3.25	0.283	13.98	0.04
3.5	0.269	14.92	0.029
3.75	0.255	15.88	0.036
4.	0.239	16.96	0.031
4.36	0.209	18.14	0.035
4.72	0.192	19.3	0.025
5.14	0.166		

SOLUTION

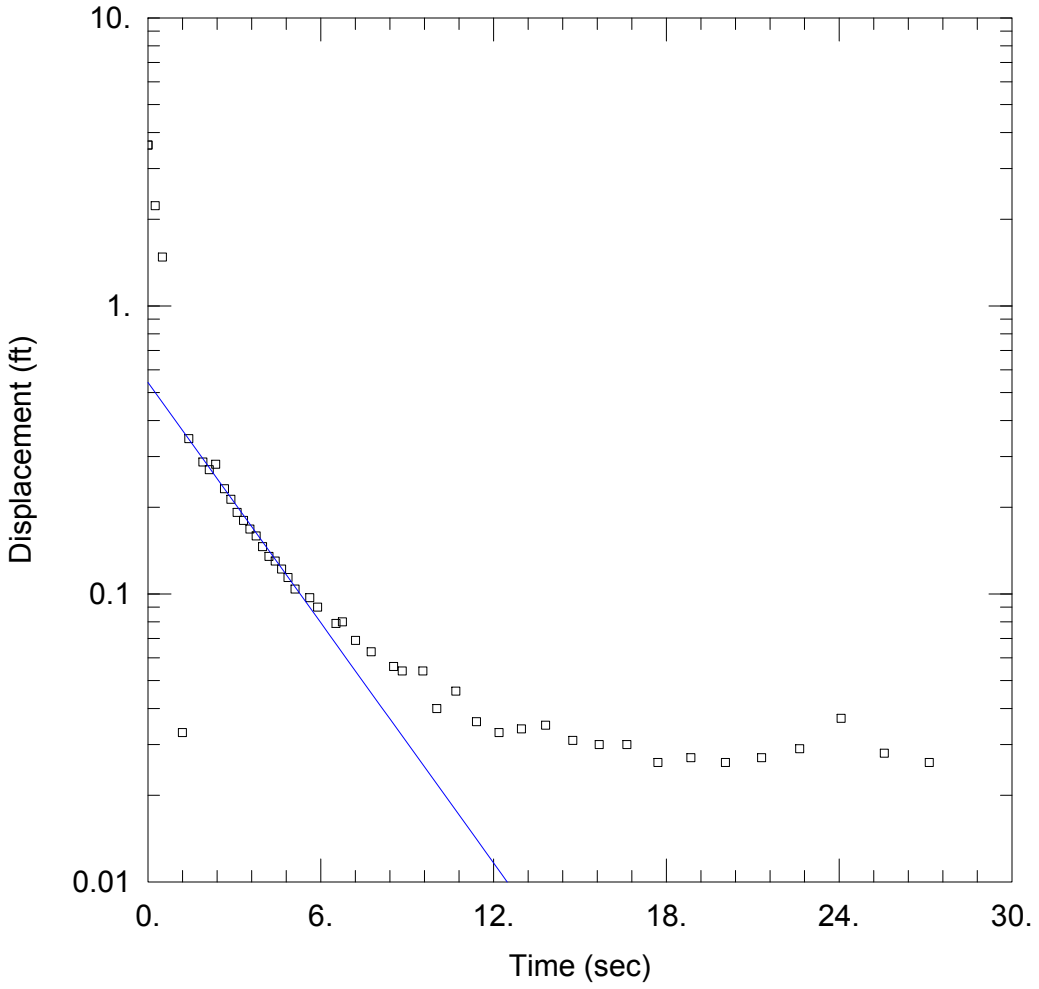
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.575

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.005535	cm/sec
y0	0.6041	ft

T = K*b = 14.34 cm²/sec



HAMW31 SLUG IN 4

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SI4.aqt
Date: 05/12/16 Time: 11:41:53

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 3.617 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.007523 cm/sec
y0 = 0.5422 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SI4.aqt
Title: HAMW31 Slug In 4
Date: 05/12/16
Time: 11:41:43

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.617 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 47

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.617	6.755	0.08
0.25	2.23	7.21	0.069
0.5	1.478	7.75	0.063
0.975	-0.119	8.528	0.056
1.197	0.033	8.83	0.054
1.418	0.346	9.545	0.054
1.91	0.287	10.03	0.04
2.132	0.27	10.69	0.046
2.353	0.282	11.41	0.036
2.657	0.232	12.19	0.033
2.878	0.213	12.97	0.034
3.099	0.192	13.81	0.035
3.319	0.18	14.75	0.031
3.54	0.168	15.67	0.03
3.76	0.159	16.63	0.03
3.981	0.146	17.71	0.026
4.201	0.135	18.85	0.027
4.421	0.13	20.05	0.026
4.641	0.122	21.31	0.027
4.862	0.114	22.63	0.029
5.11	0.104	24.07	0.037
5.617	0.097	25.57	0.028
5.89	0.09	27.13	0.026
6.532	0.079		

SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

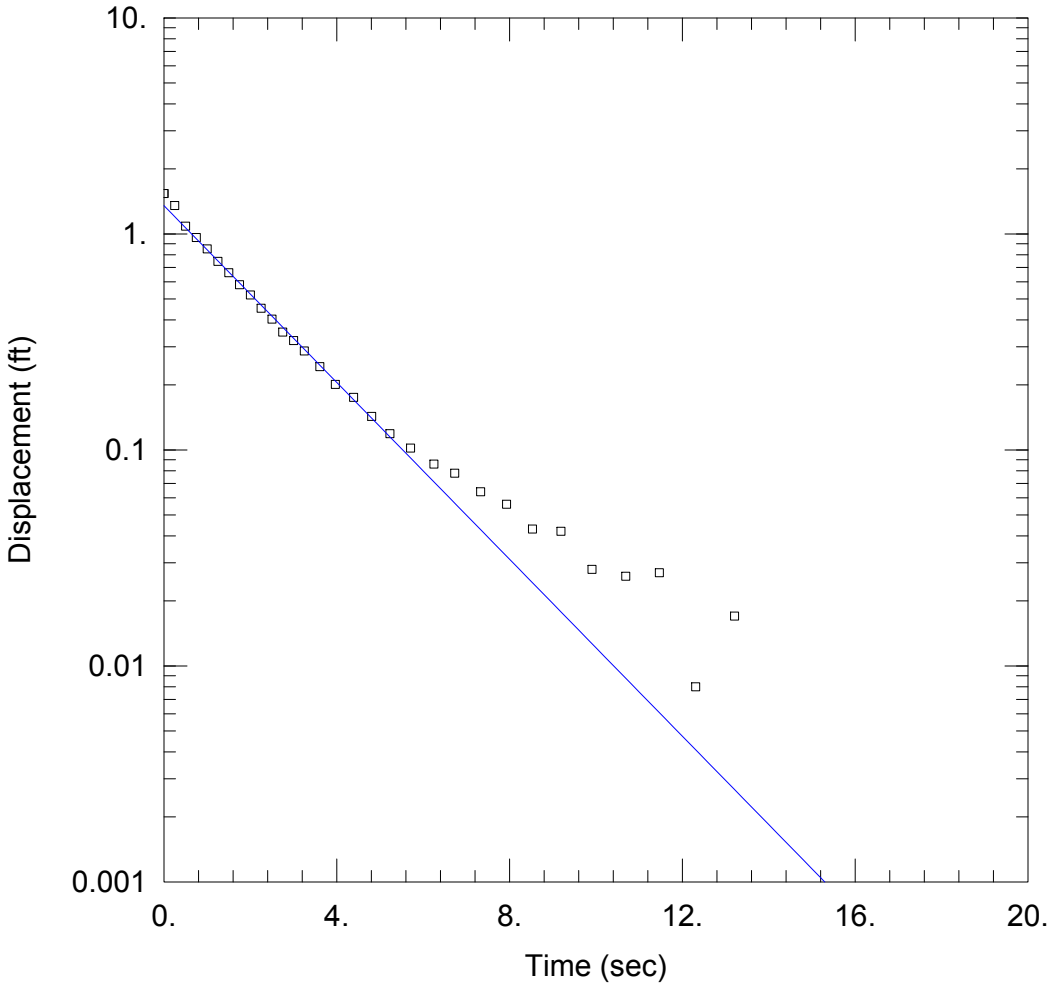
ln(Re/rw): 0.

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.007523	cm/sec
y0	0.5422	ft

T = K*b = 19.49 cm²/sec



HAMW31 SLUG OUT 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO1.aqt
Date: 05/04/16 Time: 13:01:59

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 1.539 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.01107 cm/sec
y0 = 1.351 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO1.aqt
Title: HAMW31 Slug Out 1
Date: 05/04/16
Time: 13:02:05

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.539 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 31

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.539	4.39	0.175
0.25	1.354	4.81	0.143
0.5	1.086	5.23	0.119
0.75	0.963	5.71	0.102
1.	0.853	6.25	0.086
1.25	0.746	6.73	0.078
1.5	0.661	7.33	0.064
1.75	0.582	7.93	0.056
2.	0.522	8.53	0.043
2.25	0.453	9.189	0.042
2.5	0.403	9.909	0.028
2.75	0.351	10.69	0.026
3.	0.321	11.47	0.027
3.25	0.287	12.31	0.008
3.61	0.243	13.21	0.017
3.97	0.201		

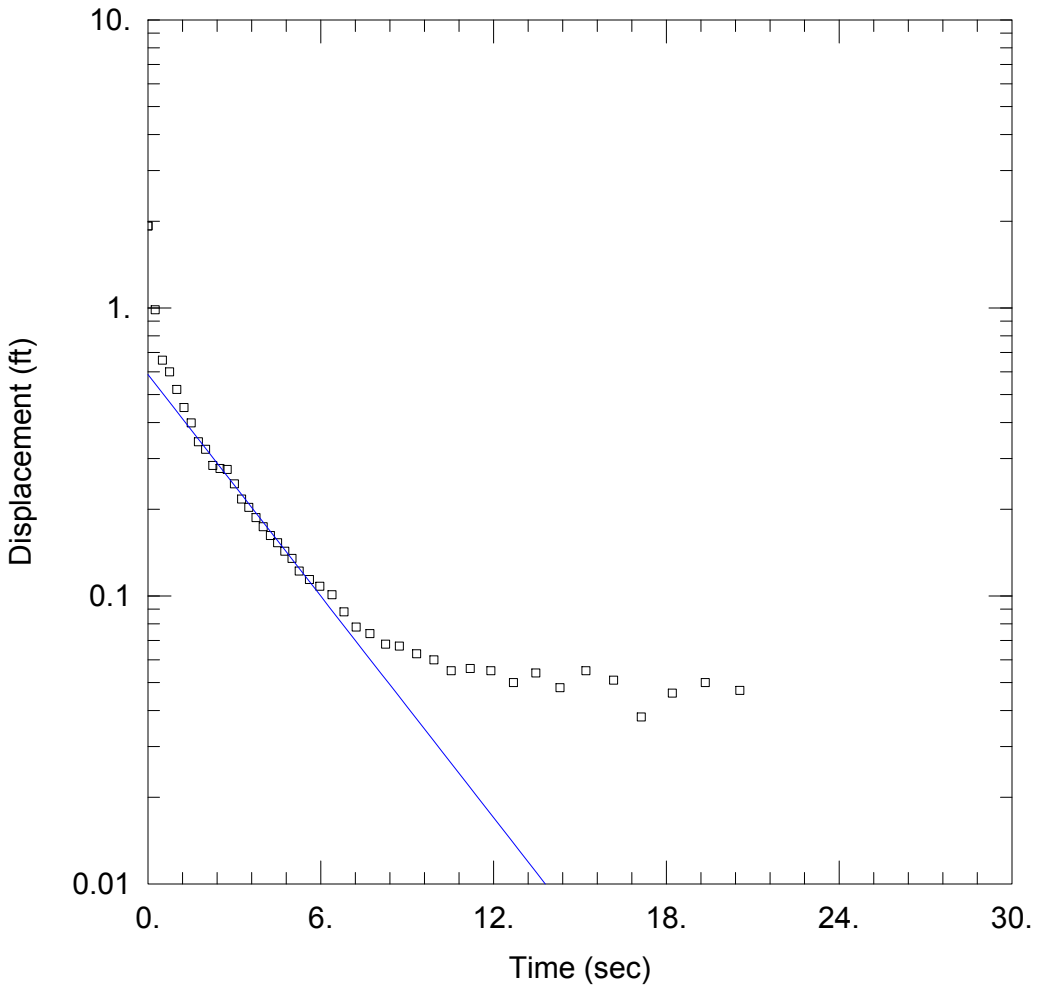
SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.575

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.01107	cm/sec



HAMW31 SLUG OUT 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO2.aqt
Date: 05/04/16 Time: 13:02:32

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 1.926 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.006939 cm/sec
y0 = 0.5871 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO2.aqt
Title: HAMW31 Slug Out 2
Date: 05/04/16
Time: 13:02:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.926 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 44

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.926	5.61	0.114
0.25	0.986	5.97	0.108
0.5	0.659	6.39	0.101
0.75	0.6	6.81	0.088
1.	0.521	7.23	0.078
1.25	0.451	7.71	0.074
1.5	0.399	8.25	0.068
1.75	0.343	8.73	0.067
2.	0.323	9.33	0.063
2.25	0.284	9.93	0.06
2.5	0.277	10.53	0.055
2.75	0.275	11.19	0.056
3.	0.245	11.91	0.055
3.25	0.217	12.69	0.05
3.5	0.203	13.47	0.054
3.75	0.187	14.31	0.048
4.	0.174	15.21	0.055
4.25	0.162	16.17	0.051
4.5	0.153	17.13	0.038
4.75	0.143	18.21	0.046
5.	0.135	19.35	0.05
5.25	0.122	20.55	0.047

SOLUTION

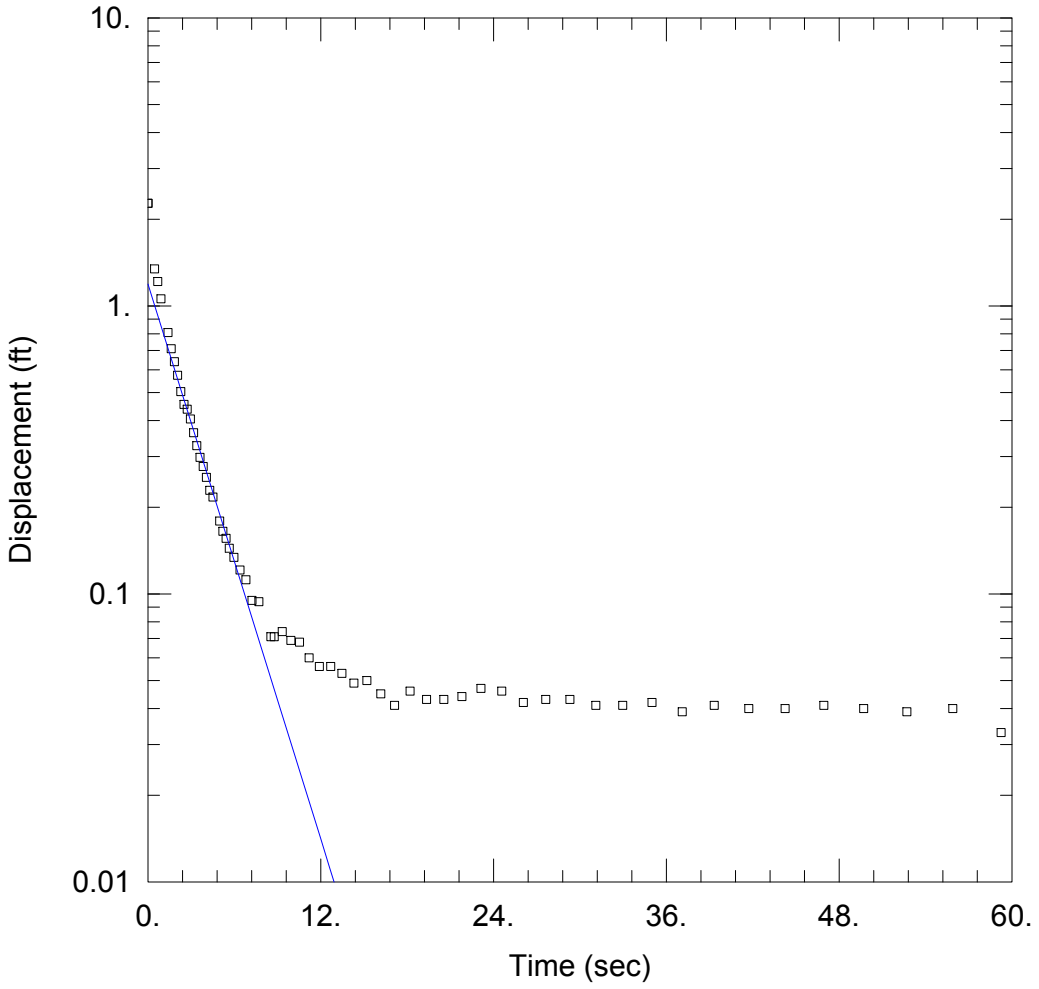
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.575

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.006939	cm/sec
y0	0.5871	ft

T = K*b = 17.98 cm²/sec



HAMW31 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO3.aqt
Date: 05/04/16 Time: 13:03:03

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 2.271 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.008687 cm/sec
y0 = 1.19 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO3.aqt
Title: HAMW31 Slug Out 3
Date: 05/04/16
Time: 13:03:09

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.271 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 62

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.271	9.93	0.069
0.461	1.345	10.53	0.068
0.681	1.215	11.19	0.06
0.903	1.059	11.91	0.056
1.394	0.808	12.69	0.056
1.617	0.71	13.47	0.053
1.838	0.64	14.31	0.049
2.059	0.574	15.21	0.05
2.283	0.504	16.17	0.045
2.506	0.455	17.13	0.041
2.729	0.438	18.21	0.046
2.953	0.405	19.35	0.043
3.175	0.363	20.55	0.043
3.398	0.327	21.81	0.044
3.62	0.298	23.13	0.047
3.843	0.277	24.57	0.046
4.066	0.254	26.07	0.042
4.29	0.229	27.63	0.043
4.512	0.217	29.31	0.043
4.988	0.179	31.11	0.041
5.209	0.165	32.97	0.041
5.43	0.156	35.01	0.042
5.652	0.144	37.11	0.039
5.97	0.134	39.33	0.041
6.39	0.121	41.73	0.04
6.81	0.112	44.25	0.04
7.23	0.095	46.94	0.041
7.71	0.094	49.71	0.04
8.544	0.071	52.71	0.039
8.767	0.071	55.89	0.04

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
9.33	0.074	59.25	0.033

SOLUTION

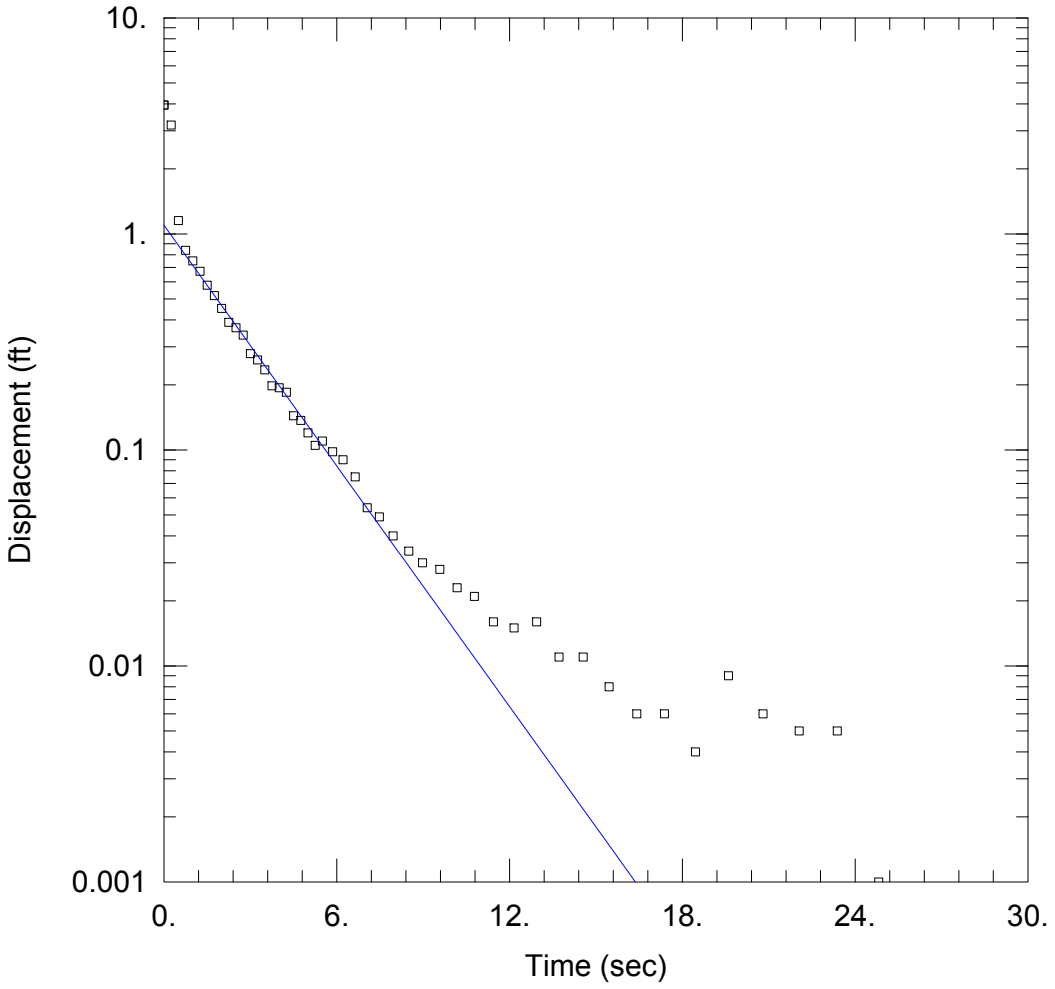
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.575

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.008687	cm/sec
y0	1.19	ft

T = K*b = 22.51 cm²/sec



HAMW31 SLUG OUT 4

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO4.aqt
Date: 05/12/16 Time: 11:42:39

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW31)

Initial Displacement: 3.948 ft
Total Well Penetration Depth: 34.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 37. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.01005 cm/sec
y0 = 1.097 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW31\HAMW31 SO4.aqt
Title: HAMW31 Slug Out 4
Date: 05/12/16
Time: 11:42:29

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW31

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW31

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.948 ft
Static Water Column Height: 37. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 34.1 ft

No. of Observations: 49

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.948	6.64	0.075
0.25	3.193	7.06	0.054
0.5	1.154	7.48	0.049
0.75	0.84	7.96	0.04
1.	0.75	8.5	0.034
1.25	0.671	8.98	0.03
1.5	0.579	9.58	0.028
1.75	0.518	10.18	0.023
2.	0.452	10.78	0.021
2.25	0.39	11.44	0.016
2.5	0.368	12.16	0.015
2.75	0.34	12.94	0.016
3.	0.279	13.72	0.011
3.25	0.261	14.56	0.011
3.5	0.235	15.46	0.008
3.75	0.198	16.42	0.006
4.	0.194	17.38	0.006
4.25	0.185	18.46	0.004
4.5	0.144	19.6	0.009
4.75	0.137	20.8	0.006
5.	0.12	22.06	0.005
5.25	0.105	23.38	0.005
5.5	0.11	24.82	0.001
5.86	0.098	26.32	0.
6.22	0.09		

SOLUTION

Slug Test
Aquifer Model: Unconfined

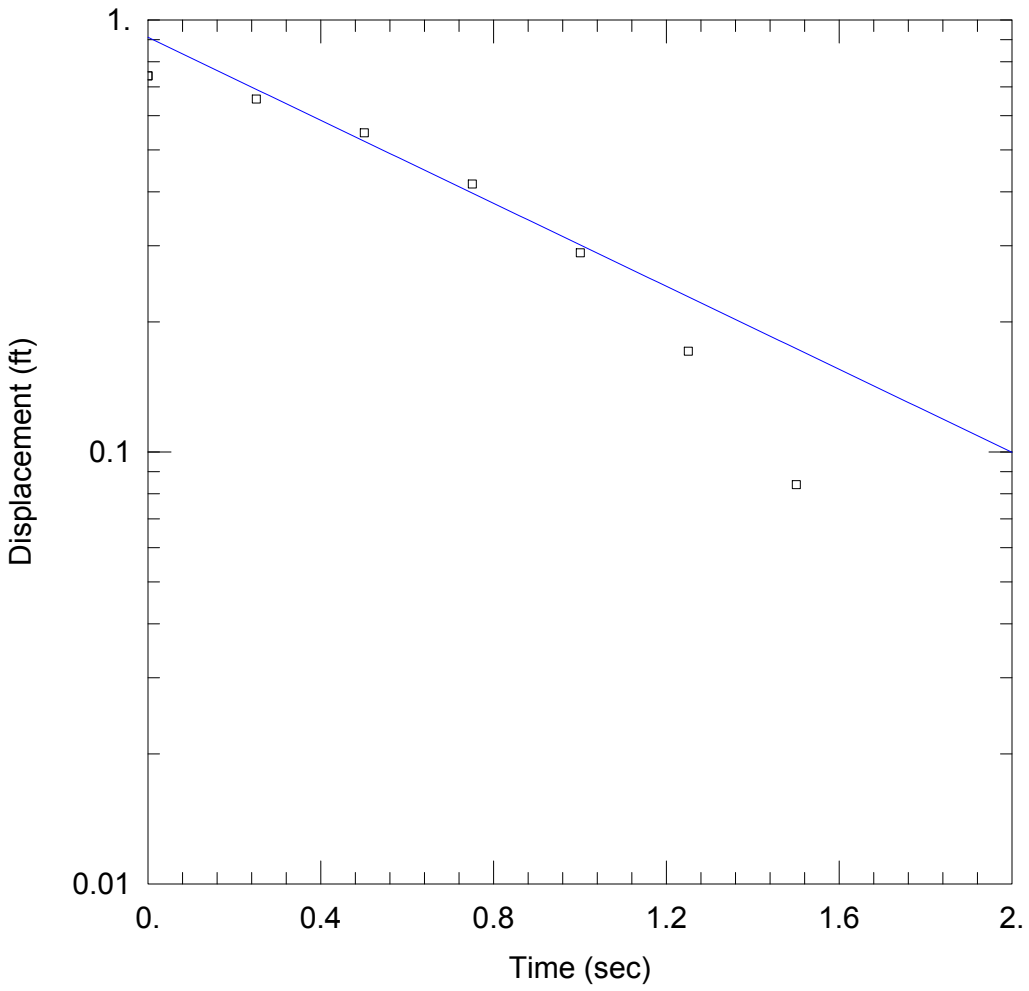
Solution Method: Bouwer-Rice
ln(Re/rw): 0.

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.01005	cm/sec
y0	1.097	ft

T = K*b = 26.04 cm²/sec



HAMW32 SLUG OUT 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW32\HAMW32 SO2.aqt
Date: 05/04/16 Time: 11:39:41

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW32

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW32)

Initial Displacement: 0.742 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.083 ft
Static Water Column Height: 10. ft
Screen Length: 10. ft
Well Radius: 0.34 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1164 cm/sec
y0 = 0.9113 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW32\HAMW32 SO2.aqt
Title: HAMW32 Slug Out 2
Date: 05/04/16
Time: 11:39:49

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW32

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW32

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.742 ft
Static Water Column Height: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft
Corrected Casing Radius (Bouwer-Rice Method): 0.1821 ft
Gravel Pack Porosity: 0.25

No. of Observations: 8

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.742	1.001	0.289
0.251	0.656	1.251	0.171
0.501	0.548	1.501	0.084
0.751	0.417	1.969	-0.039

SOLUTION

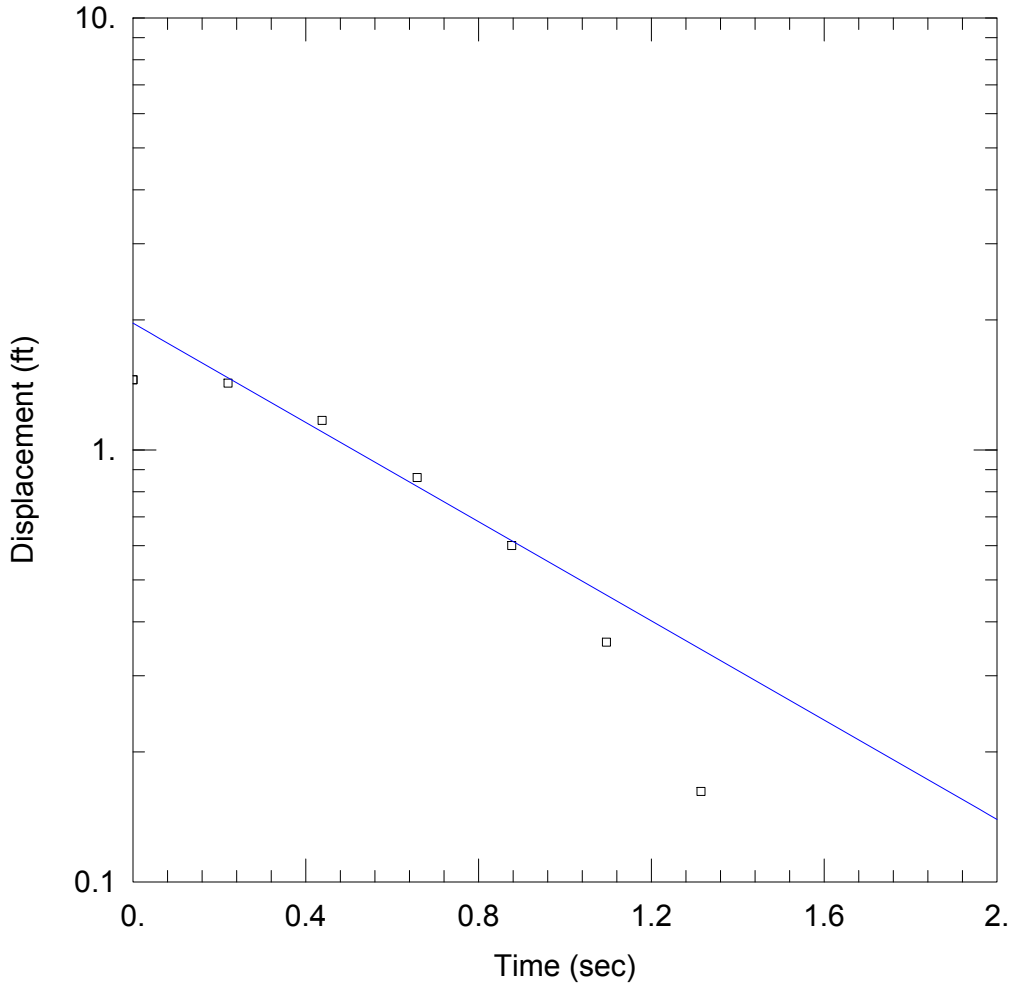
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.083

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.1164	cm/sec
y0	0.9113	ft

T = K*b = 301.6 cm²/sec



HAMW32 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW32\HAMW32 SO3.aqt
Date: 05/04/16 Time: 11:40:46

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW32

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW32)

Initial Displacement: 1.453 ft
Total Well Penetration Depth: 10. ft
Casing Radius: 0.083 ft
Static Water Column Height: 10. ft
Screen Length: 10. ft
Well Radius: 0.34 ft
Gravel Pack Porosity: 0.25

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1392 cm/sec
y0 = 1.965 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW32\HAMW32 SO3.aqt
Title: HAMW32 Slug Out 3
Date: 05/04/16
Time: 11:40:57

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW32

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW32

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.453 ft
Static Water Column Height: 10. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 10. ft
Corrected Casing Radius (Bouwer-Rice Method): 0.1821 ft
Gravel Pack Porosity: 0.25

No. of Observations: 7

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.453	0.877	0.601
0.22	1.428	1.096	0.359
0.438	1.17	1.315	0.162
0.658	0.863		

SOLUTION

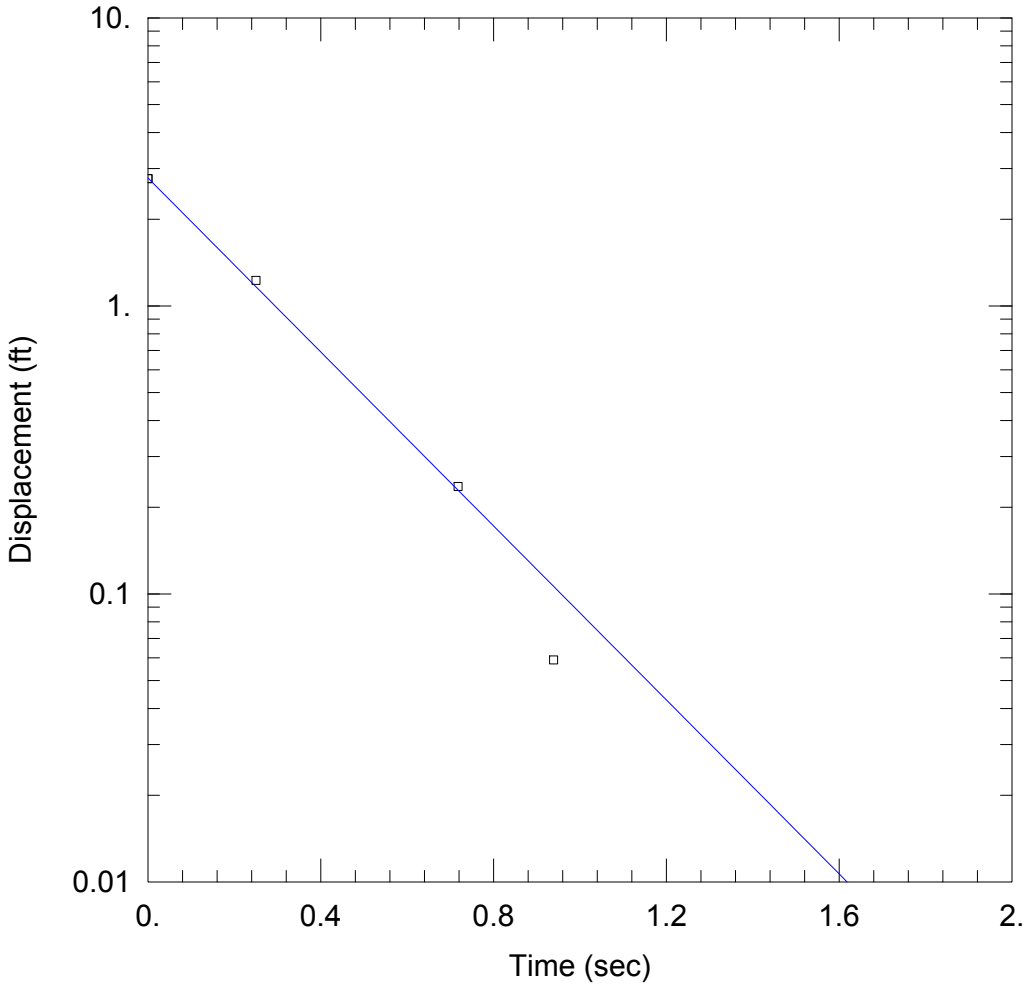
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.083

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.1392	cm/sec
y0	1.965	ft

T = K*b = 360.7 cm²/sec



HAMW37 SLUG OUT 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO1.aqt
Date: 05/04/16 Time: 11:44:57

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW37)

Initial Displacement: 2.765 ft
Total Well Penetration Depth: 45.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 49. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.08545 cm/sec
y0 = 2.78 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO1.aqt
Title: HAMW37 Slug Out 1
Date: 05/04/16
Time: 11:45:04

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW37

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.765 ft
Static Water Column Height: 49. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 45.1 ft

No. of Observations: 5

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.765	0.939	0.059
0.25	1.226	1.16	-0.012
0.718	0.236		

SOLUTION

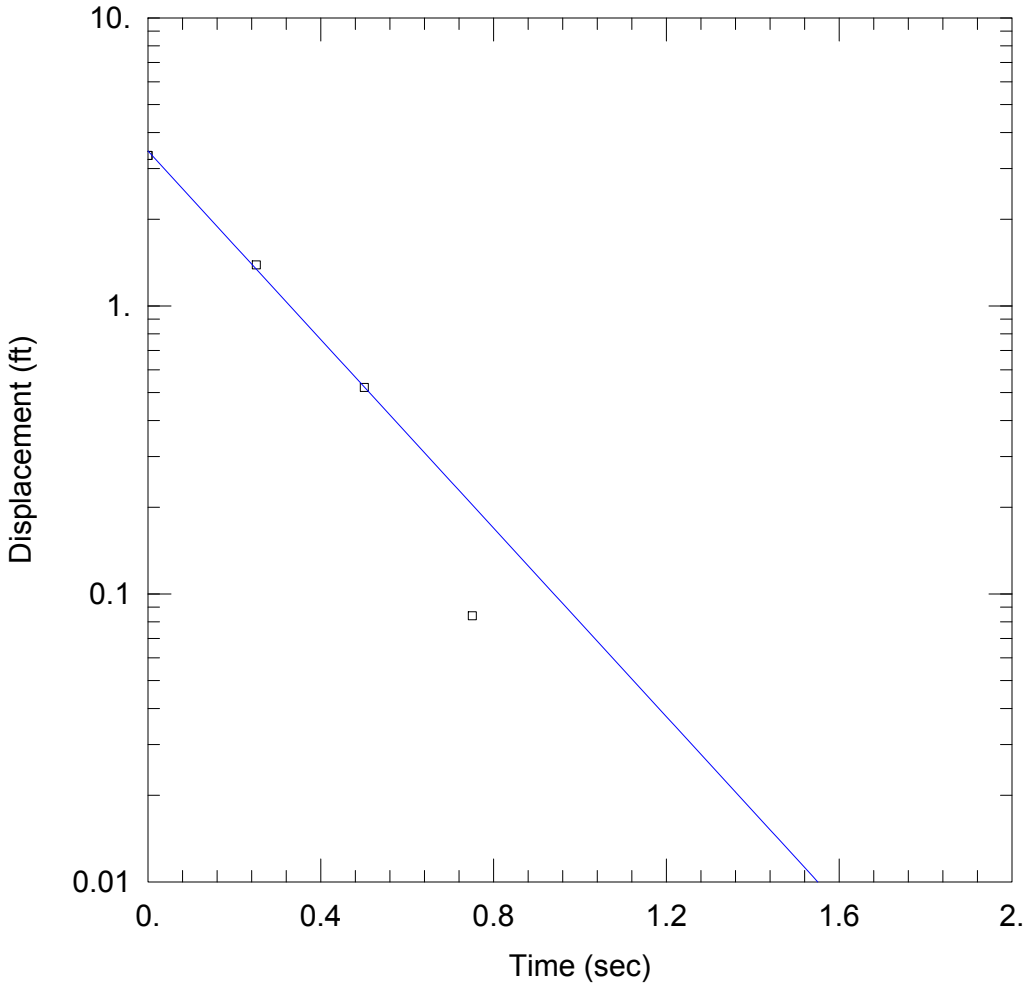
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.693

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.08545	cm/sec
y0	2.78	ft

T = K*b = 221.4 cm²/sec



HAMW37 SLUG OUT 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO2.aqt
Date: 05/04/16 Time: 11:46:24

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW37)

Initial Displacement: 3.332 ft
Total Well Penetration Depth: 45.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 49. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.09261 cm/sec
y0 = 3.45 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO2.aqt
Title: HAMW37 Slug Out 2
Date: 05/04/16
Time: 11:46:30

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW37

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.332 ft
Static Water Column Height: 49. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 45.1 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.332	0.751	0.084
0.251	1.388	1.234	-0.163
0.501	0.521	1.456	-0.153

SOLUTION

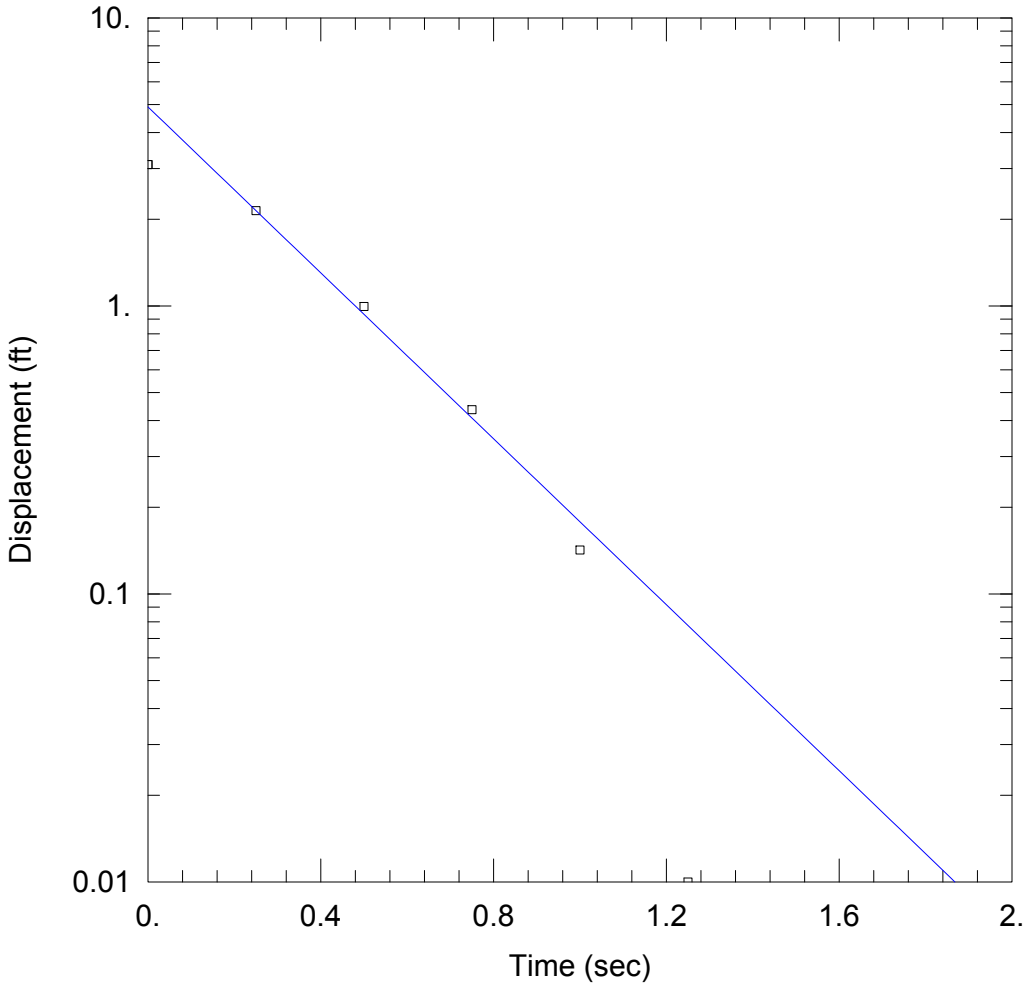
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.693

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.09261	cm/sec
y0	3.45	ft

T = K*b = 239.9 cm²/sec



HAMW37 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO3.aqt
Date: 05/04/16 Time: 11:47:07

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW37)

Initial Displacement: 3.096 ft
Total Well Penetration Depth: 45.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 49. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.08151 cm/sec
y0 = 4.909 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW37\HAMW37 SO3.aqt
Title: HAMW37 Slug Out 3
Date: 05/04/16
Time: 11:47:16

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW37

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW37

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 3.096 ft
Static Water Column Height: 49. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 45.1 ft

No. of Observations: 7

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	3.096	1.	0.142
0.25	2.142	1.25	0.01
0.5	0.995	1.5	-0.041
0.75	0.436		

SOLUTION

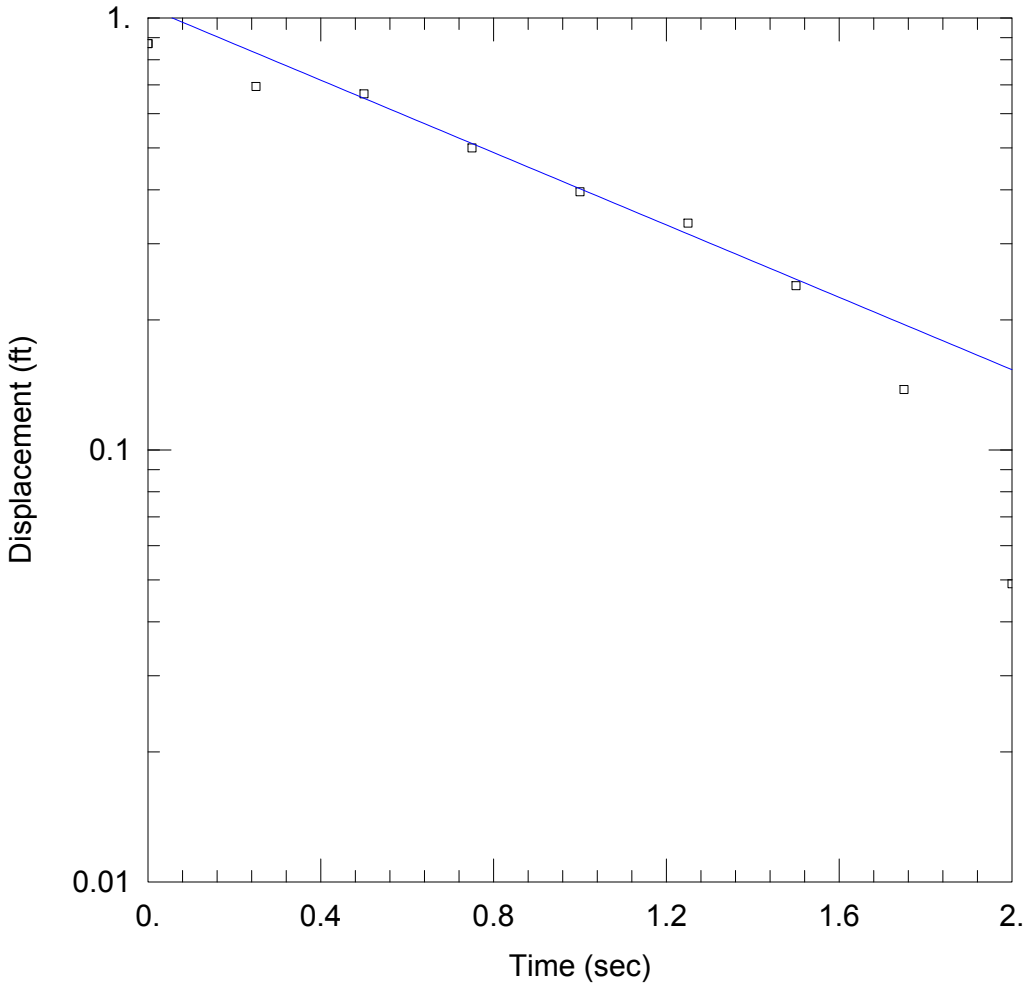
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.693

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.08151	cm/sec
y0	4.909	ft

T = K*b = 211.2 cm²/sec



HAMW39 SLUG OUT 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO1.aqt
Date: 05/04/16 Time: 11:52:27

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW39)

Initial Displacement: 0.872 ft
Total Well Penetration Depth: 18.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.1 ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02047 cm/sec
y0 = 1.055 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO1.aqt
Title: HAMW39 Slug Out 1
Date: 05/04/16
Time: 11:52:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW39

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.872 ft
Static Water Column Height: 20.1 ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.1 ft

No. of Observations: 9

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.872	1.25	0.335
0.25	0.694	1.5	0.24
0.5	0.667	1.75	0.138
0.75	0.5	2.	0.049
1.	0.396		

SOLUTION

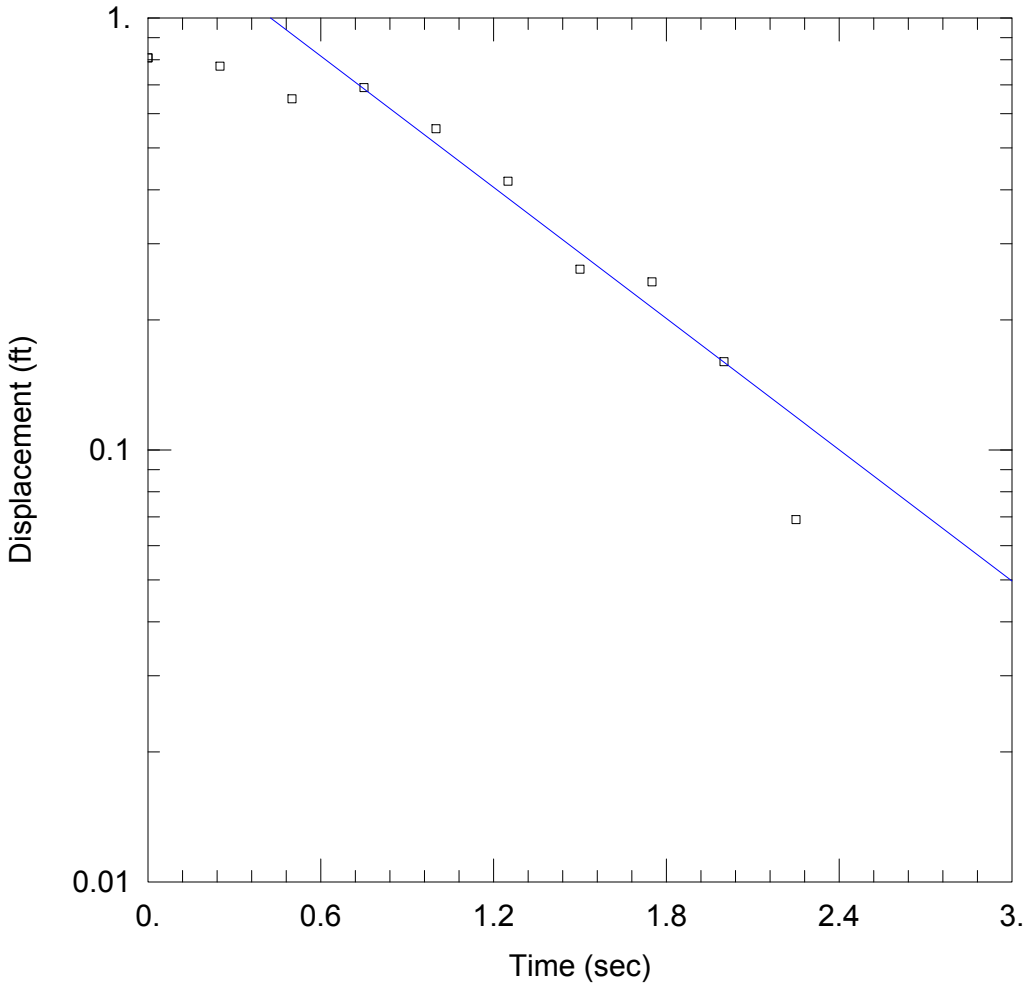
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.326

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.02047	cm/sec
y0	1.055	ft

T = K*b = 53.04 cm²/sec



HAMW39 SLUG OUT 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO2.aqt
Date: 05/04/16 Time: 11:53:04

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW39)

Initial Displacement: 0.808 ft
Total Well Penetration Depth: 18.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.1 ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02474 cm/sec
y0 = 1.643 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO2.aqt
Title: HAMW39 Slug Out 2
Date: 05/04/16
Time: 11:53:12

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW39

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.808 ft
Static Water Column Height: 20.1 ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.1 ft

No. of Observations: 10

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.808	1.25	0.419
0.25	0.773	1.5	0.262
0.5	0.65	1.75	0.245
0.75	0.69	2.	0.16
1.	0.554	2.25	0.069

SOLUTION

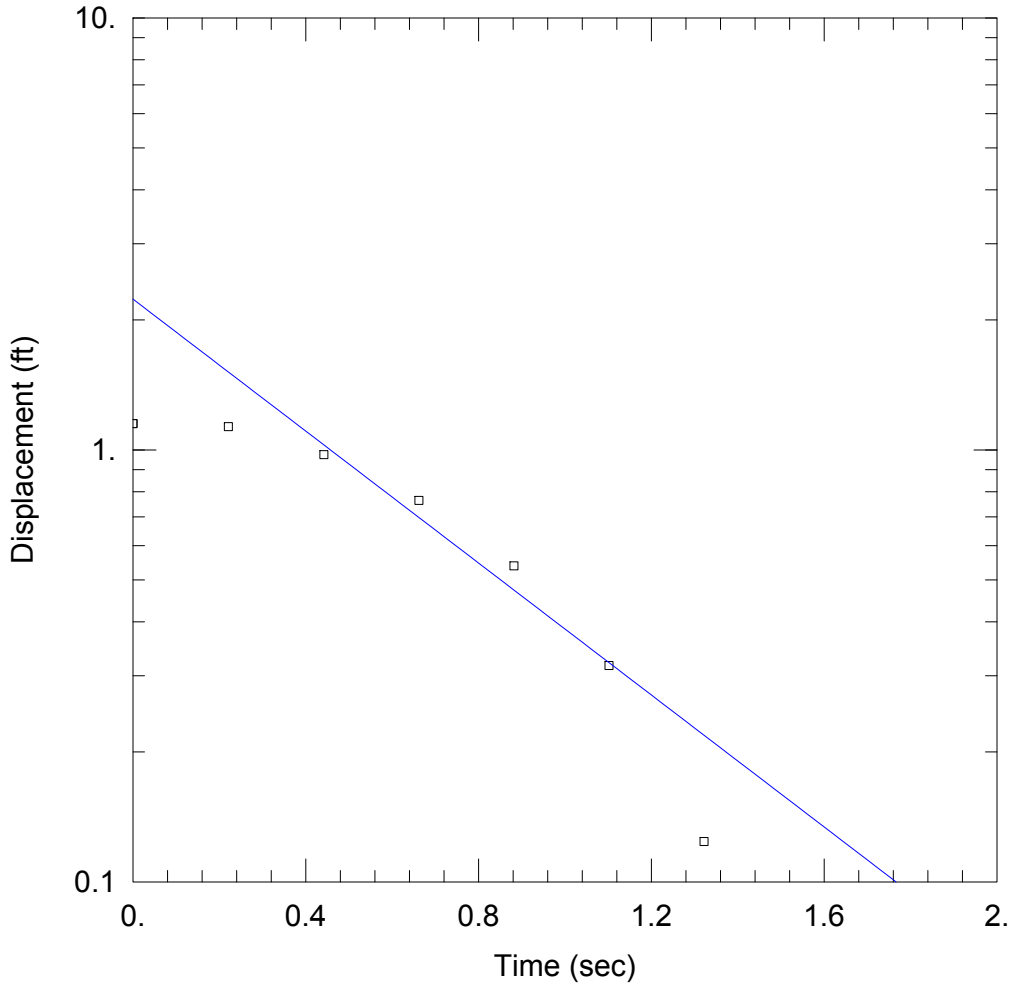
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.326

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.02474	cm/sec
y0	1.643	ft

T = K*b = 64.09 cm²/sec



HAMW39 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO3.aqt
Date: 05/04/16 Time: 11:53:50

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW39)

Initial Displacement: 1.151 ft
Total Well Penetration Depth: 18.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.1 ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03732 cm/sec
y0 = 2.233 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO3.aqt
Title: HAMW39 Slug Out 3
Date: 05/04/16
Time: 11:54:03

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW39

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.151 ft
Static Water Column Height: 20.1 ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.1 ft

No. of Observations: 7

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.151	0.882	0.539
0.221	1.132	1.102	0.317
0.442	0.975	1.322	0.124
0.662	0.764		

SOLUTION

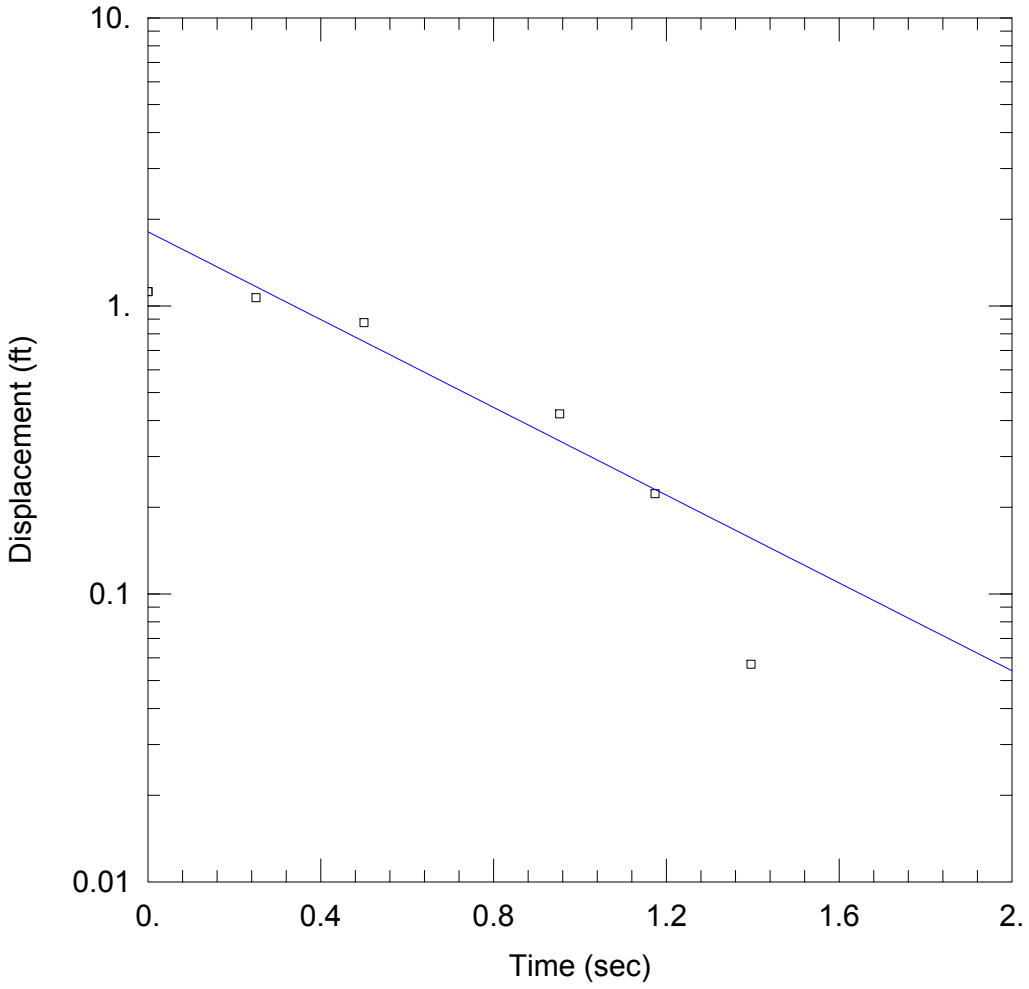
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.326

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.03732	cm/sec
y0	2.233	ft

T = K*b = 96.69 cm²/sec



HAMW39 SLUG OUT 4

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO4.aqt
Date: 05/04/16 Time: 11:54:31

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW39)

Initial Displacement: 1.122 ft
Total Well Penetration Depth: 18.1 ft
Casing Radius: 0.083 ft
Static Water Column Height: 20.1 ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03725 cm/sec
y0 = 1.809 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW39\HAMW39 SO4.aqt
Title: HAMW39 Slug Out 4
Date: 05/04/16
Time: 11:54:38

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW39

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW39

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.122 ft
Static Water Column Height: 20.1 ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 18.1 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.122	0.953	0.422
0.25	1.068	1.174	0.223
0.5	0.875	1.396	0.057

SOLUTION

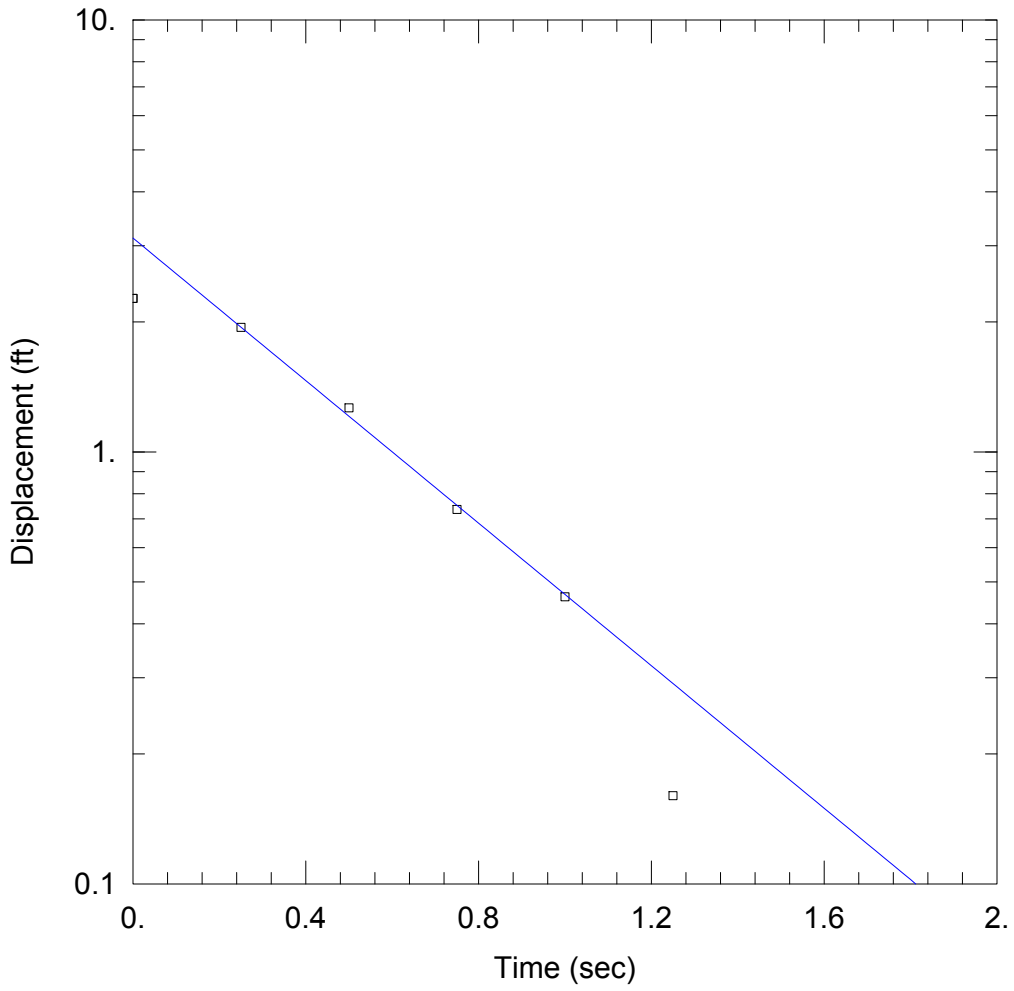
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.326

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.03725	cm/sec
y0	1.809	ft

T = K*b = 96.5 cm²/sec



HAMW40 SLUG IN 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW40\HAMW40 SI1.aqt
Date: 05/04/16 Time: 11:56:18

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW40

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW40)

Initial Displacement: 2.266 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03828 cm/sec
y0 = 3.126 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW40\HAMW40 SI1.aqt
Title: HAMW40 Slug In 1
Date: 05/04/16
Time: 11:56:24

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW40

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW40

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.266 ft
Static Water Column Height: 16. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 13.5 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.266	0.75	0.736
0.25	1.942	1.	0.462
0.5	1.265	1.25	0.16

SOLUTION

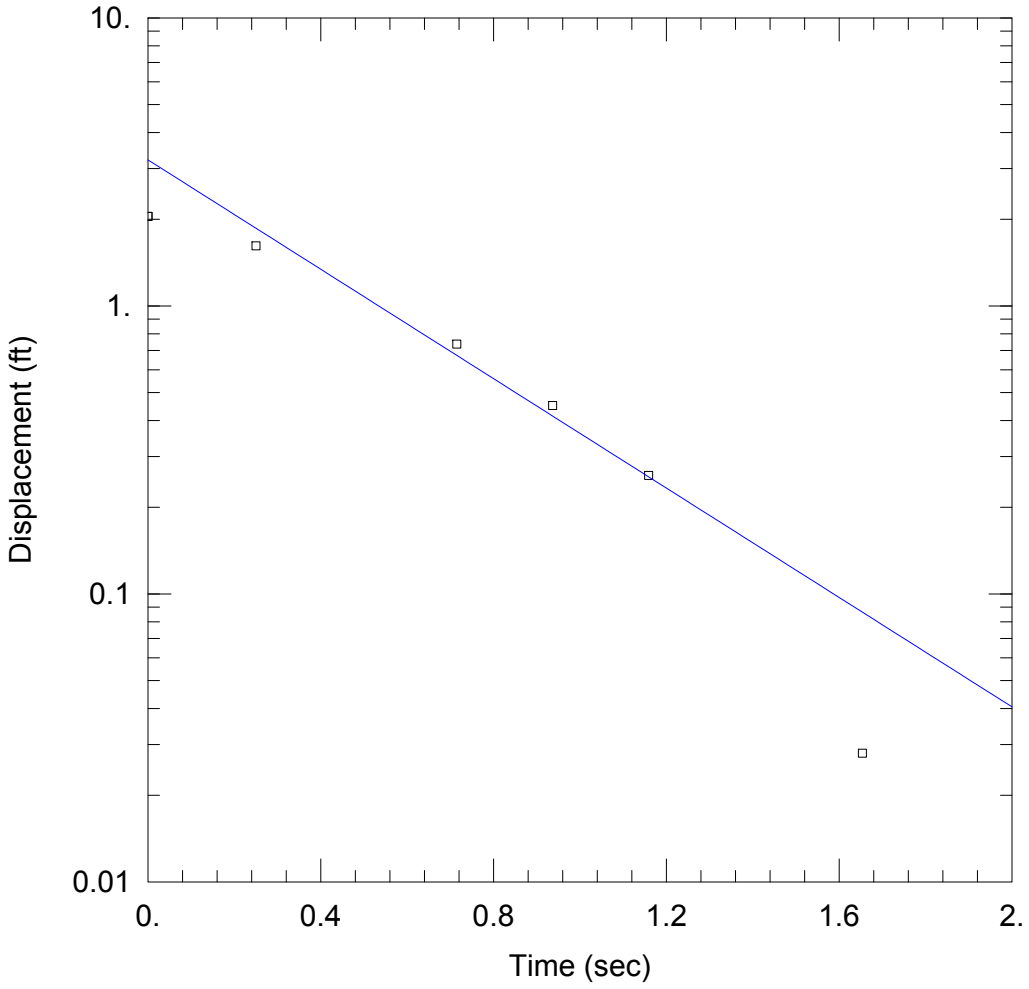
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.208

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.03828	cm/sec
y0	3.126	ft

T = K*b = 99.17 cm²/sec



HAMW40 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW40\HAMW40 SO3.aqt
Date: 05/04/16 Time: 12:14:51

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW40

AQUIFER DATA

Saturated Thickness: 85. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW40)

Initial Displacement: 2.046 ft
Total Well Penetration Depth: 13.5 ft
Casing Radius: 0.083 ft
Static Water Column Height: 16. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.04406 cm/sec
y0 = 3.215 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW40\HAMW40 SO3.aqt
Title: HAMW40 Slug Out 3
Date: 05/04/16
Time: 12:15:01

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW40

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW40

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 2.046 ft
Static Water Column Height: 16. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 13.5 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	2.046	0.937	0.451
0.25	1.617	1.159	0.258
0.715	0.737	1.654	0.028

SOLUTION

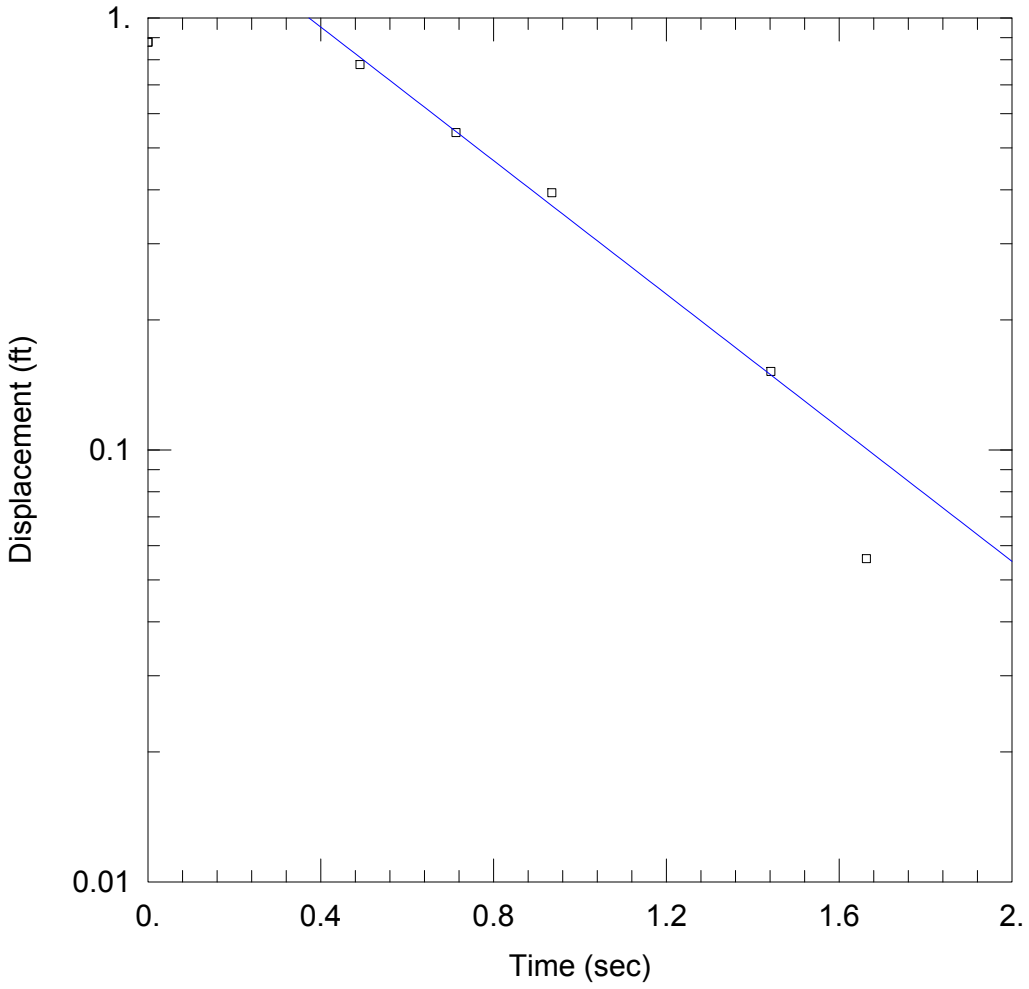
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.208

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.04406	cm/sec
y0	3.215	ft

T = K*b = 114.2 cm²/sec



HAMW41 SLUG IN 2

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SI2.aqt
Date: 05/04/16 Time: 12:22:39

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW41)

Initial Displacement: 0.879 ft
Total Well Penetration Depth: 15.2 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03665 cm/sec
y0 = 1.941 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SI2.aqt
Title: HAMW41 Slug In 2
Date: 05/04/16
Time: 12:22:47

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW41

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.879 ft
Static Water Column Height: 17. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.2 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.879	0.935	0.394
0.491	0.78	1.442	0.152
0.713	0.543	1.663	0.056

SOLUTION

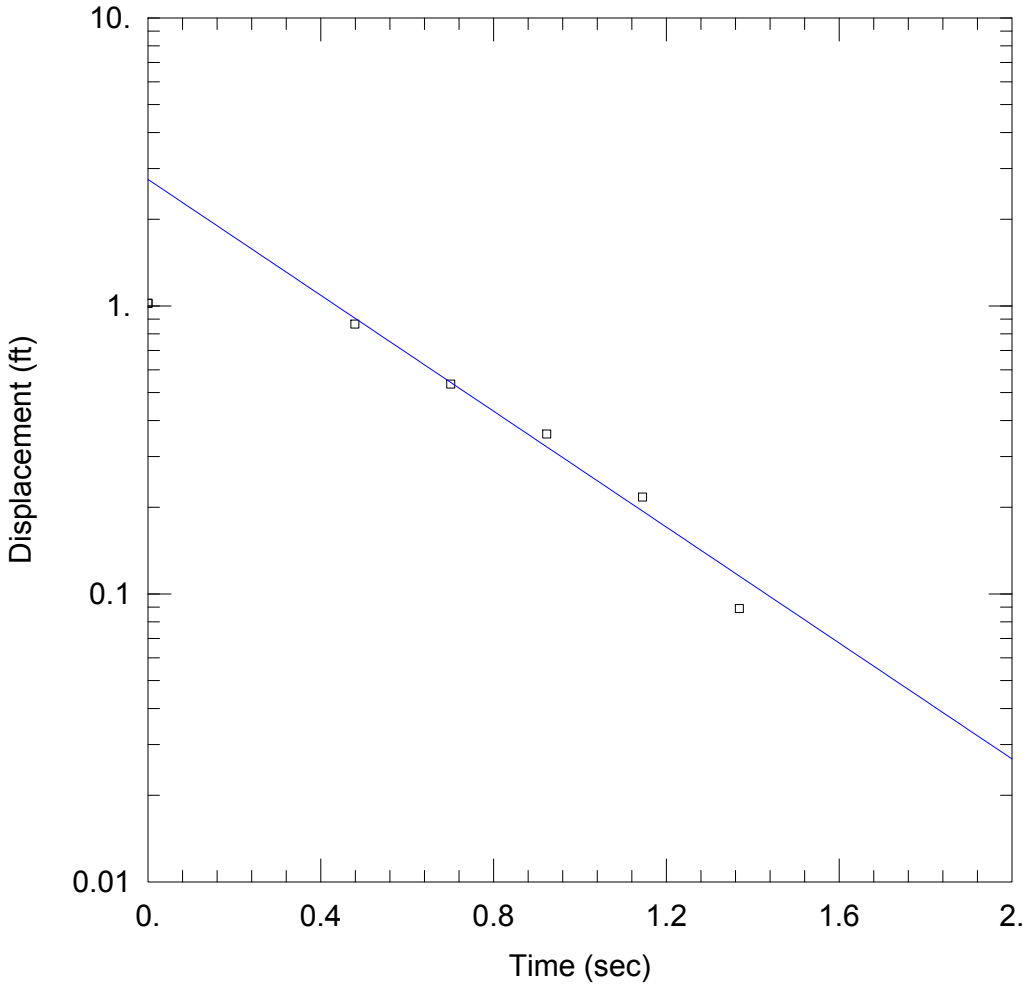
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.256

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.03665	cm/sec
y0	1.941	ft

T = K*b = 94.94 cm²/sec



HAMW41 SLUG IN 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SI3.aqt
Date: 05/04/16 Time: 12:23:12

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW41)

Initial Displacement: 1.021 ft
Total Well Penetration Depth: 15.2 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0477 cm/sec
y0 = 2.75 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SI3.aqt
Title: HAMW41 Slug In 3
Date: 05/04/16
Time: 12:23:21

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW41

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.021 ft
Static Water Column Height: 17. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.2 ft

No. of Observations: 6

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.021	0.923	0.359
0.479	0.865	1.145	0.217
0.701	0.535	1.369	0.089

SOLUTION

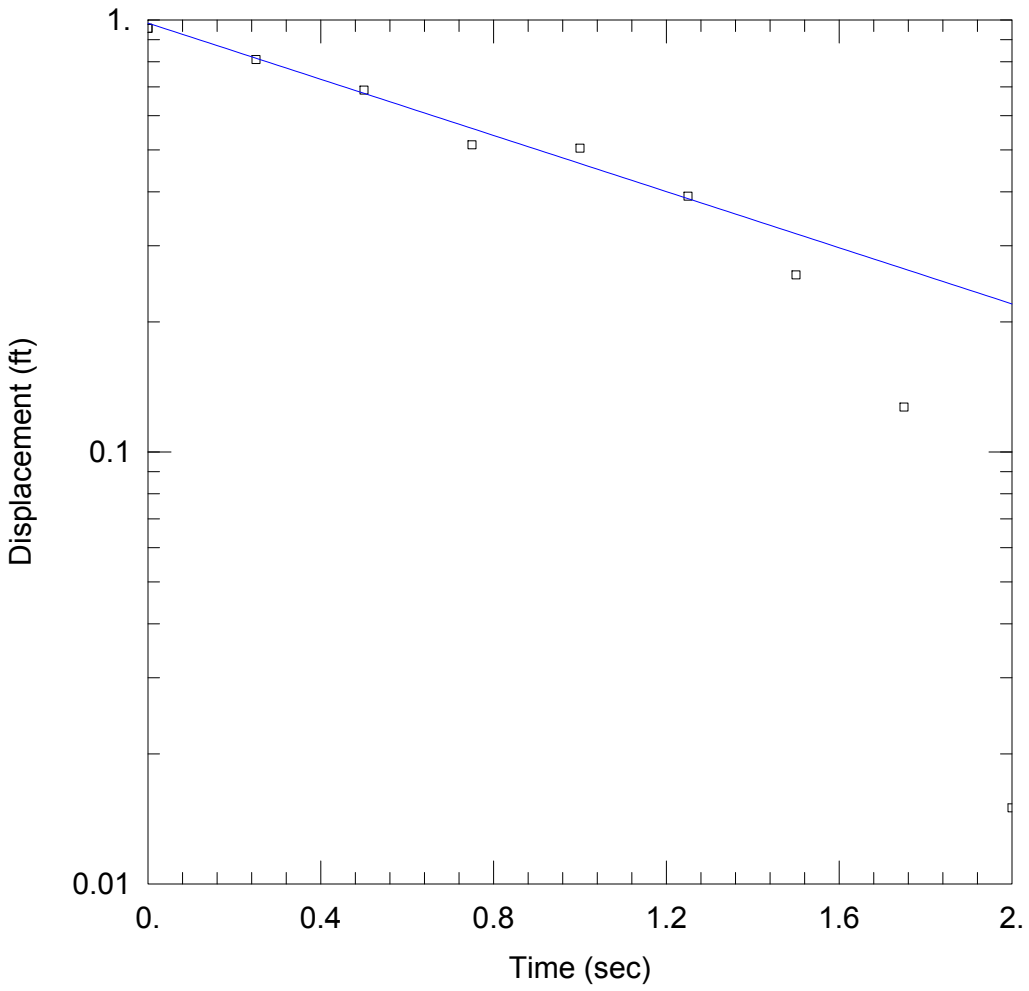
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.256

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.0477	cm/sec
y0	2.75	ft

T = K*b = 123.6 cm²/sec



HAMW41 SLUG OUT 1

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SO1.aqt
Date: 05/12/16 Time: 11:35:17

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW41)

Initial Displacement: 0.956 ft
Total Well Penetration Depth: 15.2 ft
Casing Radius: 0.083 ft
Static Water Column Height: 17. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.01541 cm/sec
y0 = 0.9831 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW41\HAMW41 SO1.aqt
Title: HAMW41 Slug Out 1
Date: 05/12/16
Time: 11:35:02

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW41

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW41

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.956 ft
Static Water Column Height: 17. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 15.2 ft

No. of Observations: 9

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.956	1.25	0.391
0.25	0.81	1.5	0.257
0.5	0.688	1.75	0.127
0.75	0.514	2.	0.015
1.	0.505		

SOLUTION

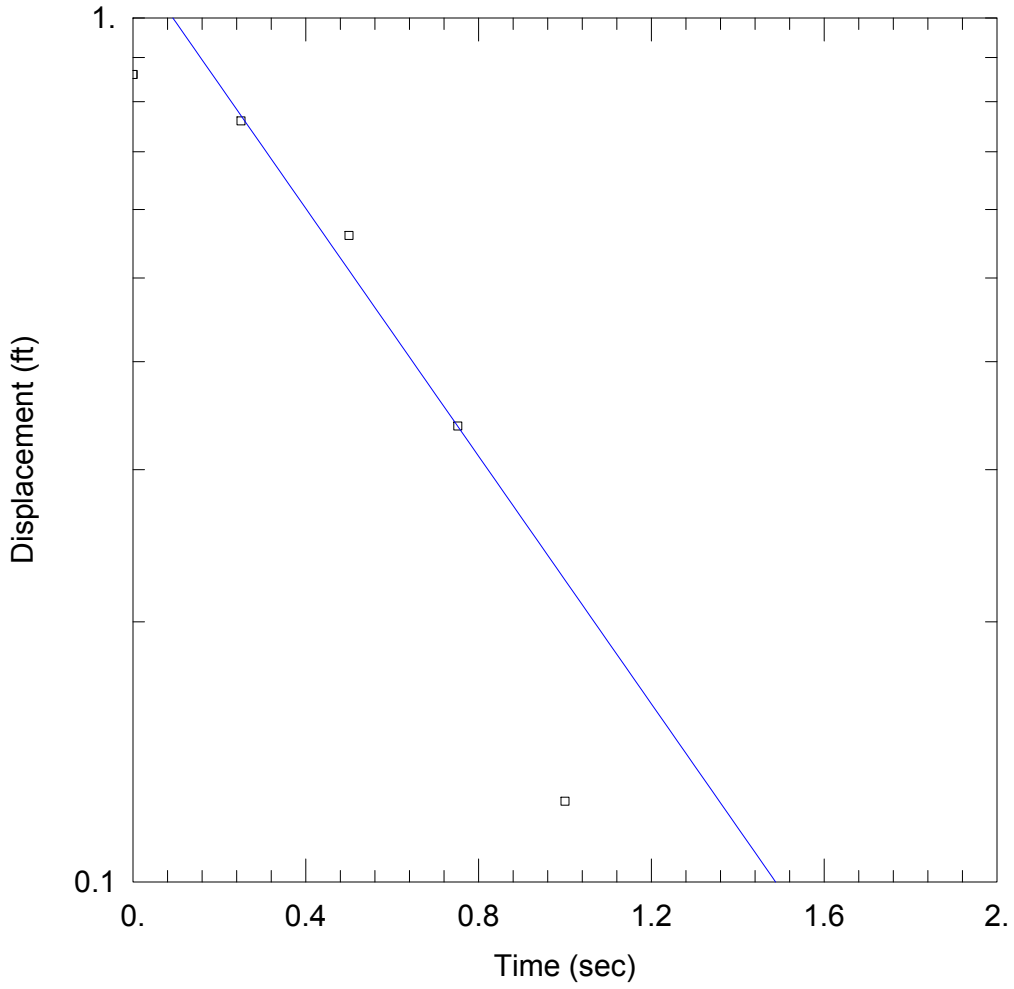
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 0.

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.01541	cm/sec
y0	0.9831	ft

T = K*b = 39.92 cm²/sec



HAMW42 SLUG OUT 2

Data Set: P:\...\HAMW42 SO2 - LOW DATA.aqt
Date: 05/12/16 Time: 11:45:20

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW42

AQUIFER DATA

Saturated Thickness: 85. ft Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW42)

Initial Displacement: 0.86 ft
Total Well Penetration Depth: 17. ft
Casing Radius: 0.083 ft
Static Water Column Height: 19. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.03465 cm/sec
y0 = 1.164 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW42\HAMW42 SO2 - LOW DATA.aqt
Title: HAMW42 Slug Out 2
Date: 05/12/16
Time: 11:45:04

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW42

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW42

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 0.86 ft
Static Water Column Height: 19. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17. ft

No. of Observations: 9

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	0.86	1.25	-0.065
0.25	0.76	1.5	-0.204
0.5	0.56	1.75	-0.288
0.752	0.337	2.	-0.315
1.	0.124		

SOLUTION

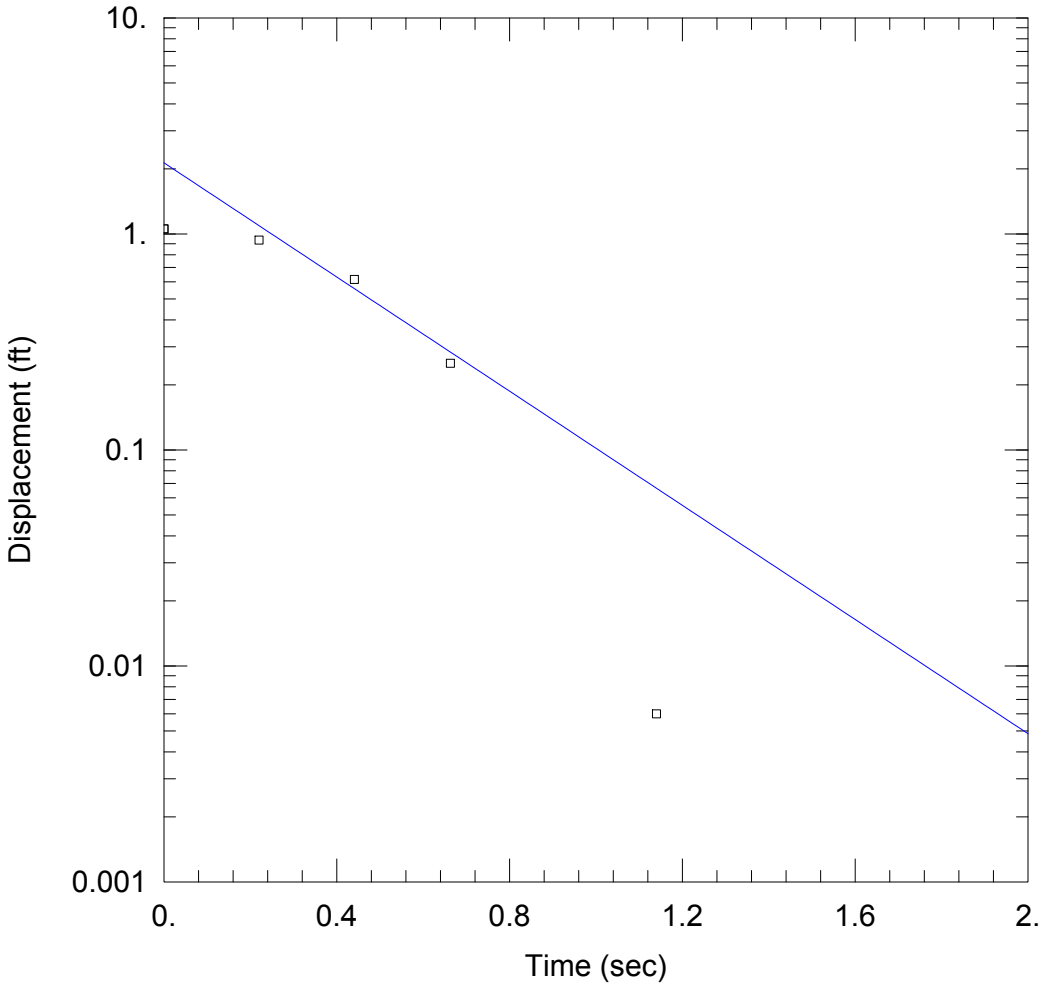
Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 0.

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.03465	cm/sec
y0	1.164	ft

T = K*b = 89.78 cm²/sec



HAMW42 SLUG OUT 3

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW42\HAMW42 SO3.aqt
Date: 05/04/16 Time: 12:34:03

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW42

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (HAMW42)

Initial Displacement: 1.055 ft
Total Well Penetration Depth: 17. ft
Casing Radius: 0.083 ft
Static Water Column Height: 19. ft
Screen Length: 10. ft
Well Radius: 0.34 ft

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.06389 cm/sec
y0 = 2.133 ft

Data Set: P:\2200\2285\Data\Slug Testing\havana\Data Analysis\HAMW42\HAMW42 SO3.aqt
Title: HAMW42 Slug Out 3
Date: 05/04/16
Time: 12:34:09

PROJECT INFORMATION

Company: Natural Resource Technology
Client: Dynegy
Project: 2365
Location: Havana
Test Well: HAMW42

AQUIFER DATA

Saturated Thickness: 85. ft
Anisotropy Ratio (Kz/Kr): 1.

SLUG TEST WELL DATA

Test Well: HAMW42

X Location: 0. ft
Y Location: 0. ft

Initial Displacement: 1.055 ft
Static Water Column Height: 19. ft
Casing Radius: 0.083 ft
Well Radius: 0.34 ft
Well Skin Radius: 0.34 ft
Screen Length: 10. ft
Total Well Penetration Depth: 17. ft

No. of Observations: 5

Observation Data

Time (sec)	Displacement (ft)	Time (sec)	Displacement (ft)
0.	1.055	0.663	0.252
0.22	0.936	1.14	0.006
0.441	0.616		

SOLUTION

Slug Test
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
ln(Re/rw): 2.301

VISUAL ESTIMATION RESULTS

Estimated Parameters

Parameter	Estimate	
K	0.06389	cm/sec
y0	2.133	ft

T = K*b = 165.5 cm²/sec

OBG

THERE'S A WAY