EPA SUBMITTAL

RCRA FACILITY INVESTIGATION WORK PLAN

APPENDICES

CHEVRON REFINERY

PHILADELPHIA, PENNSYLVANIA

APRIL 16, 1990

DAMES & MOORE

EPA SUBMITTAL
RCRA FACILITY INVESTIGATION WORK PLAN
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CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

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DAMES & MOORE

LIST OF APPENDICES

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APPENDIX A

WELL CONSTRUCTION DATA

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A1

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andreu Ivansiu

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

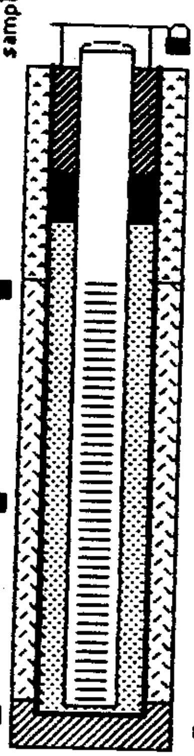
MEASUREMENTS (NGVD)

Top of Casing Elevation -	8.63'
Static Water Level Elevation -	3.08'
Date Measured -	1/9/87
Surface Elevation -	8.63'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)	*blows/ft	samples		Description
0			GM	Sandy gravel, strong petroleum odor
5	3	■	SW	Fine to coarse sand and fine to medium gravel, dark-gray, dry; (fill)
10	2	■		trace silt, trace to little clay, wet
15	2	■	CL	Silty sandy clay, light gray, wet
20				



Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer /Geologist Mark Robertson

Boring/Well No. -A2

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

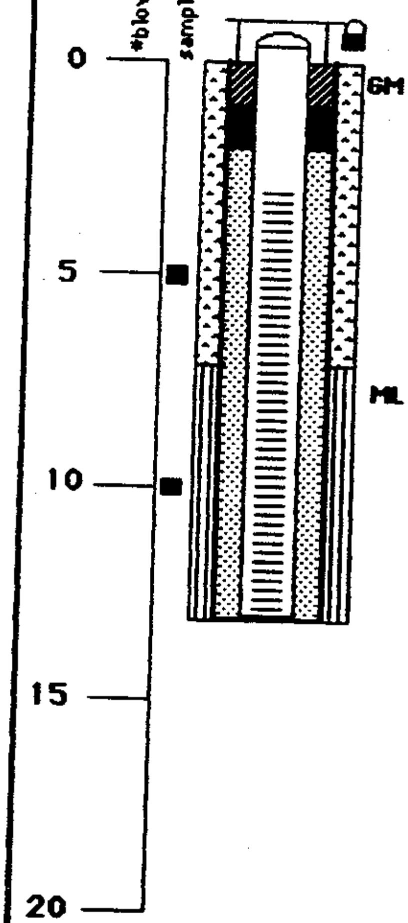
MEASUREMENTS (NGVD)

Top of Casing Elevation -	7.84'
Static Water Level Elevation -	6.12'
Date Measured -	1/9/87
Surface Elevation -	7.84'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



GM: Gravel with trace silty sand, black

decreasing gravel; (fill)

ML: Silt with some clay and trace peat, greenish-grey

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A3

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer /Geologist Mark Robertson

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

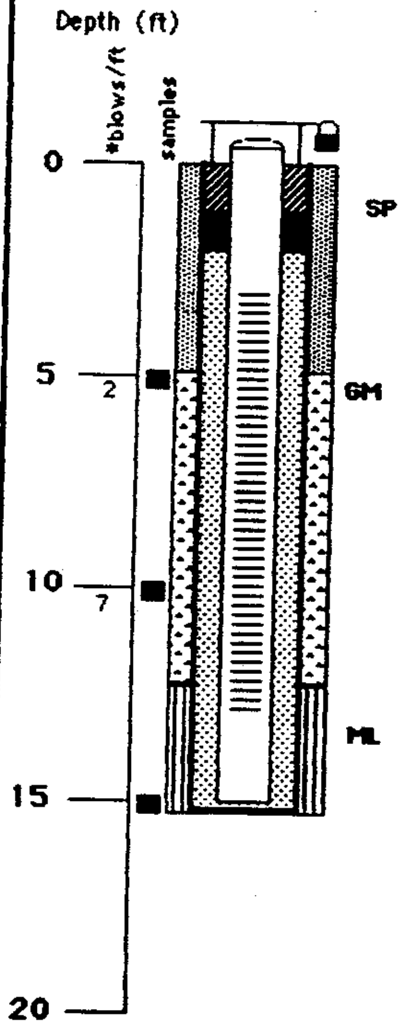
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.37'
Static Water Level Elevation -	5.26'
Date Measured -	1/9/87
Surface Elevation -	9.32'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Depth (ft)	*blows/ft		Description
0		SP	Sand with some gravel, trace silt, dark brown
5	2	GM	Sandy gravel, product visible, strong petroleum odor, black
10	7		trace silt and clay, grey
		ML	Clayey silt with trace sand, dark green
15			
20			

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

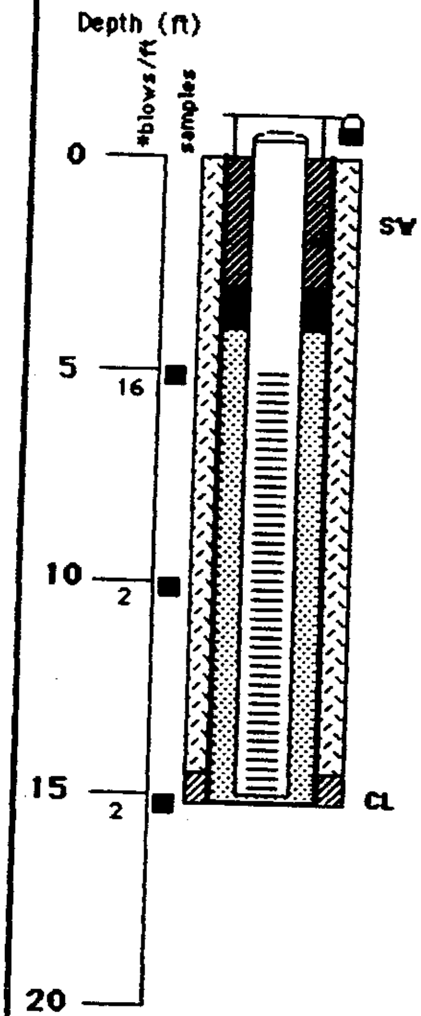
Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer /Geologist Andreu Ivansiu

Boring/Well No. - A4

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	7.06'
Static Water Level Elevation -	1.58'
Date Measured -	1/9/87
Surface Elevation -	6.90'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Depth	*blows/ft	USCS	Description
5	16	SW	Fine to coarse sand with some fine gravel, petroleum odor
10	2		trace clay, wet
15	2	CL	Silty clay, dark gray, moist

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A5

Project No.	113-909-032
Date M.W. completed	2/25/86
Supervising D & M Engineer/Geologist	Andrei Ivansiu

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	18'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	17'
Screen Setting -	4' - 17'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

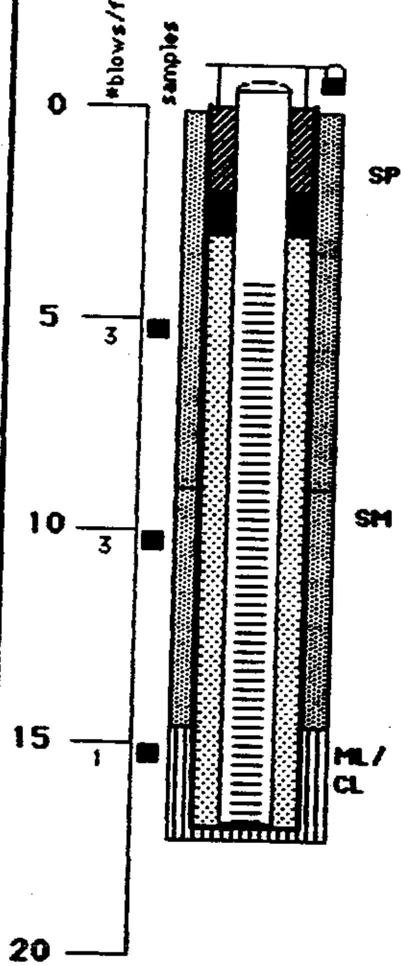
MEASUREMENTS (NGVD)

Top of Casing Elevation -	6.93'
Static Water Level Elevation -	Not Available
Date Measured -	1/9/87
Surface Elevation -	6.77'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Depth (ft)		Description
5	SP	Sandy gravel, dark grey, moist
10	SM	Silty sand, dark grey, moist, soft
15	ML/CL	Silty clay, soft, moist, dark gray

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andreu Ivansiu

Boring/Well No. - A6

Location -	Chevron Refinery
Driller -	Varren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

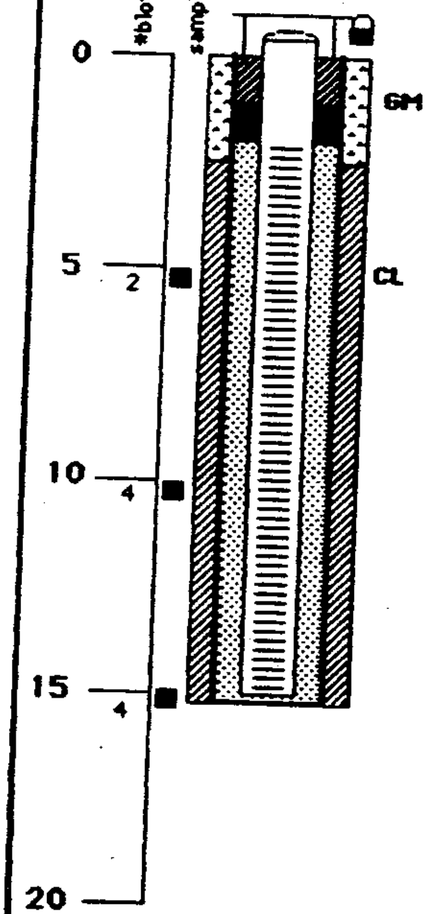
MEASUREMENTS (NGYD)

Top of Casing Elevation -	7.96'
Static Water Level Elevation -	3.25'
Date Measured -	1/9/87
Surface Elevation -	7.88'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft		Description
0–3		GM	Sandy gravel, dark grey
5	2	CL	Silty clay, dark grey, moist, soft
10	4		Clayey silt to silty clay with plant remnants, dark gray, moist, soft
15	4		trace coarse gravel

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

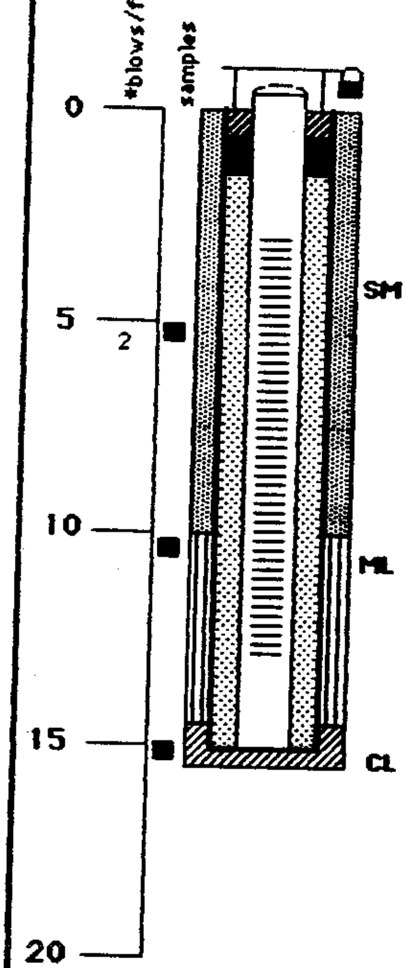
Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer /Geologist Mark Robertson

Depth (ft) | Description



SM Silty sand with gravel, dark grey-brown

ML Silty sand with trace gravel, gray, soft

CL Silty clay to clayey silt, gray

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

Boring/Well No. - A7

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.02'
Static Water Level Elevation -	4.95'
Date Measured -	1/9/87
Surface Elevation -	8.02'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A8

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

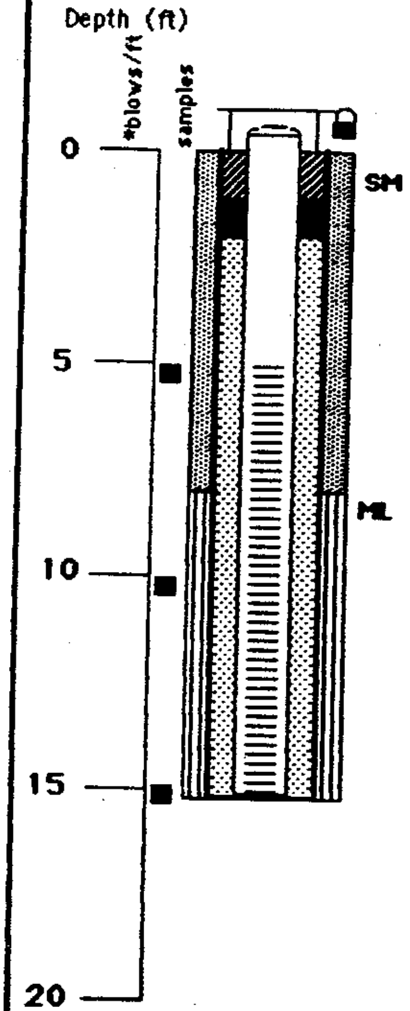
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	6.29'
Static Water Level Elevation -	1.04'
Date Measured -	1/9/87
Surface Elevation -	6.13'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

SM Silty to clayey sand with trace gravel, brown

grades to dark gray-brown

ML Grades to clayey silt, greenish-brown, soft

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A9

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' -13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

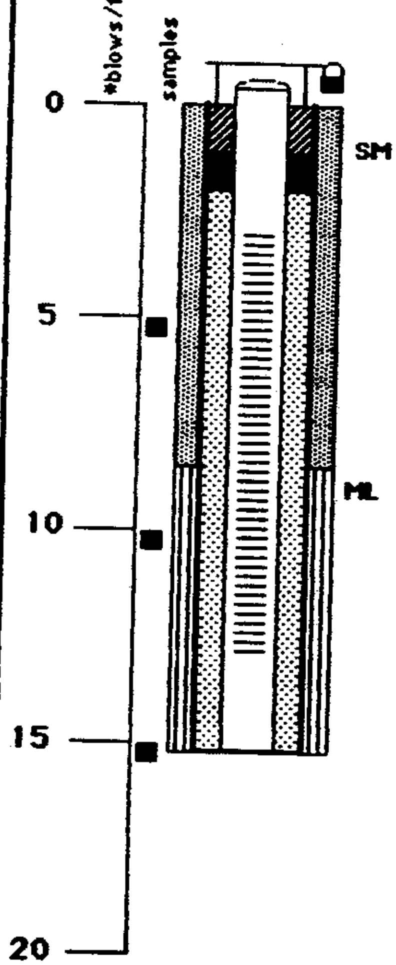
MEASUREMENTS (NGVD)

Top of Casing Elevation -	7.17'
Static Water Level Elevation -	3.23'
Date Measured -	1/9/87
Surface Elevation -	7.17'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



SM — Silty sand with some gravel, dark grey-brown

ML — Changes to clayey silt with trace sand and gravel, greenish-brown, soft

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A10

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

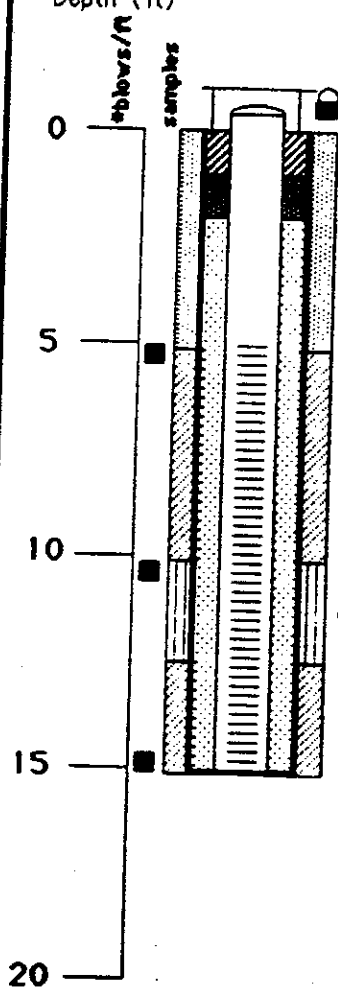
MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.48'
Static Water Level Elevation -	6.04'
Date Measured -	1/13/87
Surface Elevation -	9.40'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



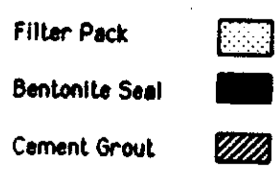
SM	Silty sand with trace gravel, brown, very soft
CL	Silty clay with trace fine to med. sand, dark gray, visible product with sheen, strong chemical oder, very soft
	grades to greenish-grey
ML/CL	Silty clay to clayey silt
CL	Silty clay, light gray

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY



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LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

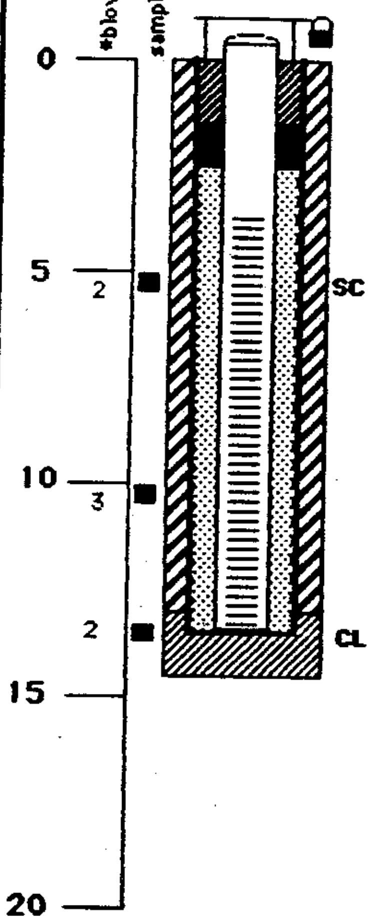
Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Andrei Ivansiu

Boring/Well No. - A11

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13' 6"
Screen Setting -	3' 6" - 13' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	5.89'
Static Water Level Elevation -	4.04'
Date Measured -	1/13/87
Surface Elevation -	5.57'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft	USCS	Description
5	2	SC	Silty sand with trace gravel, black; (fill)
10	3		Clayey sand with some pebbles, black, soft, loose
	2	CL	Silty clay, black, fine

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

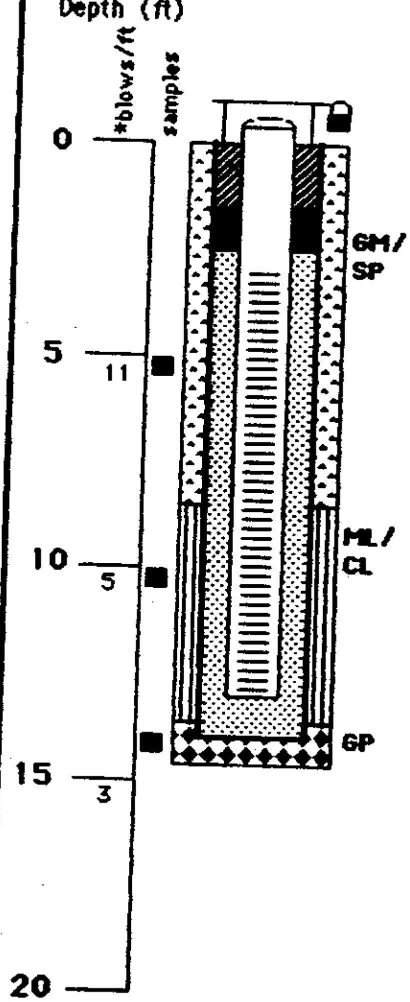
Date M.W. completed 2/24/86

Supervising D & M Engineer / Geologist: Andrei Ivansiu

Boring/Well No. - A12

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	6.14'
Static Water Level Elevation -	3.53'
Date Measured -	1/13/87
Surface Elevation -	5.90'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Depth	*blows/ft		Description
0–~8		GM/SP	Sandy gravel, dark grey
5	11		wet, loose, strong petroleum odor
~8–14	5	ML/CL	Silty clay to clayey silt, dark grey, wet
~14	3	GP	well washed

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

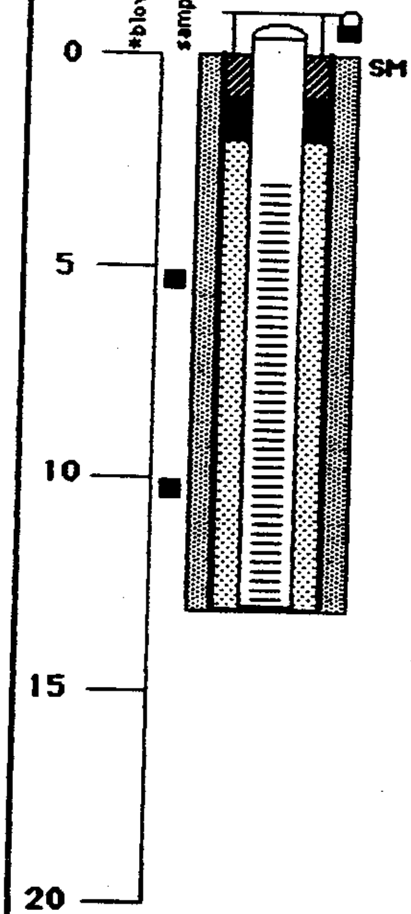
Date M.W. completed 2/27/86

Supervising D & M Engineer /Geologist Mark Robertson

Boring/Well No. -A13

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	7.91'
Static Water Level Elevation -	4.52'
Date Measured -	1/9/87
Surface Elevation -	7.83'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Silty sand with trace gravel, gray-brown

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A13D

Project No. 113-950-032

Date M.W. completed 11/13/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	11/13/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

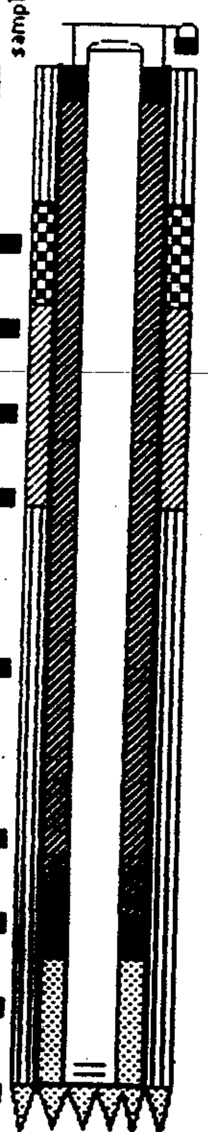
Borehole Diam. -	10"
Borehole Depth -	70'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	69'
Screen Setting -	59' - 69'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Bentonite

MEASUREMENTS(NGVD)

Top of Casing Elevation -	7.99'
Static Water Level Elevation -	-1.95'
Date Measured -	12/22/86
Surface Elevation -	8.10'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Depth (ft)	*blows/ft	samples		Description
0			ML	Silt with some fine to coarse sand, trace fine gravel, black, saturated; petroleum odor; petroleum residues present
10	7	■	GW	Fine gravel with some silt, little fine to coarse sand, black, loose, saturated; strong petroleum odor
	3	■	CL	Clay with little to some silt, dark gray, very soft, saturated; trace organics
20	2	■		Grading to dark brown
	3	■	ML	Increasing silt; silt with some clay
30				
	3	■		Grading to medium brown
40				
	3	■		Grading to brownish-gray
50	4	■		Trace mica
	7	■		Silt with little to some clay, trace fine to medium sand, gray, medium stiff, saturated; trace organics; very micaceous
60	19	■		

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

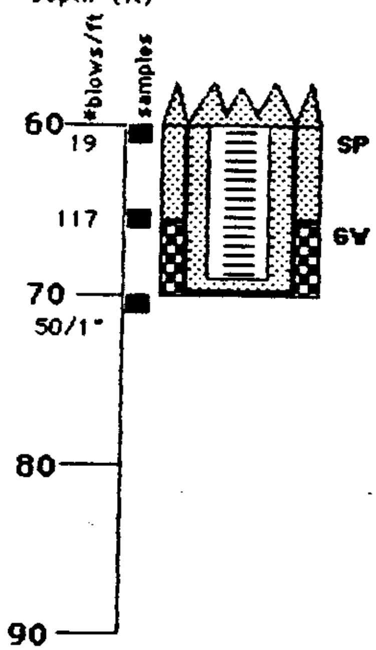
Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery	Boring/Well No. - A13D (Cont.)
Project No._ 113-950-032	Location - Chevron Refinery
Date M.W. completed 11/13/86	Driller - Lambert, Inc.
Supervising D & M Geologist David Wagner	Drilling Completed - 11/13/86
	Type of Rig - Hollow Stem Auger

Depth (ft) Description



SP — Fine sand with little to some medium sand, trace silt, reddish-brown, medium dense, saturated

GW — Fine to coarse gravel with some fine to coarse sand, reddish-brown, very dense, saturated

WELL CONSTRUCTION KEY
- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A14

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/26/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

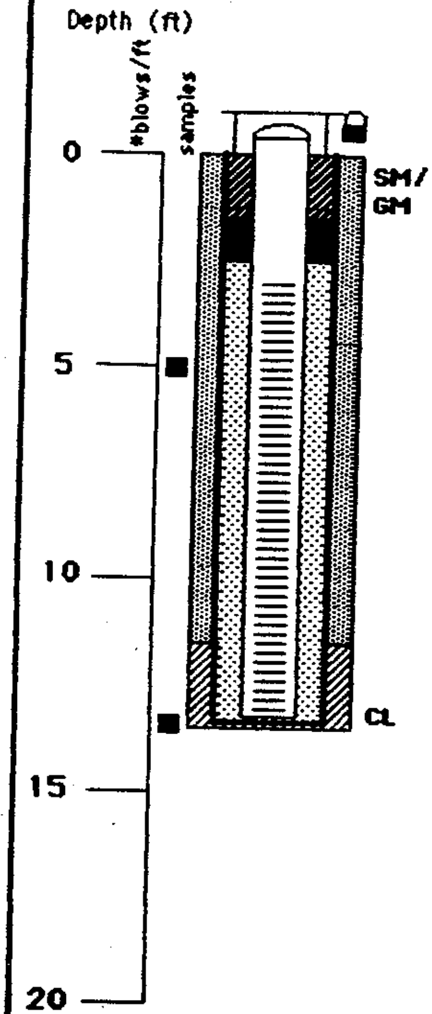
Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	8.55'
Static Water Level Elevation -	4.95'
Date Measured -	1/13/87
Surface Elevation -	8.55'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

SM/GM — Silty sand and gravel, brown

grades dark grey

gravel decreasing

very loose

CL — Silty clay with trace sand, light gray, wet

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

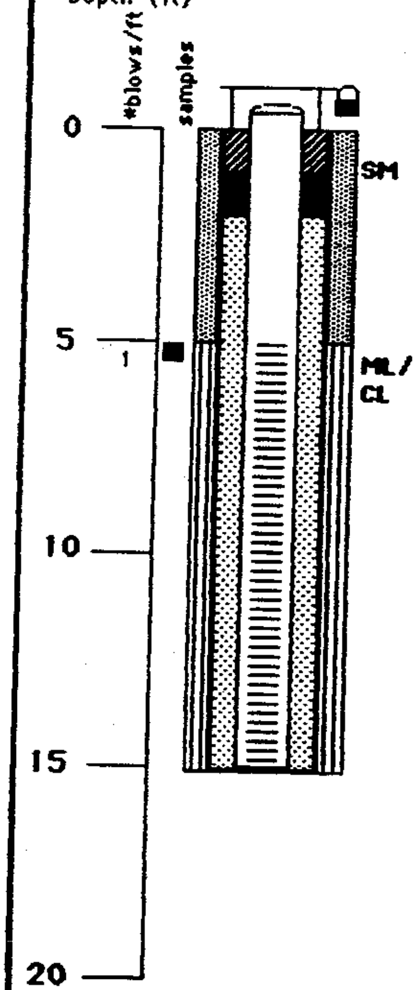
Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Depth (ft)

Description



Silty sand with gravel, brown

grades to black

Silty clay with trace sand, greenish-grey, very soft

trace peat

Boring/Well No. - A15

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	6.90'
Static Water Level Elevation -	6.48'
Date Measured -	1/13/87
Surface Elevation -	6.84'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A16

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	1'6" - 11'6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

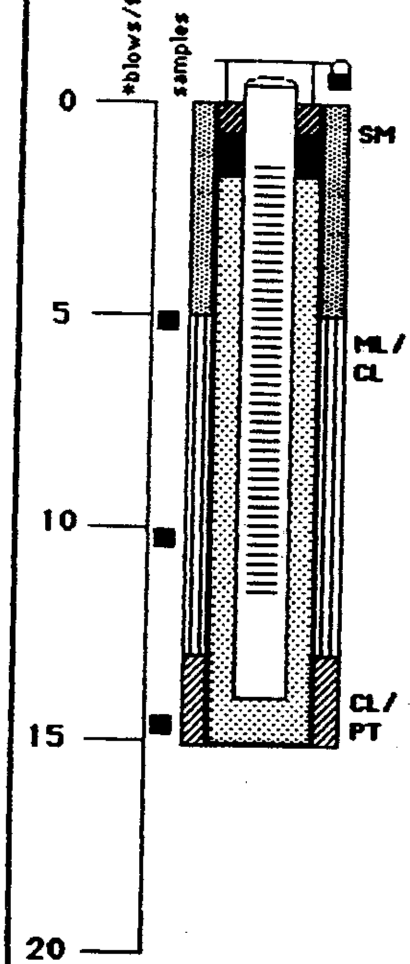
MEASUREMENTS (NGVD)

Top of Casing Elevation -	8.47'
Static Water Level Elevation -	6.33'
Date Measured -	1/13/87
Surface Elevation -	7.81'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SM — Silty sand with some gravel and cobbles, dark-grey

decreasing cobbles and gravel

ML / CL — Clayey silt, green

grades to greenish-brown

CL / PT — grades to silty clay and peat

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOO

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A17

Location - Chevron Refinery

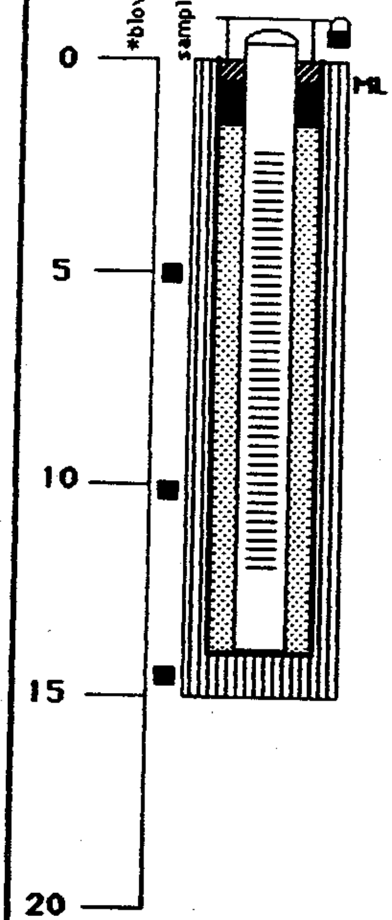
Driller - Warren George

Drilling Completed - 2/27/86

Type of Rig - Hollow Stem Auger

Depth (ft) *blows/ft samples

Description



Clayey silt with some fine gravel and sand, blackish-brown, moist, soft; petroleum odor

very moist, some wood debris, petroleum odor

increased moisture

saturated

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	2' - 12'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout - Cement/Bentonite	

MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.42'
Static Water Level Elevation -	6.02'
Date Measured -	1/13/87
Surface Elevation -	9.34'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

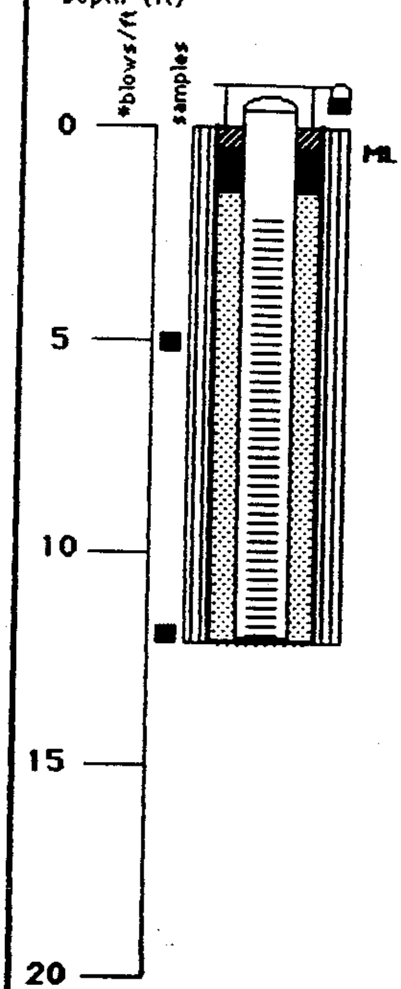
Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A18

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	12'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12'
Screen Setting -	2' - 12'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.52'
Static Water Level Elevation -	7.27'
Date Measured -	1/13/87
Surface Elevation -	9.35'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Clayey silt with some fine gravel and sand, blackish-brown, moist, soft; petroleum odor

very moist to wet, some wood debris, petroleum odor

increased moisture; wet to saturated

sample not collected

resistance; wood at 10'

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOI

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Ralph T. Golia

Boring/Well No. -A19

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	12'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	11'6"
Screen Setting -	1'6" - 11'6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

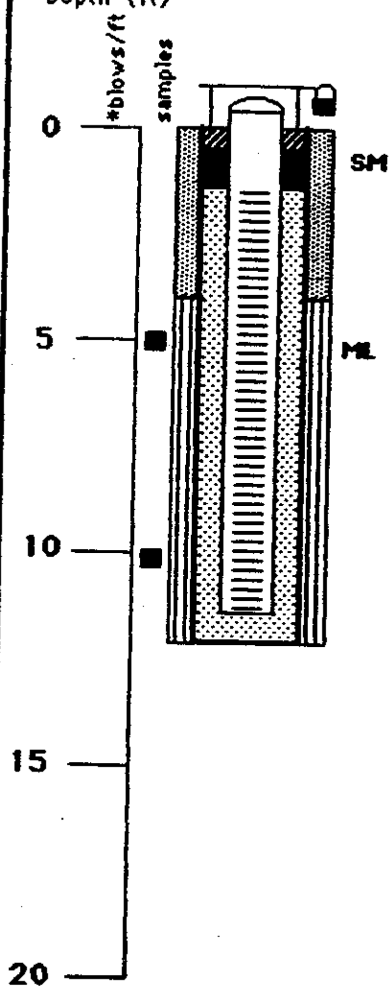
MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.52'
Static Water Level Elevation -	5.77'
Date Measured -	1/13/87
Surface Elevation -	9.28'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Asphalt

SM Silty sand with some gravel and trace clay, medium brown, damp, medium dense,(fill)

change to blackish-brown, slight petroleum odor

ML Clayey silt with trace sand, blackish-brown, wet to saturated, soft; petroleum oder

wood debris; resistance

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A19D

Project No. 113-950-032

Date M.W. completed 10/30/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/30/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	60'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	60'
Screen Setting -	50' - 60'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	2 Sand
Type of Grout -	Bentonite

MEASUREMENTS(NGVD)

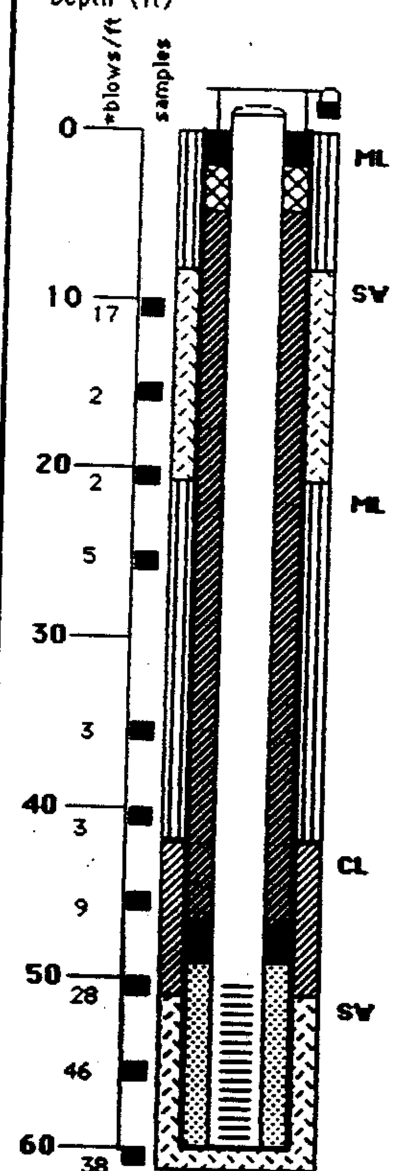
Top of Casing Elevation -	11.69'
Static Water Level Elevation -	-1.71'
Date Measured -	12/22/86
Surface Elevation -	8.69'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



ML Silt with some fine to coarse sand, trace clay, brown, soft, moist; petroleum odor
Grading to very dark gray, saturated

SW Fine to coarse sand with some fine gravel, little silt, blackish-gray, medium dense, saturated; resistance encountered - wood

ML Silt with some clay, dark gray, soft, moist; organics; micaceous; weak petroleum odor

SHELBY TUBE taken from 30' to 31.5'

Increasing clay; silt and clay

CL Clay with some silt and little fine sand, reddish-brown, soft, saturated, micaceous

SW Fine to coarse sand with some fine gravel, reddish-brown, medium dense, saturated
Grading to brownish-gray
Increasing density : dense
Increasing gravel: fine gravel and sand

WELL CONSTRUCTION KEY

FILTER PACK
BENTONITE SEAL
BENTONITE GROUT
CAVE IN MATERIAL
CONCRETE

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

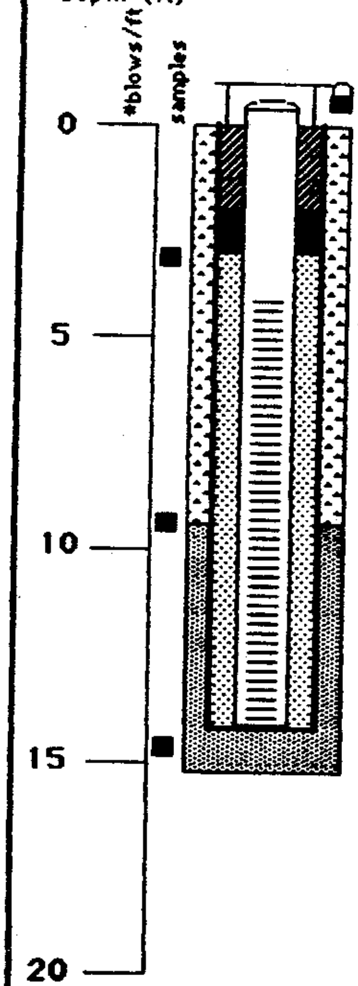
Date M.W. completed 2/24/86

Supervising D & M Engineer /Geologist Andreu Ivansiu

Boring/Well No. - A20

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4'-14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.81'
Static Water Level Elevation -	4.08'
Date Measured -	1/13/87
Surface Elevation -	8.73'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



GM	Silty to clayey fine sand, black, moist, soft, petroleum odor
SP	Sand with some pebbles, black, wet, petroleum oder

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

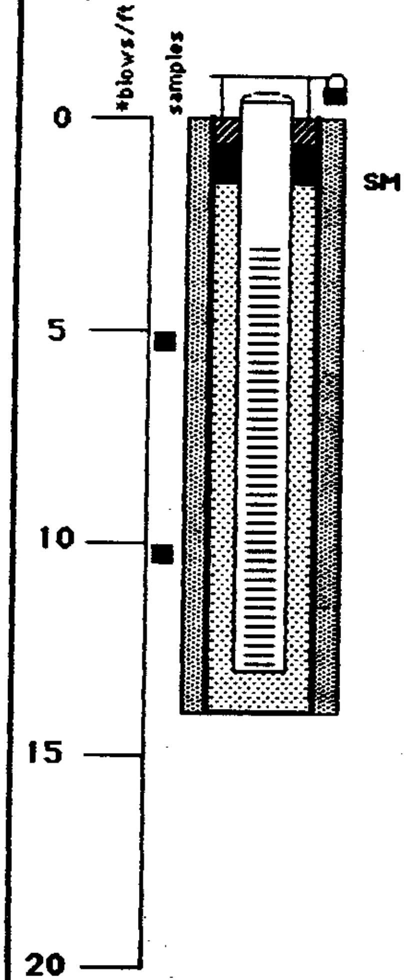
Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A21

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.84'
Static Water Level Elevation -	Not Available
Date Measured -	1/13/87
Surface Elevation -	9.02'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



SM Silty sand with some gravel and cobble

grades to black, strong petroleum odor

decreasing gravel and cobbles

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOO

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A21D

Project No. 113-950-032

Date M.W. completed 10/28/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/28/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	85'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	85'
Screen Setting -	75' - 85'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

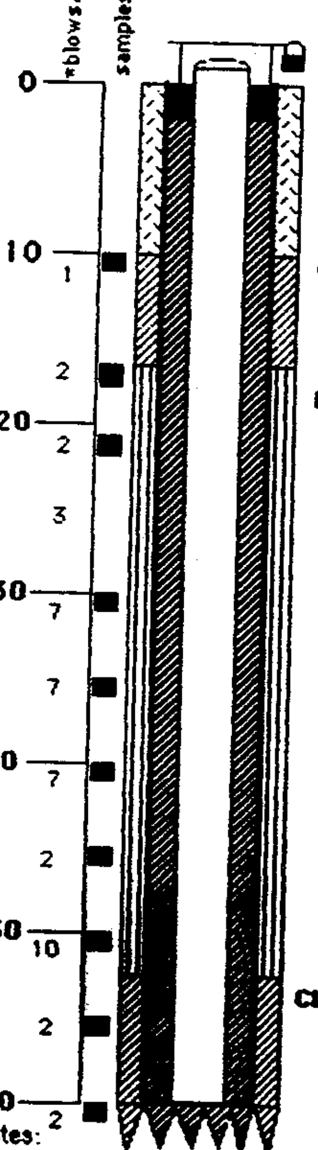
MEASUREMENTS(NGVD)

Top of Casing Elevation -	12.18'
Static Water Level Elevation -	-4.13'
Date Measured -	12/22/86
Surface Elevation -	8.48'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



SW Fine to coarse sand with some silt, little fine gravel, very dark brown, soft, very moist; wood debris, brick, wire, etc.; petroleum odor; oily

CL Clay with little silt, trace fine sand, very dark brown, soft, saturated; very strong petroleum odor; oily

ML Silt with some clay, trace fine sand, medium gray, soft, saturated; trace mica; trace organics; petroleum odor

Decreasing clay; little clay, weak petroleum odor

SHELBY TUBE taken from 19' to 21'

Decreasing clay and increasing fine sand; trace to little clay, little fine sand

2" sand lense at 36'; fine to medium sand with little clay, medium gray, trace mica

Silt with little to some clay, little fine sand, dark gray, soft, saturated; wood debris

Increasing clay and decreasing fine sand; some clay, trace fine sand

Decreasing clay : little clay

No petroleum odor

CL Clay with little silt, dark gray, soft, saturated; trace mica

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE/CEMENT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - A21D **(Cont.)**

Project No. 113-950-032

Date M.W. completed 10/28/86

Supervising D & M Geologist David Wagner

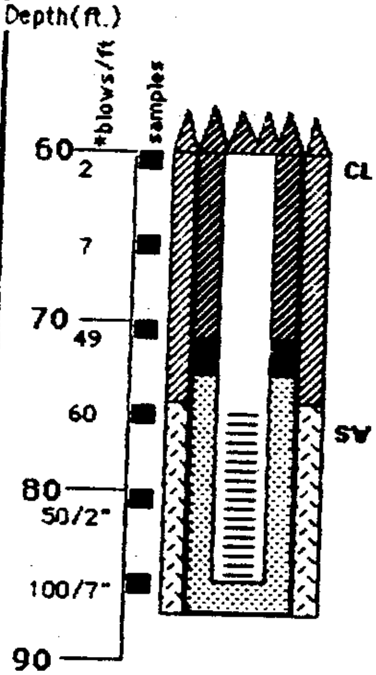
Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/28/86

Type of Rig - Hollow Stem Auger

Depth(ft.) Description



Increasing silt: some silt

6" lense of fine to medium sand with little coarse sand at 66', grayish-brown, saturated

Clay with some silt, trace to little fine sand, dark-gray, soft, saturated

Little to some fine gravel and little fine to coarse sand

Fine to coarse sand with some fine gravel, brownish-gray, very dense, saturated

Fine to coarse sand with some fine gravel, trace clay(white), very light gray, very dense, saturated

Weathered bedrock: Wissahickon Schist

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE/CEMENT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. -A22

Project No.	113-909-032
Date M.W. completed	2/26/86
Supervising D & M Engineer /Geologist	Mark Robertson

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/26/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

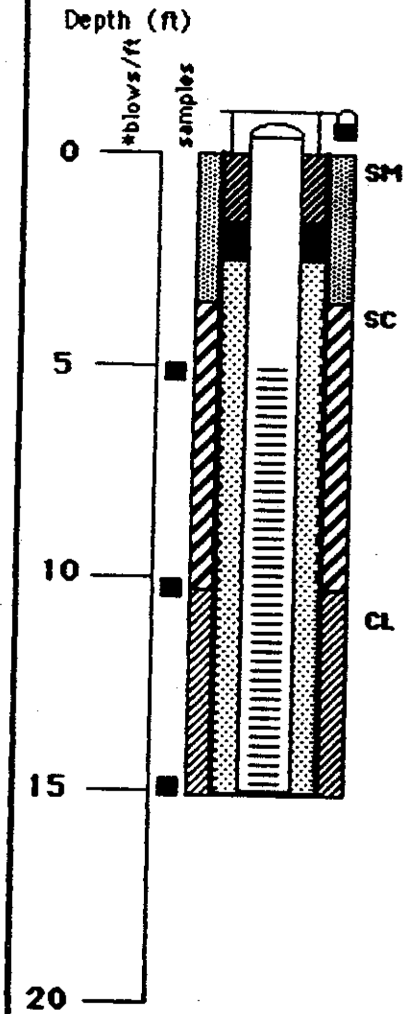
Top of Casing Elevation -	9.02'
Static Water Level Elevation -	1.71'
Date Measured -	1/13/87
Surface Elevation -	8.78'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



SM — Silty sand with trace gravel, discolored, strong petroleum odor

SC — Silty to clayey fine to coarse sand with trace fine gravel, petroleum odor

CL — Silty clay, gray, petroleum odor

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

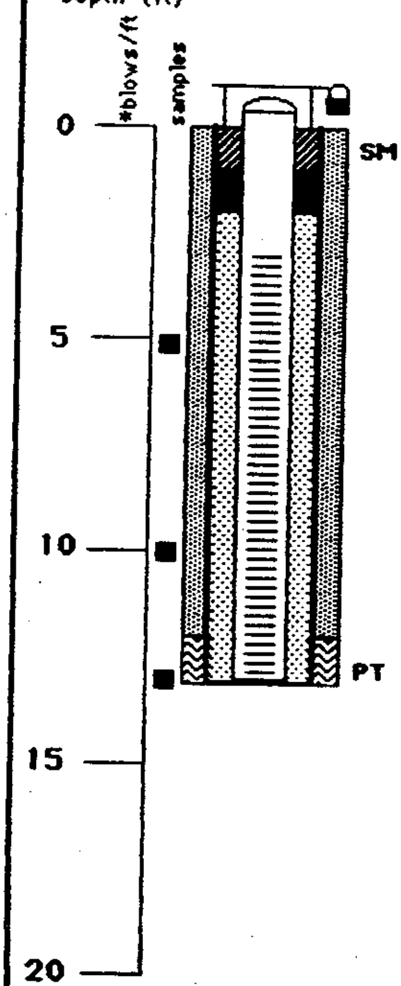
Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A23

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	4.71'
Static Water Level Elevation -	4.31'
Date Measured -	1/13/87
Surface Elevation -	4.71'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SM — Silty sand with some gravel and mica flakes, light brown

grades to dark brown with trace gravel, very soft

grades to grey-brown

PT — Fibrous peat

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - A24

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	14' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14' 6"
Screen Setting -	2' - 12'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

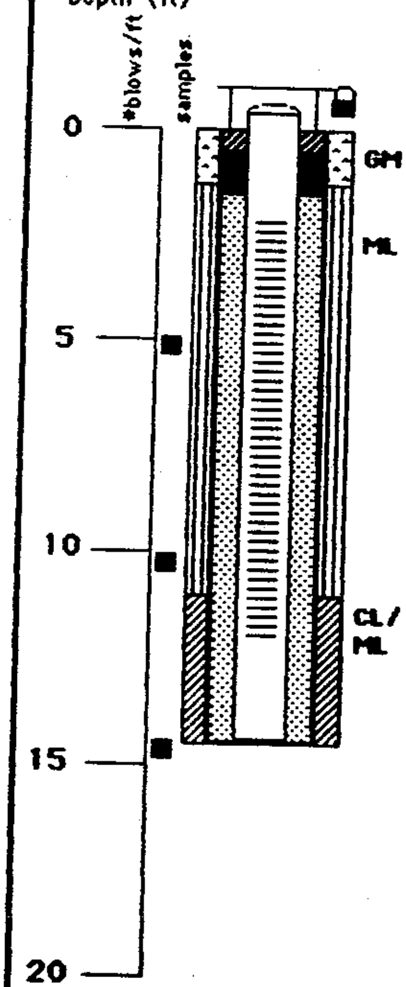
Top of Casing Elevation -	6.54'
Static Water Level Elevation	3.78'
Date Measured -	1/9/87
Surface Elevation -	6.46'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



GM Silty sand with gravel, brown

ML Silt with some sand, black, discolored, strong odor

CL/ML Silty clay with trace sand, green, medium stiff

grades to brown with some peat fibers

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. -A25

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

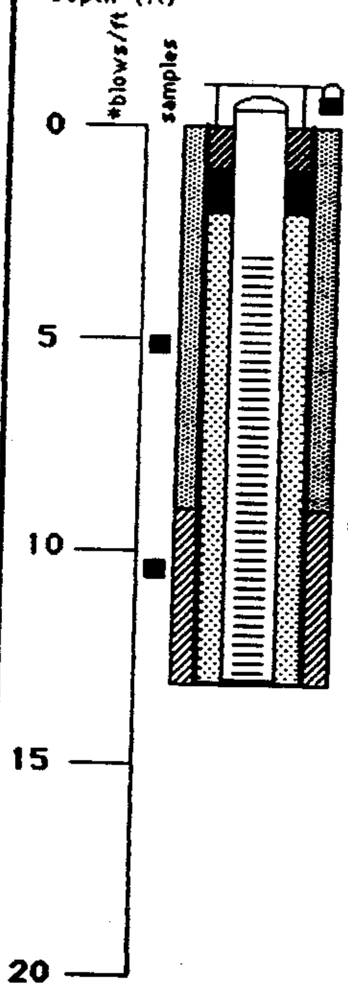
MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.46'
Static Water Level Elevation -	5.16'
Date Measured -	1/13/87
Surface Elevation -	10.38'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SM Silty sand with trace gravel, brown

decreasing sand and gravel

very moist

CL Silty clay, grey

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer /Geologist Ralph T. Golia

Boring/Well No. -A26

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3'6" - 13'6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

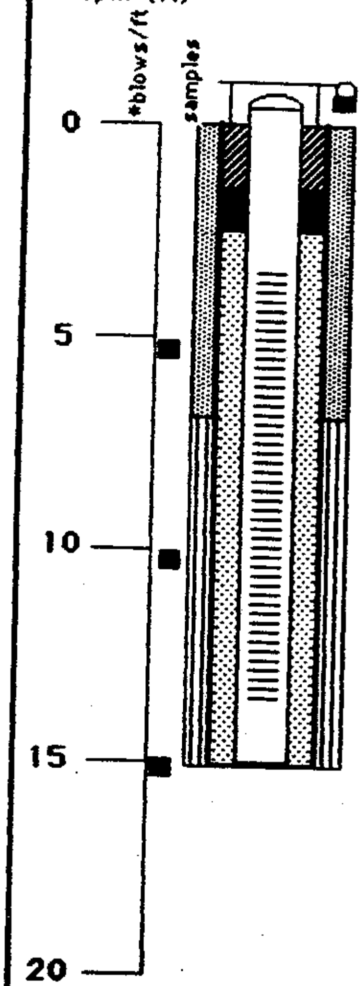
MEASUREMENTS (NGVD)

Top of Casing Elevation -	11.38'
Static Water Level Elevation -	4.23'
Date Measured -	1/13/87
Surface Elevation -	11.24'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Asphalt

SP Gravelly sand with trace silt and clay, reddish-brown, damp, medium dense; fill

change to dark brown

moist to very moist

ML/CL Clayey silt to silty clay, blackish-brown, wet to saturated, soft; slight petroleum oder

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/27/86

Supervising D & M Engineer /Geologist Ralph T. Golia

Boring/Well No. -A27

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/27/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5'-15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

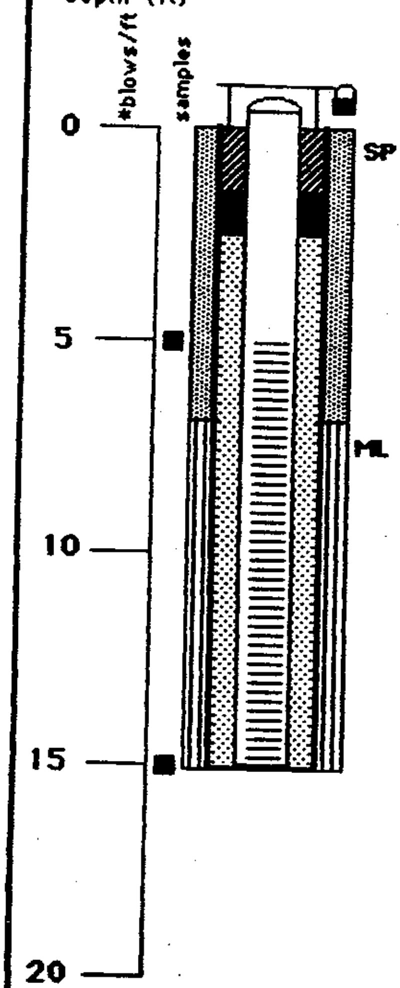
Top of Casing Elevation -	12.08'
Static Water Level Elevation -	3.84'
Date Measured -	1/13/87
Surface Elevation -	11.58'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



Gravelly sand with trace silt and clay, reddish-brown, damp, medium dense

change to dark brown

moist to very moist

Clayey silt to silty clay with trace wood, blackish-brown, wet to saturated, soft; slight petroleum odor, wood

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - A91

Project No.– 113-950-032

Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3'-13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

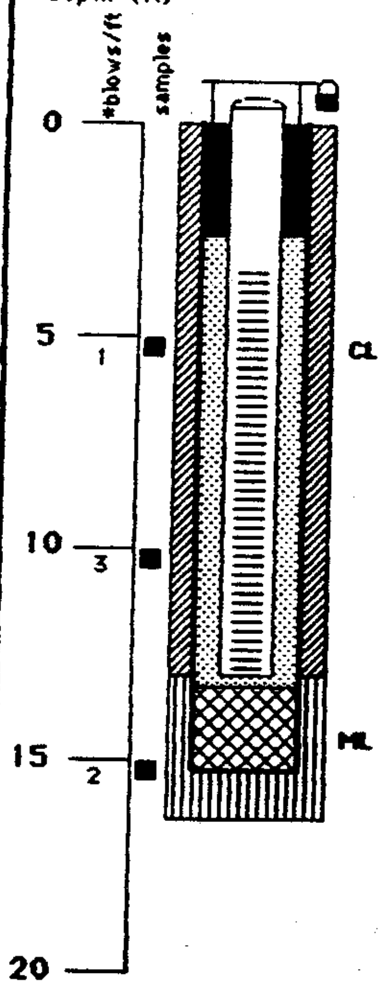
MEASUREMENTS(NGVD)

Top of Casing Elevation -	10.85'
Static Water Level Elevation -	5.93'
Date Measured -	1/14/87
Surface Elevation -	7.85'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



CL — Clay with some silt, blackish-brown, very soft, saturated; organics; petroleum odor

Decreased clay; silt and clay

ML — Inceased silt; silt with some clay; weak petroleum odor

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

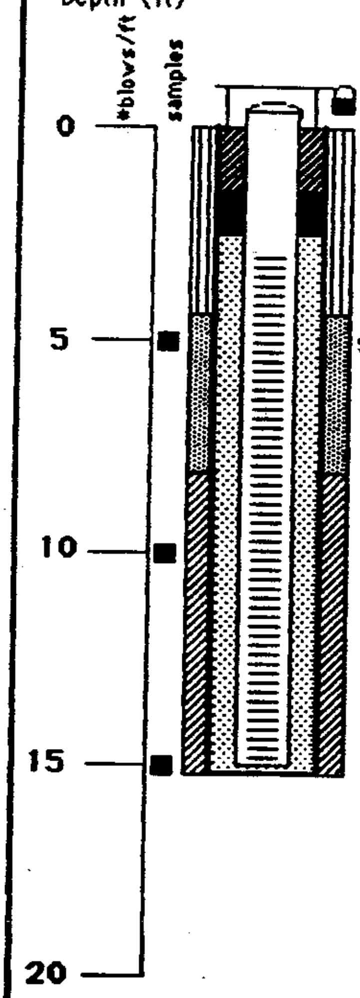
Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B39

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3'-15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.73'
Static Water Level Elevation -	6.68'
Date Measured -	1/13/87
Surface Elevation -	8.33'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Depth (ft)	Class	Description
0	ML	Sandy silt with trace clay, black-brown-grey, very moist, loose
5	SM	Silty sand with some gravel visible product, black-brown, oily
10	CL	Silty clay with clay lenses, black-brown, organic content increasing toward bottom; wood fragments
		increasing silt

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - B40

Project No.	113-909-032
Date M.W. completed	2/18/86
Supervising D & M Engineer/Geologist	Mark Robertson

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/18/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

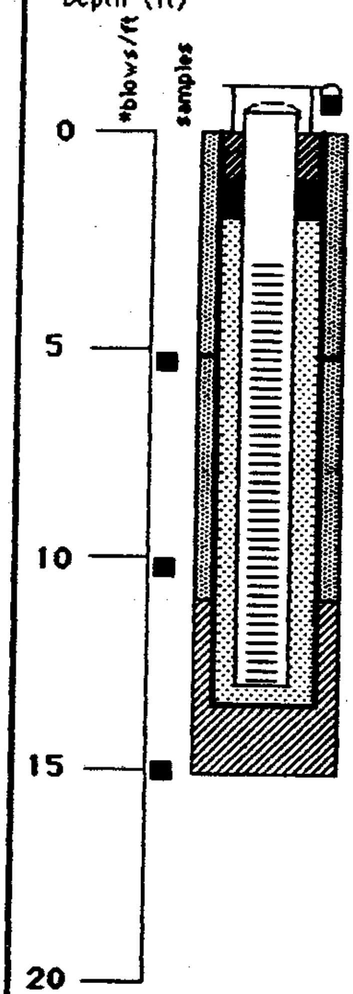
MEASUREMENTS (NGVD)

Top of Casing Elevation -	7.17'
Static Water Level Elevation -	5.56'
Date Measured -	1/13/87
Surface Elevation -	7.17'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SM — Silty sand with trace cobbles, brown; petroleum odor

changes to dark gray

SP — Sandy gravel with trace silt and clay, dark gray, wet

CL/ML — Clayey silt with trace sand and fibrous peat, brown, soft

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B41

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12'
Screen Setting -	2' - 12'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

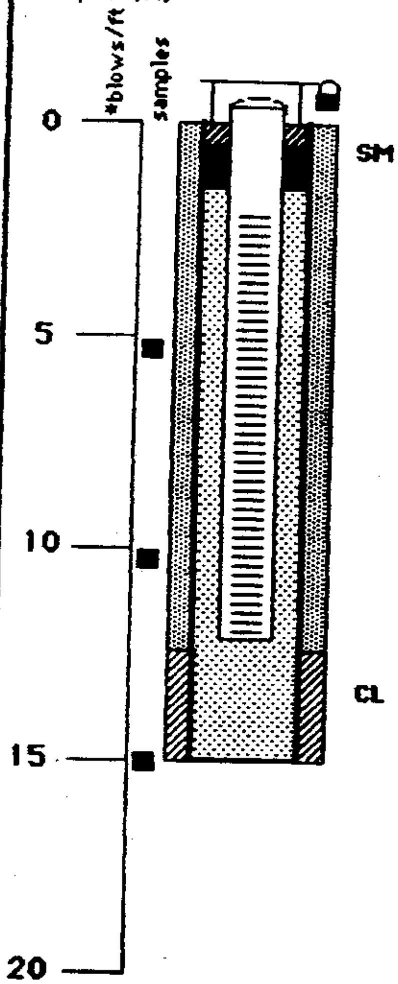
MEASUREMENTS (NGVD)

Top of Casing Elevation -	8.85'
Static Water Level Elevation-	6.77'
Date Measured -	1/13/87
Surface Elevation -	8.78'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



SM Silty sand with some gravel, brown

grades to black

CL Silty clay with trace peat, grades to brown

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOI

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

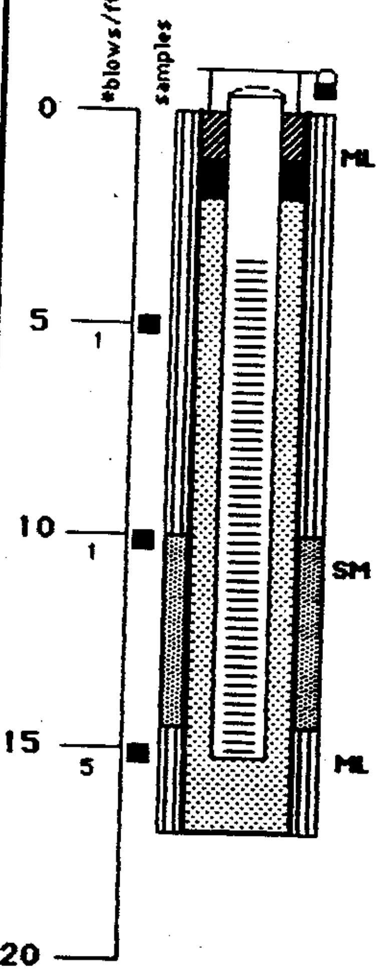
Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B42

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	2.5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.04'
Static Water Level Elevation-	7.11'
Date Measured -	1/13/87
Surface Elevation -	8.04'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Silt with some sand and cobbles, dark grey, very soft; petroleum odor

Clayey silt with trace sand and wood, greenish -grey, very soft

Grades to silty sand with trace gravel, dark grey-brown

Silt, laminated, greenish brown, medium stiff

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/19/85

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B43

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14.5'
Screen Setting -	3' - 14.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

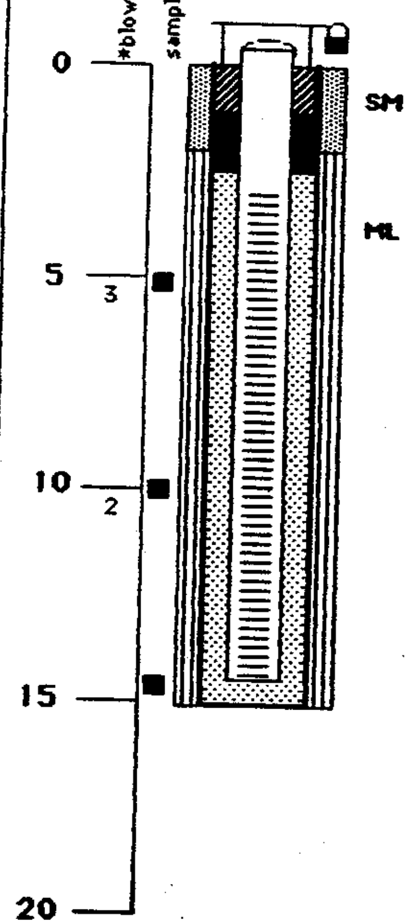
MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.36'
Static Water Level Elevation -	4.30'
Date Measured -	1/13/87
Surface Elevation -	9.28'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth	Class	Description
0	SM	Silty sand with some pebbles and cobbles, black-brown, moist; (fill)
	ML	Silty clay, with coarse sand, black-brown, fairly moist; brick fragments, (fill)
		very moist
		Silty to sandy clay, black-brown; (fill)
		mica flakes

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION DETAILS

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

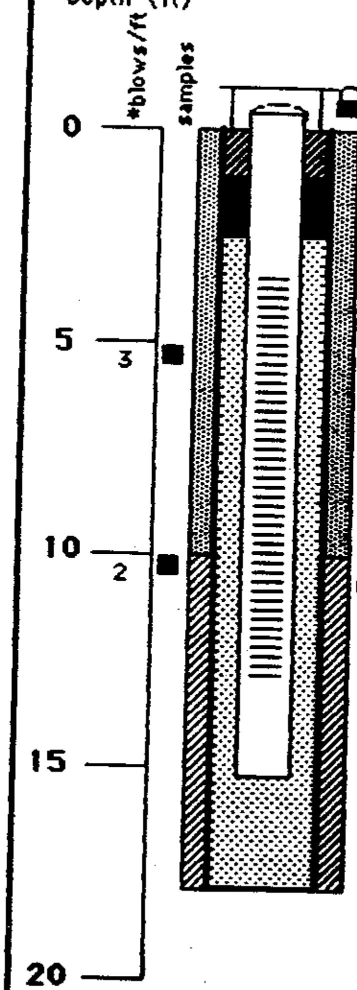
Date M.W. completed 2/20/86

Supervising D & M Engineer /Geologist Blake Moyer, Jr.

Boring/Well No. - B44

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.21'
Static Water Level Elevation -	6.16'
Date Measured -	1/13/87
Surface Elevation -	7.97'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)



Description

SP/SM — Medium to coarse silty sand with trace gravel, brownish-black, slightly moist, soft; gasoline odor; (fill)

CL — Silty clay with trace organic matter, greyish-brown, very moist, very soft

brownish-black

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer / Geologist Blake Moyer, Jr.

Boring/Well No. - B45

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

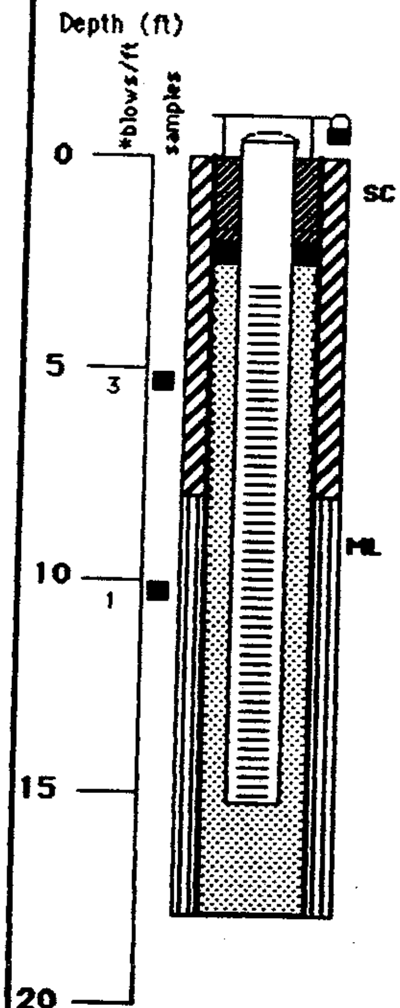
MEASUREMENTS (NGVD)

Top of Casing Elevation -	7.30'
Static Water Level Elevation -	5.70'
Date Measured -	1/13/87
Surface Elevation -	6.98'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Sandy clay with fine to medium, silt and gravel, black, very moist to wet, soft; (fill)

Silty clay to clayey silt with trace fine sand, brownish-black, very moist to wet, very soft;

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - B46

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	2' - 12'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

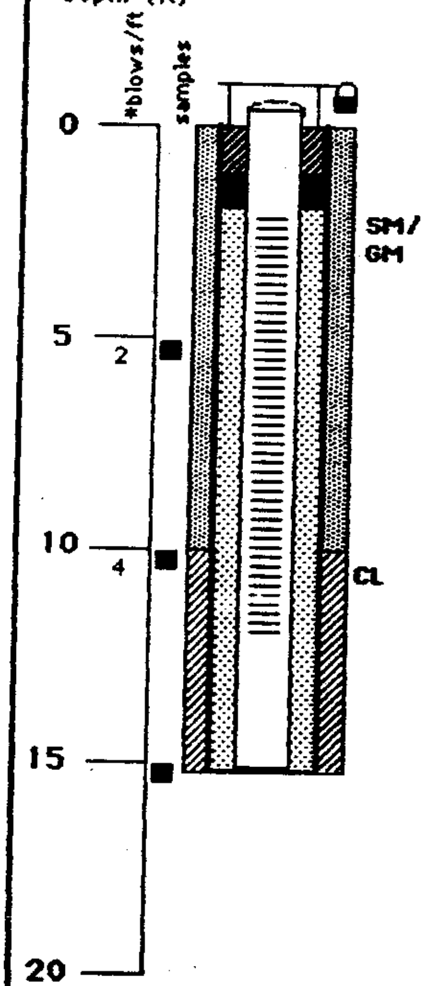
MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.56'
Static Water Level Elevation -	9.03'
Date Measured -	1/13/87
Surface Elevation -	10.47'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Silty sand to sandy silt, with trace gravel, brownish-grey, wet to saturated

Grading to silty sand with gravel, brownish-grey, saturated

Silty clay, grey-brown, saturated

trace organics

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer /Geologist David Wagner

Boring/Well No. - B47

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

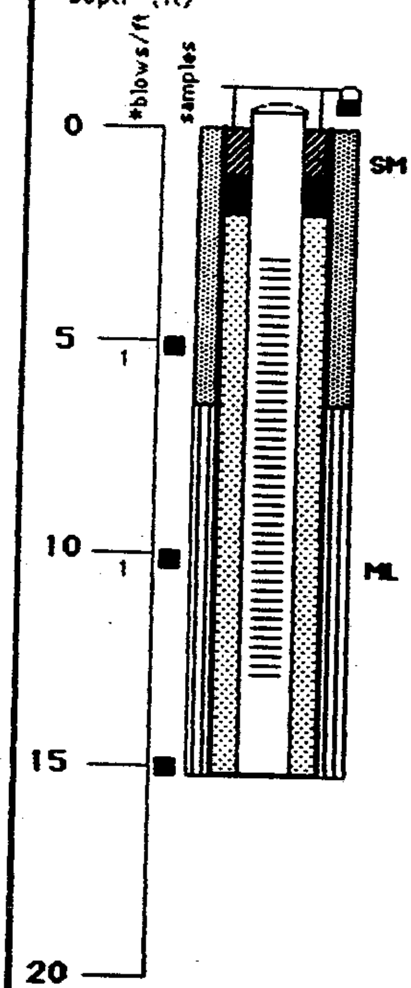
MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.56'
Static Water Level Elevation -	7.28'
Date Measured -	1/13/87
Surface Elevation -	10.32'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



SM — Silty sand with trace gravel, brown, moist, loose

changes to grey-brown, very moist

trace mica flakes

ML — Sandy silt with sand lense and trace clay, very moist

wet to saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

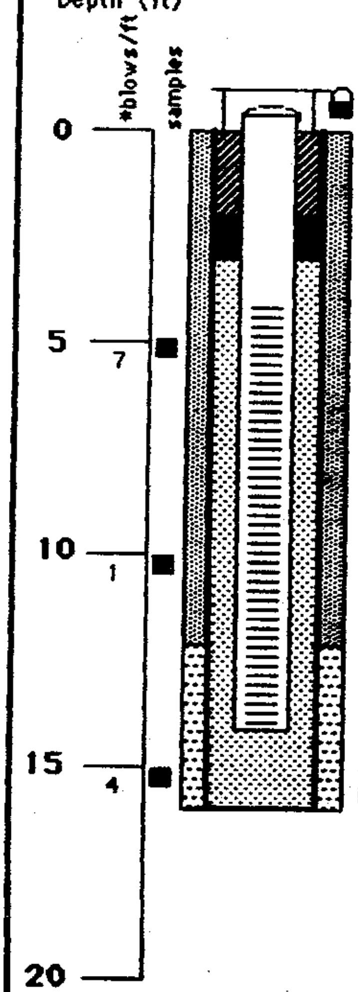
Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Mark Robertson

Boring/Well No. - B48

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/21/86
Type of Rig	Hollow Stem Auger

Depth (ft) | Description



Depth (ft)	Class	Description
0	SM	Silty sand with trace gravel, brown, petroleum odor
		grades to dark grey
5		trace gravel and clay
10		very soft
15	OH/PT	Silty sand and fibrous peat

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	8.90'
Static Water Level Elevation -	8.35'
Date Measured -	1/13/87
Surface Elevation -	8.90'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - B48D

Project No. 113-950-032

Date M.W. completed 11/6/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	11/6/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	55'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	55'
Screen Setting -	45' - 55'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

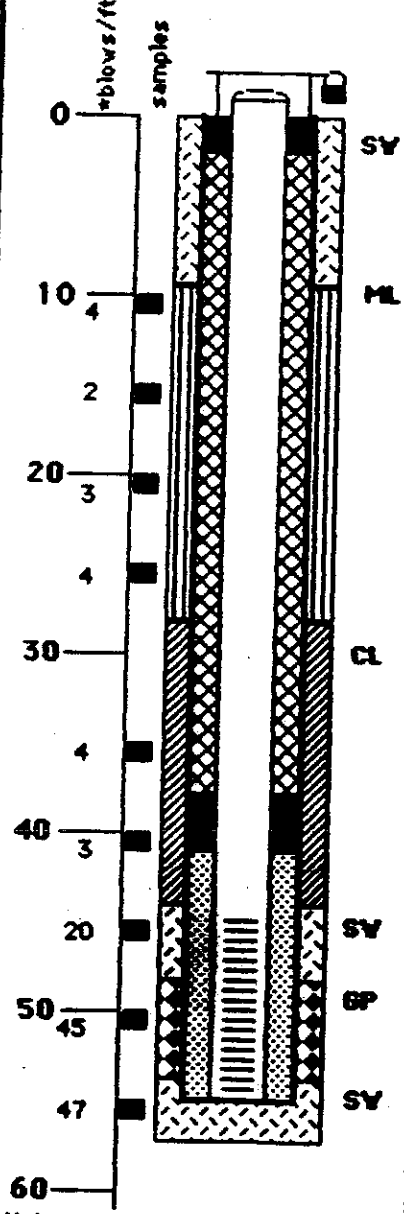
MEASUREMENTS(NGVD)

Top of Casing Elevation -	9.82'
Static Water Level Elevation -	-2.17'
Date Measured -	12/22/86
Surface Elevation -	8.90'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



SW — Fine to coarse sand with little to some fine gravel, little clay and silt, very dark brown, soft, saturated; strong petroleum odor

ML — Silt with little clay, very dark brown, soft, very moist; micaceous; strong petroleum odor

Increasing clay; some clay with abundant organics

Increasing clay; silt and clay

Decreasing clay; some clay and trace fine sand; organics; weak petroleum odor

CL — Clay with some silt, dark gray, soft, very moist; organics; very weak petroleum odor
SHELBY TUBE taken from 30' to 31.5'

SW — Fine to coarse sand with some fine gravel, trace silt, reddish-brown, medium dense, saturated

GP — Fine gravel with little to some fine to coarse sand, trace silt and clay, dark reddish-brown, dense, saturated; micaceous

SW — Fine to coarse sand with some fine gravel, light reddish-brown to light reddish-gray, dense, saturated

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - B92

Project No. 113-950-032

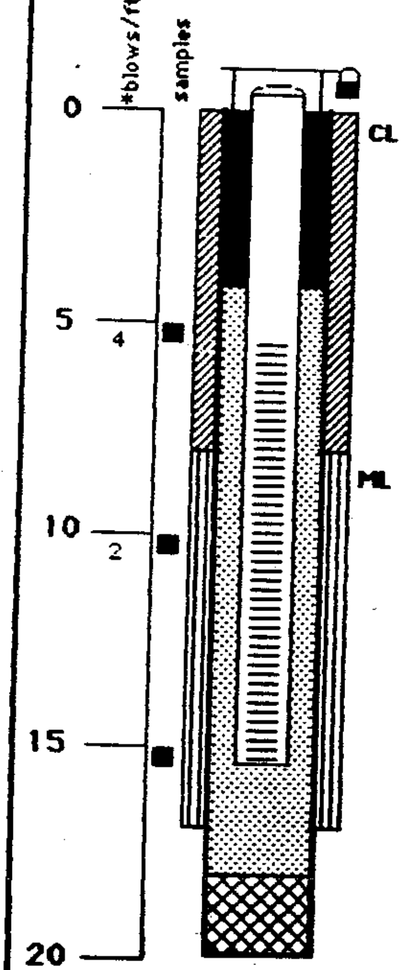
Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/21/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15.5'
Screen Setting -	5.5' - 15.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	
MEASUREMENTS(NGVD)	
Top of Casing Elevation -	12.33'
Static Water Level Elevation -	7.19'
Date Measured -	1/14/87
Surface Elevation -	9.33'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



CL — Clay with little silt, trace fine sand, blackish - brown, very soft, saturated; organics; petroleum odor

ML — Increased silt; silt with some clay

Decreased clay; little to some clay

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - B93

Project No. 113-950-032

Date M.W. completed 10/22/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/22/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13.5'
Screen Setting -	3.5' - 13.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	-

MEASUREMENTS (NGVD)

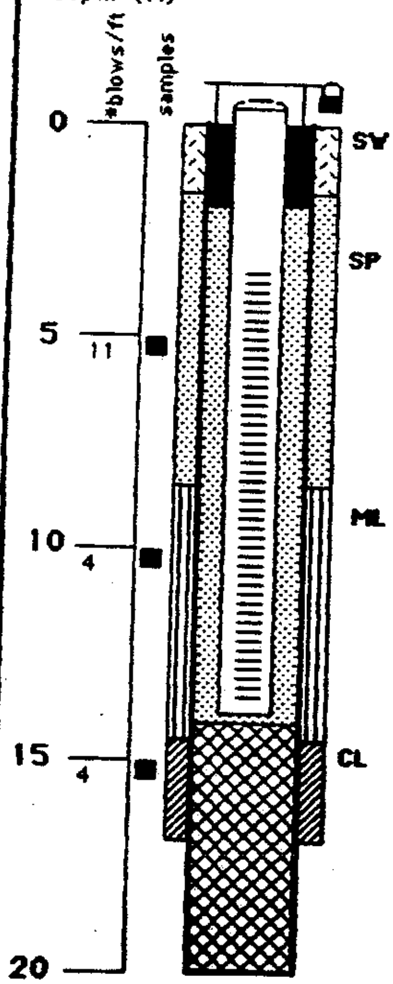
Top of Casing Elevation -	12.83'
Static Water Level Elevation -	7.79'
Date Measured -	1/14/87
Surface Elevation -	9.83'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



	Description
SW	Fine to coarse sand with little silt and little to some fine gravel, very dark brown, loose, slightly moist
SP	Fine to medium sand with little coarse sand and little silt, blackish - brown, medium dense, saturated; micaceous; petroleum odor; sheen on water
ML	Silt with little to some clay, dark - brownish - gray, soft, saturated; micaceous; weak petroleum odor
CL	Increased clay; clay with little to some silt

WELL CONSTRUCTION KEY

FILTER PACK
BENTONITE SEAL
CONCRETE
CAVE IN MATERIAL

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - B94

Project No. 113-950-032

Date M.W. completed 10/22/86

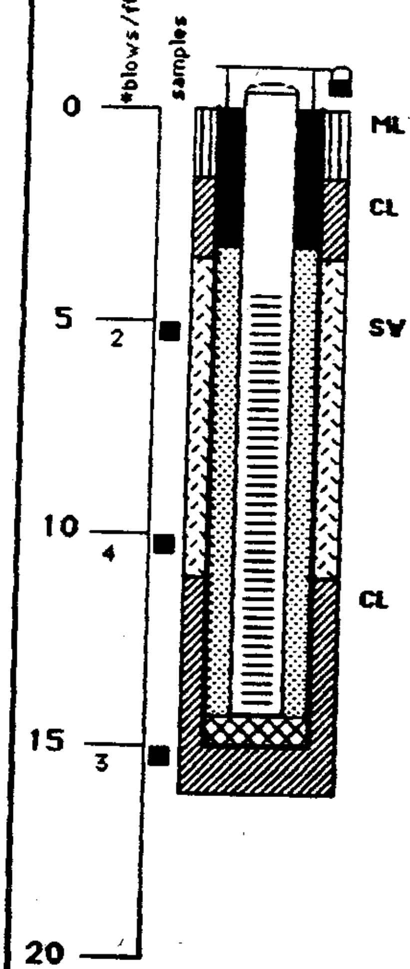
Supervising D & M Geologist David Wagner

Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/22/86

Type of Rig - Hollow Stem Auger



Description

ML Silt and fine to coarse sand and fine gravel, dark gray, loose, moist

CL Clay with little to some silt, trace fine to medium sand, dark gray, soft, moist; micaceous

SW Fine to coarse sand with fine gravel, little silt, trace clay, dark brown, loose, saturated; weak petroleum odor; sheen on water

CL Clay with some silt, dark gray, soft, saturated; micaceous

CONSTRUCTION DATA

Borehole Diam. - 10"

Borehole Depth - 15'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 14'

Screen Setting - 4' - 14'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout -

MEASUREMENTS (NGVD)

Top of Casing Elevation - 11.21'

Static Water Level Elevation - 5.11'

Date Measured - 1/14/87

Surface Elevation - 8.03'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

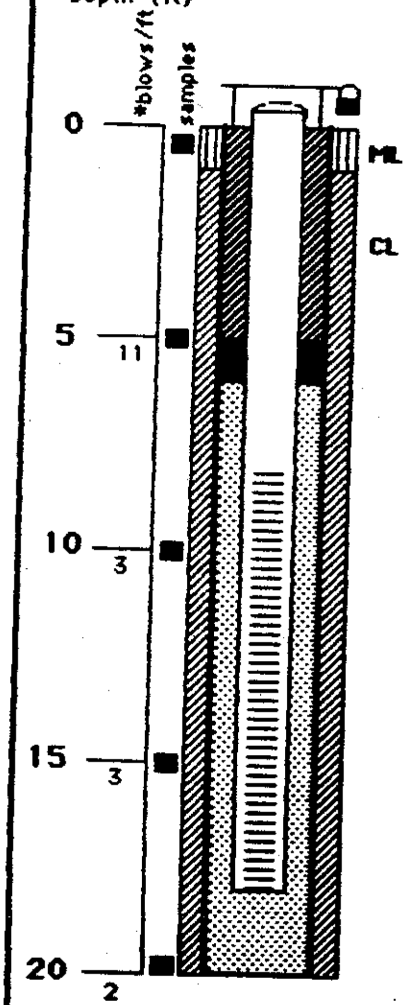
Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/22/86

Supervising D & M Engineer/Geologist T. Helgason

Depth (ft)



Description

Gravelly silt with trace brick fragments, brown

Silty clay with some fine sand, greyish-brown, slightly moist

petroleum odor, decomposed material

trace coarse sand, wet

Boring/Well No. - C49

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/22/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	18'
Screen Setting -	8' - 18'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	12.16'
Static Water Level Elevation -	5.94'
Date Measured -	1/13/87
Surface Elevation -	10.92'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

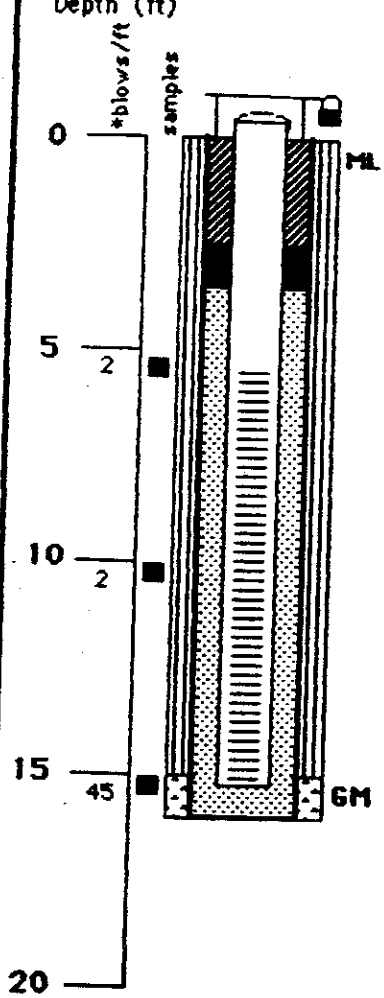
Date M.W. completed 2/22/86

Supervising D & M Engineer/Geologist E.J. Fillo

Boring/Well No. - C50

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/22/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15' 6"
Screen Setting -	5' 6" - 15' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	15.35'
Static Water Level Elevation-	4.71'
Date Measured -	1/13/87
Surface Elevation -	11.14'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Depth (ft)	Description
0	Clayey silt; (fill)
5	Clayey silt, black, wet, very soft; (oily)
10	trace organics
15	Sandy gravel, with trace silt, wet, very dense

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - C50D

Project No. 113-950-032

Date M.W. completed 11/4/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	11/4/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	27'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	26'
Screen Setting -	16' - 26'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

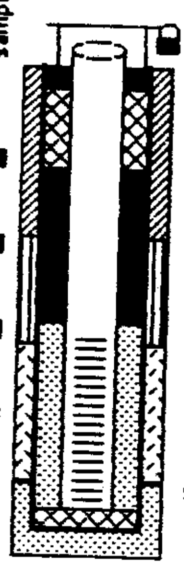
MEASUREMENTS(NGVD)

Top of Casing Elevation -	13.76'
Static Water Level Elevation -	1.43'
Date Measured -	12/22/86
Surface Elevation -	10.97'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — *blows/ft — samples — Description



Depth (ft)	*blows/ft	Class	Description
0		CL	Clay with some silt, blackish-gray, very soft, saturated; micaceous; organics; petroleum odor
	2		SHELBY TUBE taken from 7' to 9'
10	2	ML	Increased silt; silt with some clay; strong petroleum odor
	40		Little to some fine sand
		SW	Fine to coarse sand with some fine gravel, medium brown, dense, saturated
20	11		Increasing gravel; sand and gravel, trace silt and clay
	16	SP	Decreased fine gravel; fine to medium sand with trace to little gravel; petroleum odor
	16		
30			
40			
50			
60			

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

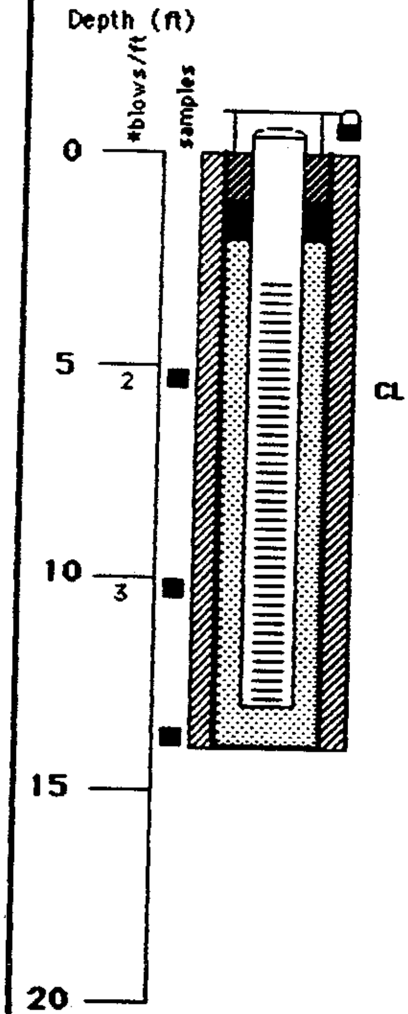
LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer /Geologist Blake Moyer, Jr.



Description

CL Silty clay, reddish brown, very moist, very soft

trace organics, moist, soft

very moist to wet

Boring/Well No. - C51

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	10.71'
Static Water Level Elevation -	7.86'
Date Measured -	1/13/87
Surface Elevation -	9.06'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C52

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

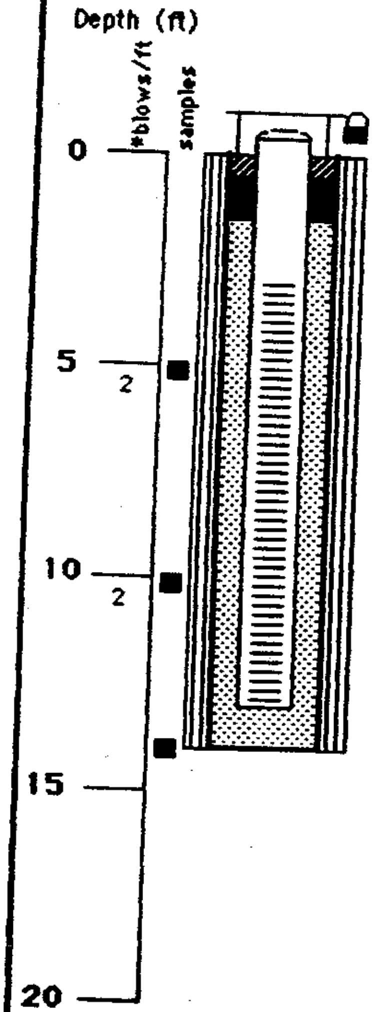
Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.14'
Static Water Level Elevation -	2.91'
Date Measured -	1/13/87
Surface Elevation -	9.07'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

CL Silty clay with trace organics, reddish-brown, moist, very soft

trace sand, soft

greyish-black, moist to wet, petroleum odor

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

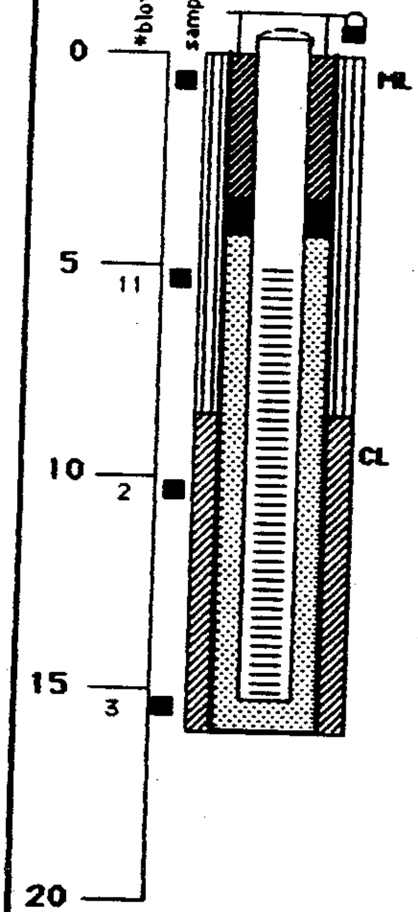
Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C53

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	11.93'
Static Water Level Elevation -	6.78'
Date Measured -	1/13/87
Surface Elevation -	10.13'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



ML — Clayey silt to silty sand with some fine sand, trace brick fragments and gravel, black; (fill)

Sandy silt, fine

CL — Silty clay with trace fine sand, black

grading to gray, less fine sand

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C54

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

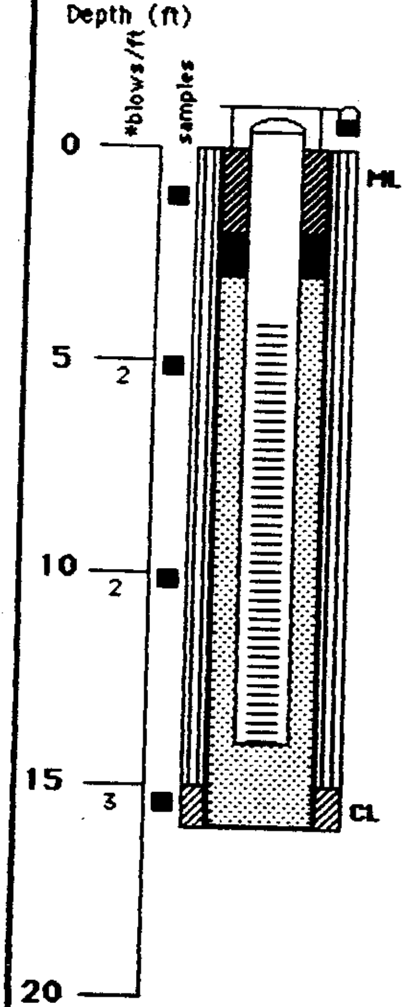
MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.58'
Static Water Level Elevation -	8.44'
Date Measured -	1/13/87
Surface Elevation -	8.26'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



ML — Clayey silt with some fine sand and trace cobbles, black

Sandy silt with trace brick fragments, black; (fill)

trace fine to coarse sand

CL — Silty clay with trace wood blackish-grey,

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - C55

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

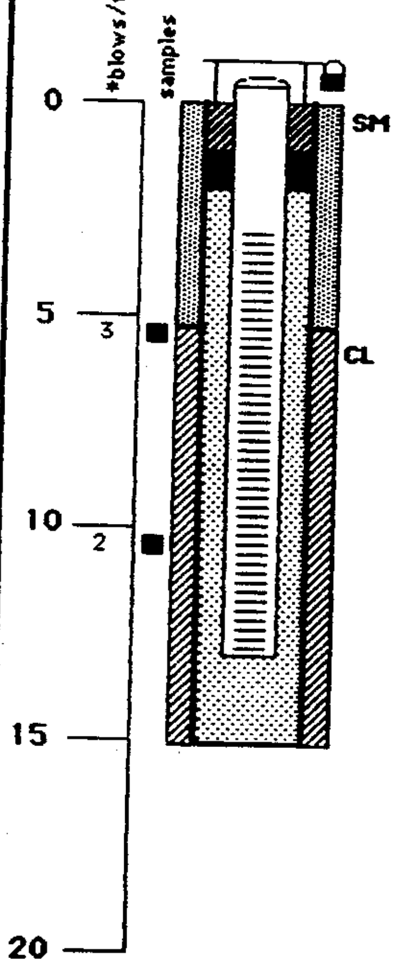
MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.21'
Static Water Level Elevation -	6.73'
Date Measured -	1/13/87
Surface Elevation -	8.31'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft	Class	Description
0		SM	Silty sand with some gravel and trace brick, brown-grey, moist, loose
5	3	CL	Silty clay with some sand and gravel, brown-grey, moist, loose
10	2		wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

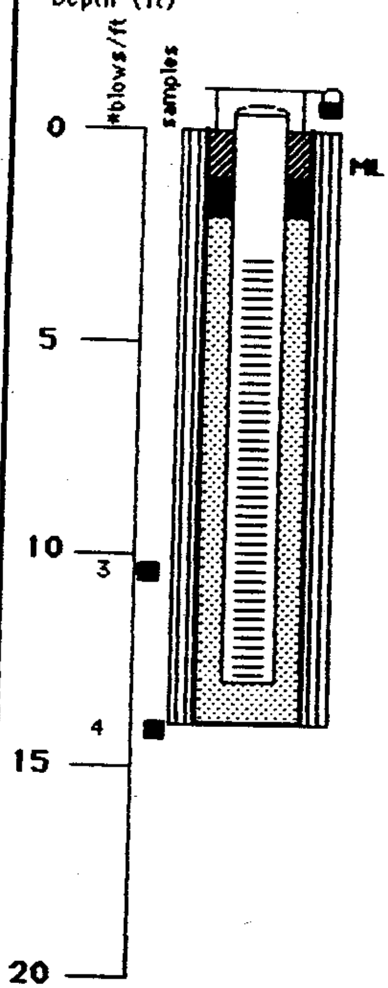
LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason



Description

Clayey silt with some fine to coarse sand, trace cobbles and trace brick fragments, blackish-grey

trace fine sand

trace wood

Boring/Well No. - C56

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	11.77'
Static Water Level Elevation -	9.39'
Date Measured -	1/13/87
Surface Elevation -	10.04'

TEST DATA

Pump Type -	
Depth to intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOO[illegible]

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C57

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	15' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14' 6"
Screen Setting -	4' 6" - 14' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	2 Sand
Type of Grout -	Cement/Bentonite

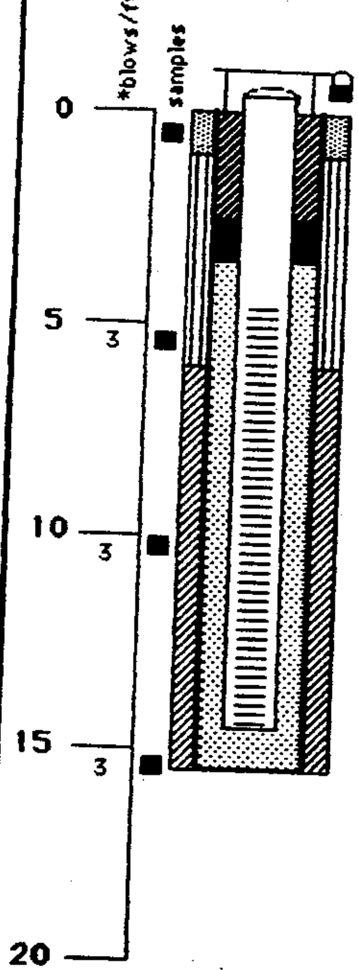
MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.77'
Static Water Level Elevation -	7.67'
Date Measured -	1/13/87
Surface Elevation -	10.61'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



SM Silty sand, fine, brown

ML Clayey silt with some fine sand, black

CL Silty clay to clayey silt with some fine sand, black; wood fragments

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

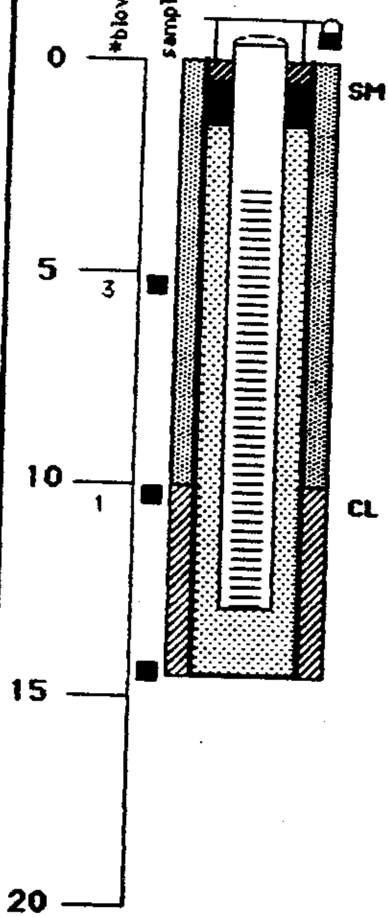
Date M.W. completed 2/29/86

Supervising D & M Engineer /Geologist Dave Wagner

Boring/Well No. - C58

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/29/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	14' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.75'
Static Water Level Elevation -	8.57'
Date Measured -	1/13/87
Surface Elevation -	9.58'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



SM Silty sand with trace clay and gravel, black, wet, loose

CL Silty clay with trace organics, black-brown, wet, loose

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

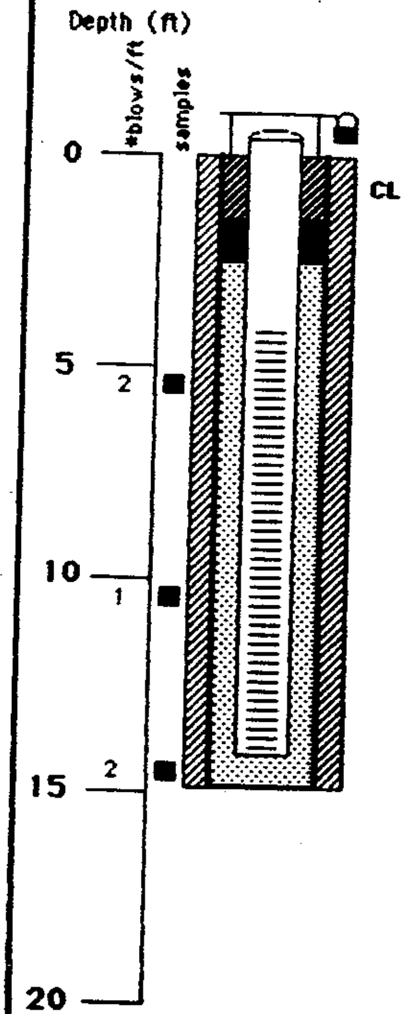
Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist David Wagner

Boring/Well No. - C59

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.75'
Static Water Level Elevation -	8.73'
Date Measured -	1/13/87
Surface Elevation -	9.67'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Depth (ft)	*blows/ft	Description
0		CL Silty clay with some gravel, black, moist, loose
5	2	black-brown
		wet to saturated
10	1	
15	2	trace sand, very moist
20		

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer /Geologist Dave Wagner

Boring/Well No. - C60

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

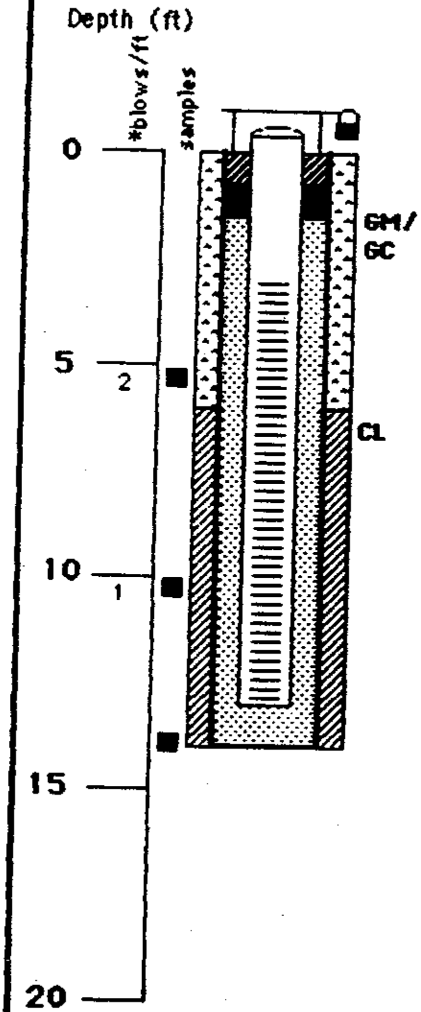
Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.85'
Static Water Level Elevation -	6.05'
Date Measured -	1/13/87
Surface Elevation -	8.61'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Sandy to silty gravel, black-brown, moist, loose

Sandy to silty clay, brown-grey, wet, very soft

black-brown, trace organics

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

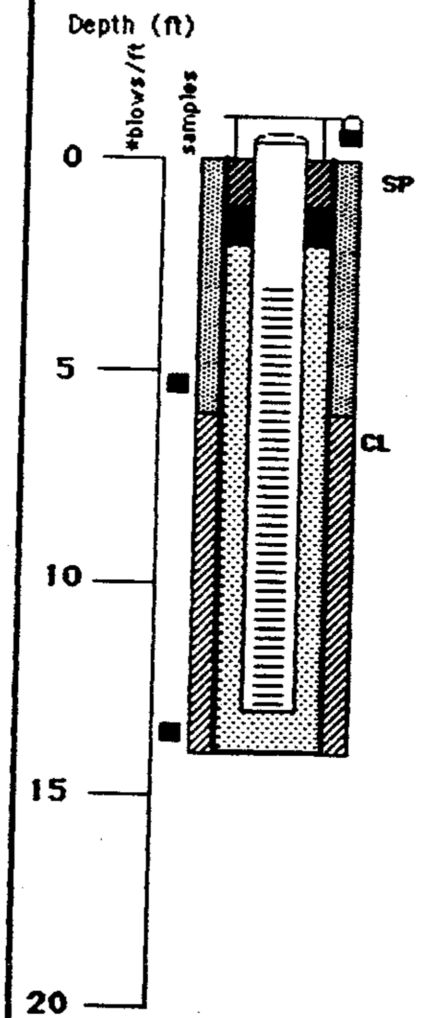
LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.



Description

- SP: Sand with trace gravel
- CL: Silty clay with trace sand, brownish-black, slightly moist, very soft
- very moist, soft

Boring/Well No. - C61

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	11.27'
Static Water Level Elevation -	7.72'
Date Measured -	1/13/87
Surface Elevation -	9.87'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project :Chevron/Philadelphia Refinery

Project No. 113-909-032

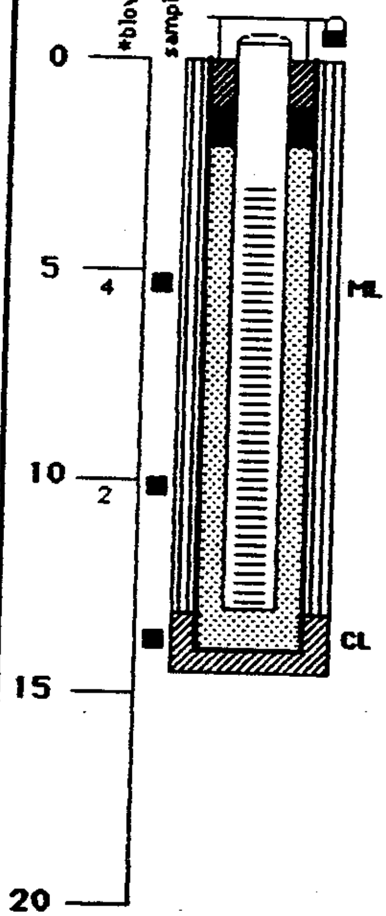
Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C62

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	13.90'
Static Water Level Elevation -	9.96'
Date Measured -	1/13/87
Surface Elevation -	10.35'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Silty clay with trace sand, reddish-brown, moist, soft

trace organics, greyish-black, very moist

moist to wet

Silty clay to clayey silt with trace very fine sand, very soft

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

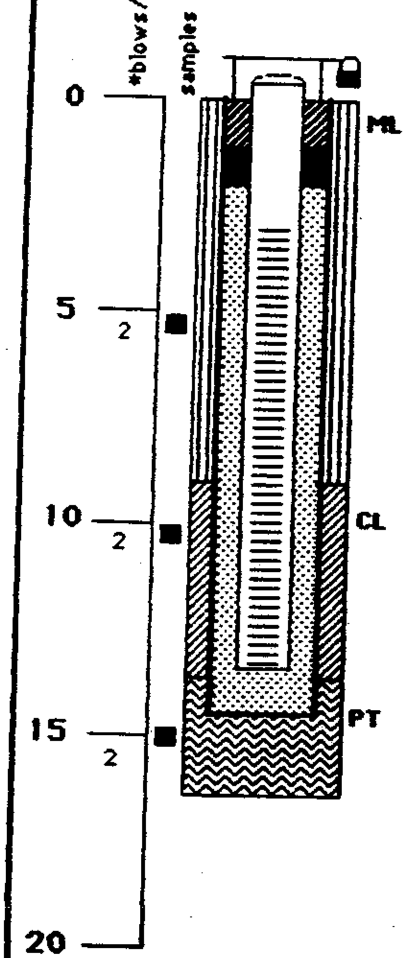
Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - C63

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.22'
Static Water Level Elevation -	4.02'
Date Measured -	1/13/87
Surface Elevation -	7.82'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	Blows/ft	Soil	Description
0		ML	Sandy silt, fine, black
5	2		Clayey silt with some fine to coarse sand, blackish-grey
10	2	CL	Silty clay with trace wood, blackish grey
15	2	PT	Clayey peat with some wood

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Dave Wagner

Boring/Well No. - C64

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/24/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

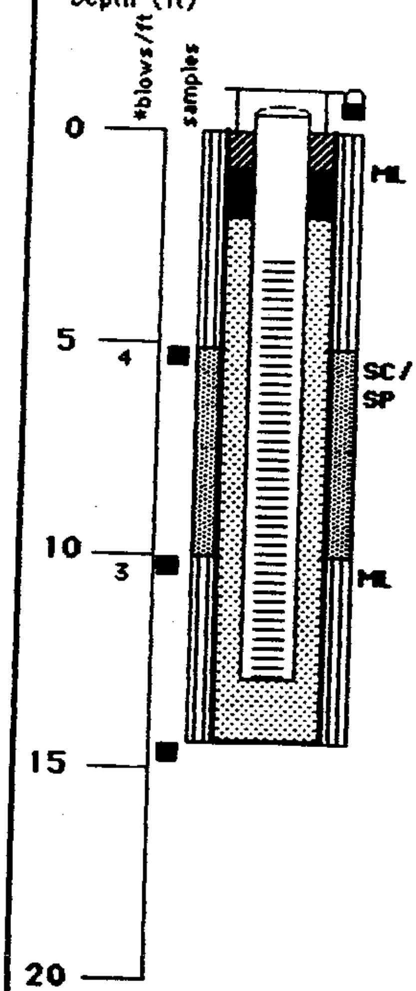
MEASUREMENTS (NGVD)

Top of Casing Elevation -	10.21'
Static Water Level Elevtation -	3.72'
Date Measured -	1/13/87
Surface Elevation -	8.40'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



ML — Silty clay with gravel and brick, black-brown, moist; (fill)

SC/SP — Sandy clay with trace silt, gravel and brick, black-brown, very moist

ML — Silty clay with trace organics, moist

wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - C65

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

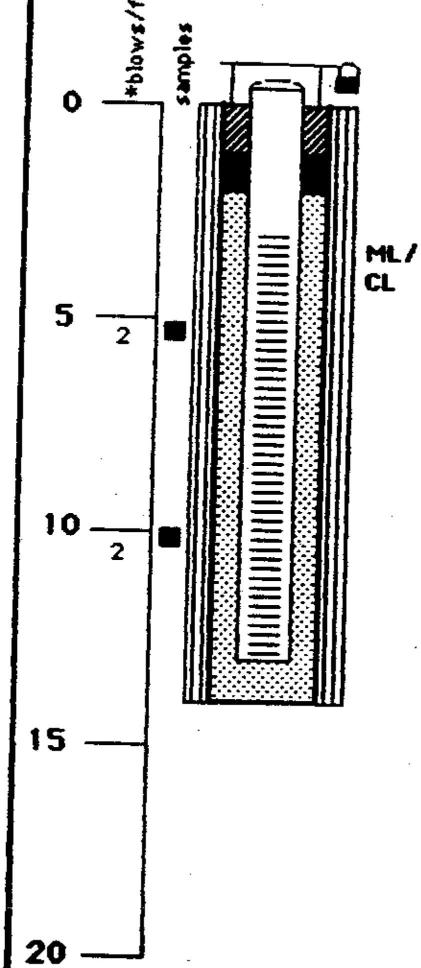
MEASUREMENTS (NGVD)

Top of Casing Elevation -	13.33'
Static Water Level Elevation -	Not Available
Date Measured -	1/15/87
Surface Elevation -	9.70'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



ML/CL Silty clay to clayey silt with trace sand, greyish-black, very moist, very soft

Silty clay with trace sand

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - C65D

Project No.	113-950-032
Date M.W. completed	11/11/86
Supervising D & M Geologist	David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	11/11/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	75'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	75'
Screen Setting -	65' - 75'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Bentonite

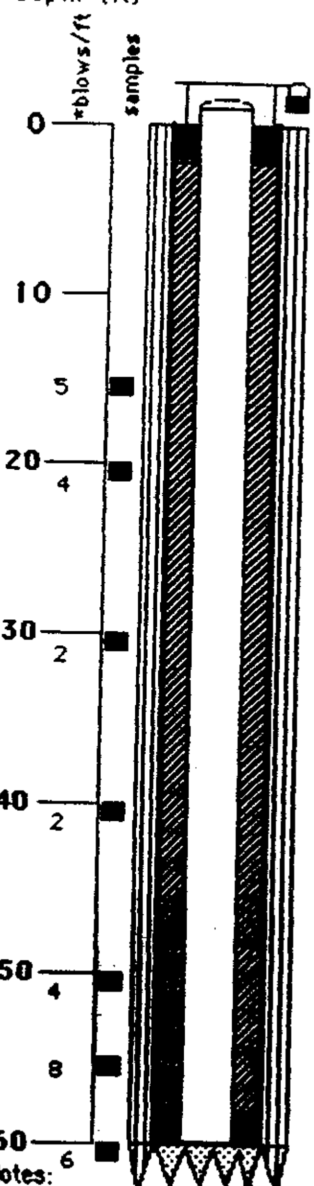
MEASUREMENTS (NGVD)

Top of Casing Elevation -	11.96'
Static Water Level Elevation -	-2.16'
Date Measured -	12/22/86
Surface Elevation -	9.94'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Silt with trace to little fine to coarse sand, trace fine gravel, black, moist; strong petroleum odor; brick fragments

Silt with little clay, medium gray, soft, moist; organics

SHELBY TUBE taken from 25' to 27'
Trace mica

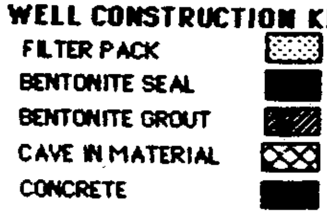
Decreasing density; very soft

Increasing density; soft

Decreasing clay; trace clay and trace fine sand

Increasing sand; little fine sand, stratified

WELL CONSTRUCTION KEY



Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C65D **(Cont.)**

Project No. 113-950-032

Date M.W. completed 11/12/86

Supervising D & M Geologist David Wagner

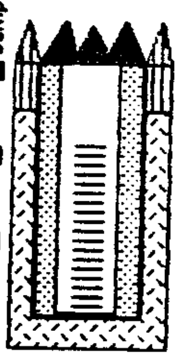
Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 11/12/86

Type of Rig - Hollow Stem Auger

Depth (ft)	*blows/ft	samples		Description
60	6	■	ML	1" interbeds of fine to coarse sand from 60' to 62'
	94	■	SW	Fine to coarse sand with little fine gravel, trace to little clay, trace silt, brownish-gray, medium dense, saturated
70	25	■		
	32,75/ 3"	■		Decreasing clay; no clay
80				
90				



Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

WELL ABANDONMENT FORM

A. WELL ABANDONMENT RECORD

CONTRACTOR/AGENT DAMES & MOORE

REG. NO.

1. WELL LOCATION: (Show a sketch of the location on back of form.)

Municipality: Philadelphia, PA County ______

Chevron Refinery
(Road, Community, Subdivision, Lot No., Latitude and Longitude) Quadrangle No. ______

2. OWNER OR RESPONSIBLE PARTY: CHEVRON USA INC.

3. ADDRESS: P.O. Box 7408
Philadelphia, PA 19101

4. TOPOGRAPHY: draw, slope, hilltop, valley, flat

5. USE OF WELL: monitoring DATE: 2-27-90

6. TOTAL DEPTH: 75' DIAMETER: 4"

7. CASING REMOVED: N/A

feet	diameter

8. SEALING MATERIAL:

Neat cement		Sand cement	
bags of cement	3	bags of cement	
gals. of water	40	yds. of sand	
		gals. of water	

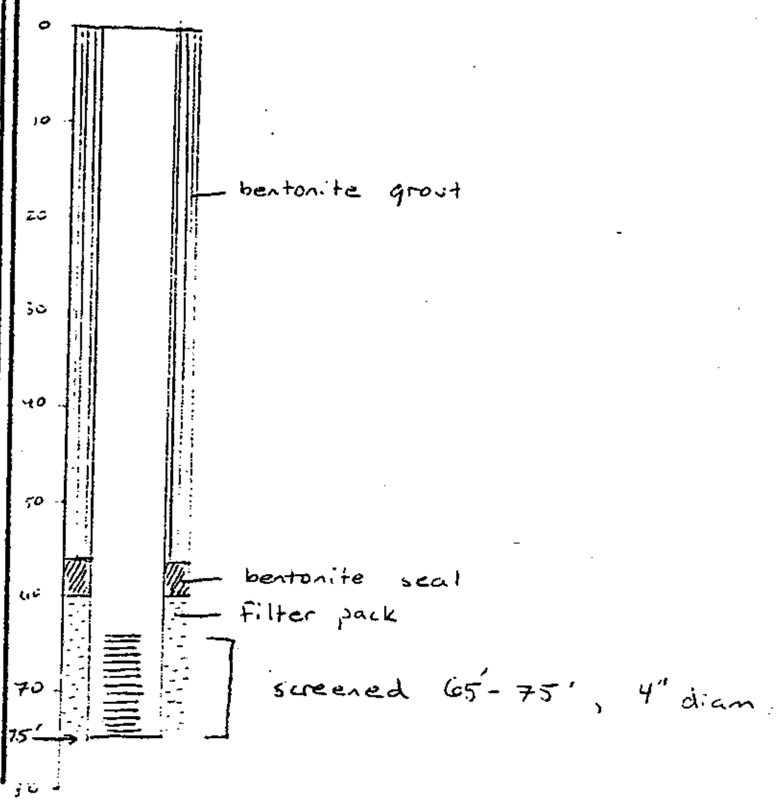
Other
Type material bentonite 1/2-1 bag
Amount

9. EXPLAIN METHOD OF EMPLACEMENT OF MATERIAL
60' of pipe was lowered into the well and cement/bentonite was injected into the well. The pipe was partially withdrawn and the rest of the well was filled.

I do hereby certify that this well abandonment record is true and exact.

Kendra McDonough 2/28/90
Signature of Contractor or Agent Date

WELL DIAGRAM: Draw a detailed sketch of the well showing total depth, depth and diameter of screens remaining in the well, gravel interval, intervals of casing perforatio and depths and types of fill materials used.



B. CERTIFICATION

We hereby certify that this well abandonment was accomplished in the manner as described in the above well abandonment record at 12:00 AM/PM on 27th day of the month of February, 1990, with our active participation and that we are experienced and qualified to participate in such abandonment operations.

1. Kendra McDonough
Signature of Participant

Name: Kendra McDonough Date: 2-27-90

Address: 2360 Maryland Rd.

Title: Asst. Geologist

2. ______
Signature of Participant

Name: ______ Date: ______

Address: ______

Title: ______

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - C95

Project No. 113-950-032

Date M.W. completed 10/22/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/22/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

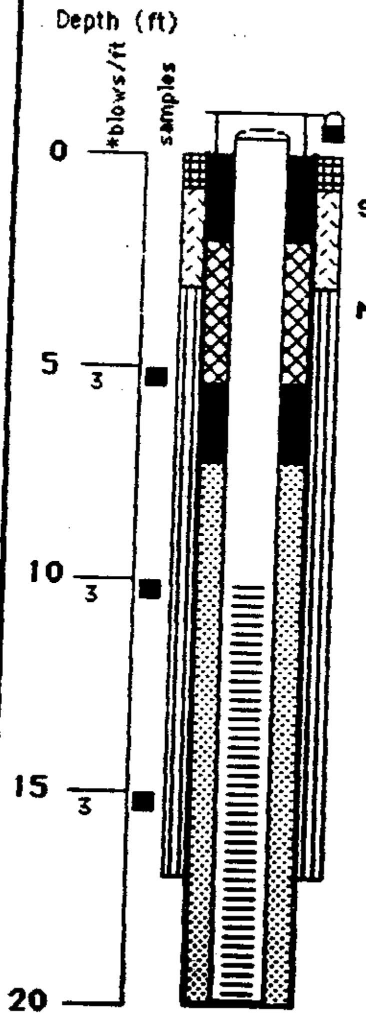
Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	20'
Screen Setting -	10' - 20'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

MEASUREMENTS(NGVD)

Top of Casing Elevation -	14.84'
Static Water Level Elevation -	8.71'
Date Measured -	1/14/87
Surface Elevation -	12.38'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Macadam underlain by gravel

SW Fine to coarse sand with some fine gravel, little silt, black, dry; brick fragments

ML Silt with little to some clay, dark - gray, soft, moist; organics; micaceous; weak petroleum odor

Increasing moisture; saturated

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. – 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner

Boring/Well No. - C96

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/23/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	17'
Screen Setting -	7' - 17'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	2 Sand
Type of Grout -	

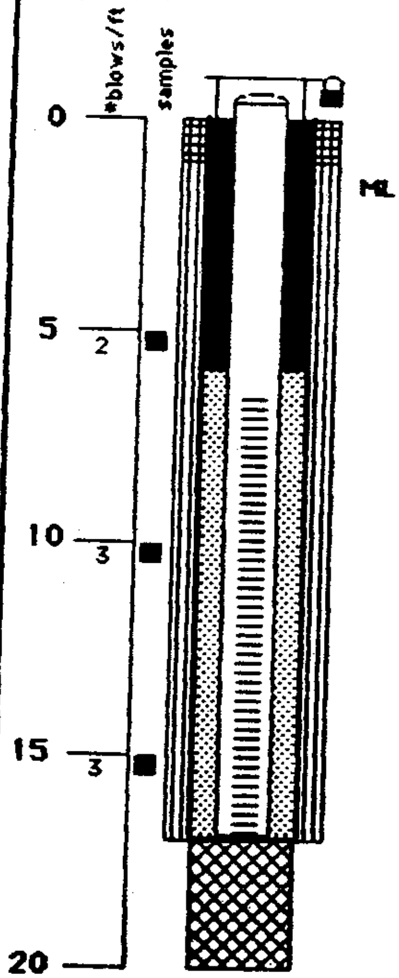
MEASUREMENTS(NGVD)

Top of Casing Elevation -	14.61'
Static Water Level Elevation -	9.96'
Date Measured -	1/14/87
Surface Elevation -	11.51'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Slag, silt and sand

Silt with little to some clay and trace fine sand, dark - gray, soft, slightly moist, organics; micaceous; petroleum odor

Increased moisture; moist

Increased moisture; saturated

Increased organics

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C97

Project No. – 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/23/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	Sand
Type of Grout -	

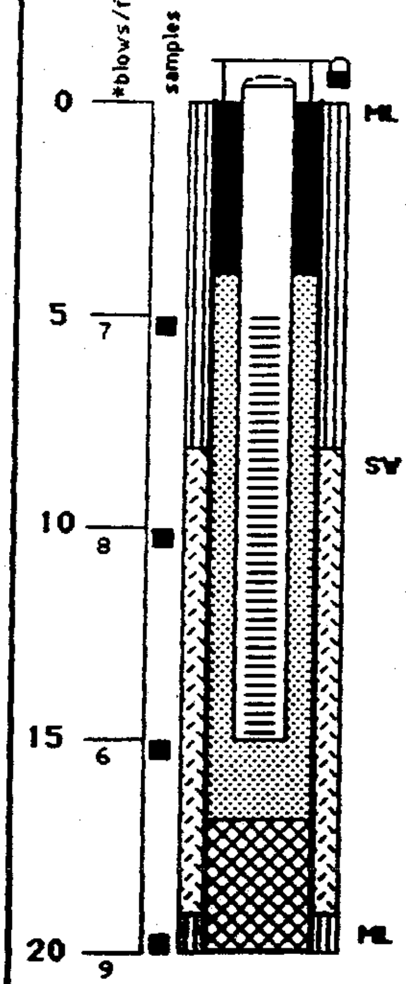
MEASUREMENTS(NGVD)

Top of Casing Elevation -	13.07'
Static Water Level Elevation -	3.17'
Date Measured -	1/14/87
Surface Elevation -	9.68'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



	Description
ML	Silt with little to some clay, little fine gravel, trace fine to coarse sand, blackish - brown, soft, slightly moist to moist; brick fragments; petroleum odor
SW	Fine to coarse sand with some fine gravel, little silt, little clay, blackish - gray and brown, loose, saturated; brick fragments; strong petroleum odor; sheen on water
ML	Silt with some clay, blackish-gray, soft, very moist; organics; petroleum odor

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - C98

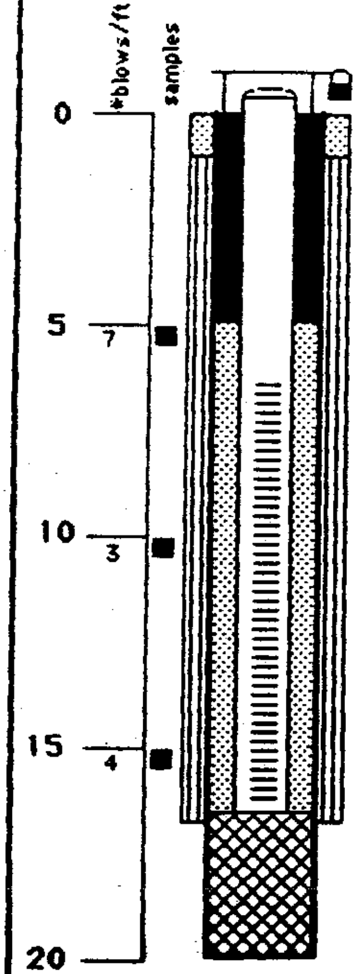
Project No. 113-950-032

Date M.W. completed 10/23/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10 /23/86
Type of Rig -	Hollow Stem Auger

Depth (ft) Description



SP Fine to medium sand and gravel

ML Silt with little clay, little to fine to medium sand, little to some fine gravel, grayish - black, medium stiff, moist; micaceous; glass and brick fragments; strong petroleum odor

Silt with some clay, grayish - brown, soft, moist, weak petroleum odor

Increasing moisture; saturated

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	16.5'
Screen Setting -	6.5' - 16.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

MEASUREMENTS(NGVD)

Top of Casing Elevation -	12.90'
Static Water Level Elevation -	5.98'
Date Measured -	1/14/87
Surface Elevation -	9.47'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - D66

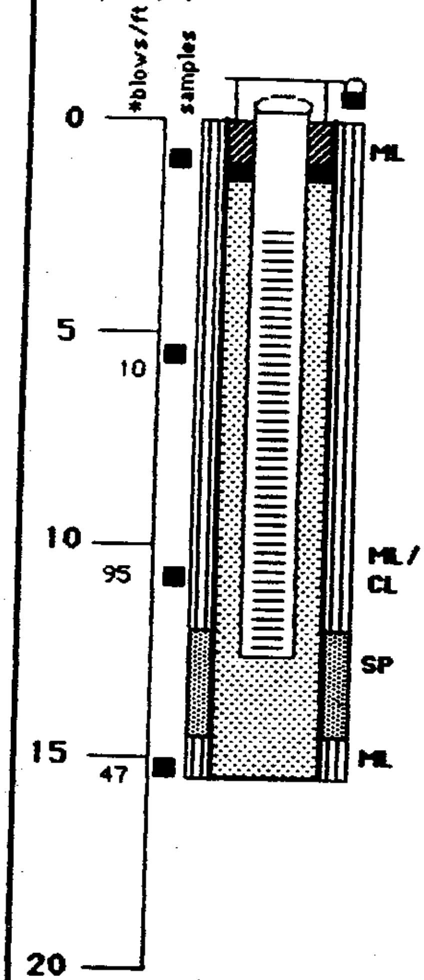
Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist T. Helgason

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15.5'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12.5'
Screen Setting -	2.5' - 12.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	35.23'
Static Water Level Elevation -	30.53'
Date Measured -	1/9/87
Surface Elevation -	33.50'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft		Description
0		ML	Sandy silt with trace gravel fine, blackish-grey, trace gravel
5	10		some clay
10	95	ML / CL	Clayey silt with some coarse sand, grey
		SP	Coarse sand, grey
15	47	ML	Sandy silt, fine, light brown

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

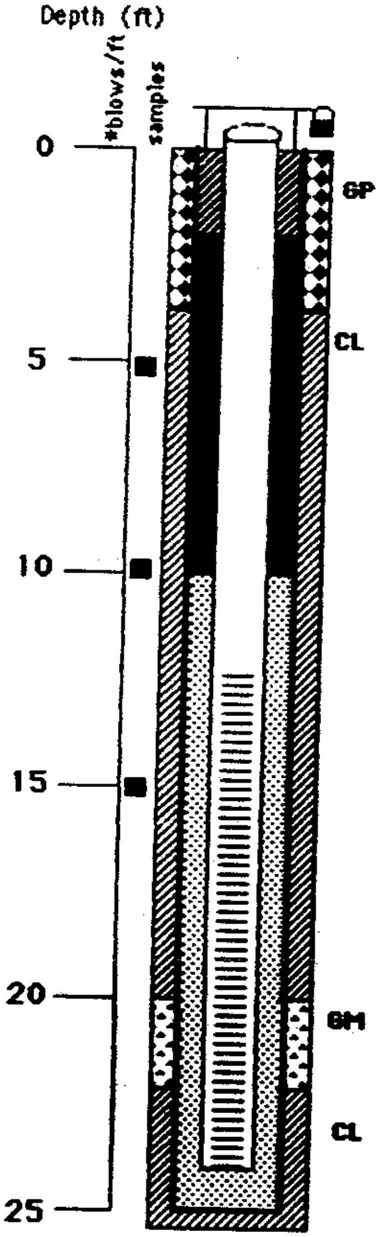
Boring/Well No. - D67

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist E.J. Fillo

Depth (ft) | Description



Depth (ft)	Description
0	Crushed Stone; (fill)
4	Silty clay with trace fine sand, dark gray, moist, very soft; micaceous
15	medium stiff
20	Fine sandy and silty gravel, dark gray
22	Silty clay, dark gray
25	weathered bedrock; mica schist

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	25'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	24'
Screen Setting -	14' - 24'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	16.12'
Static Water Level Elevation -	2.33'
Date Measured -	1/9/87
Surface Elevation -	12.82'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

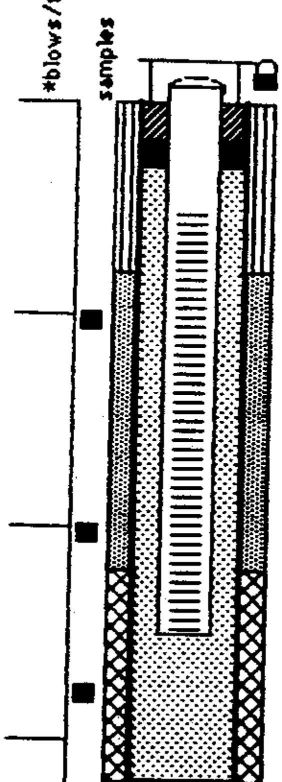
Boring/Well No. - D68

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist T. Helgason

Depth (ft)	Description
0	ML Sandy silt with some cobbles, fine, light brown
5	SP Silty fine to coarse sand with some cobbles, tan, moist
10	ms Mica schist, weathered to sand
15	
20	



Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12' 6"
Screen Setting -	2' 6" - 12' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	13.28'
Static Water Level Elevation -	9.04'
Date Measured -	1/9/87
Surface Elevation -	9.73'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

Filter Pack
Bentonite Seal
Cement Grout

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - D69

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist T. Helgason

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	15.5'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13.5'
Screen Setting -	2.5' - 12.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

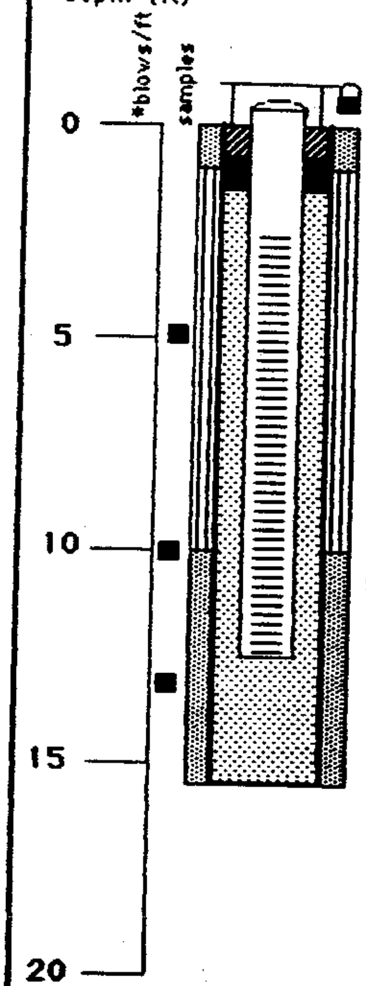
MEASUREMENTS (NGVD)

Top of Casing Elevation -	14.97'
Static Water Level Elevation -	10.60'
Date Measured -	1/9/87
Surface Elevation -	12.91'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)



Description

SP	Sand with some gravel, fine to coarse, brown
ML	Sandy silt, fine, greyish-black, wet
SM	Sand, fine to coarse, light brown; (fill)

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - D70

Project No. 113-909-032

Date M.W. completed 2/19/96

Supervising D & M Engineer/Geologist E.J. Fillo

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

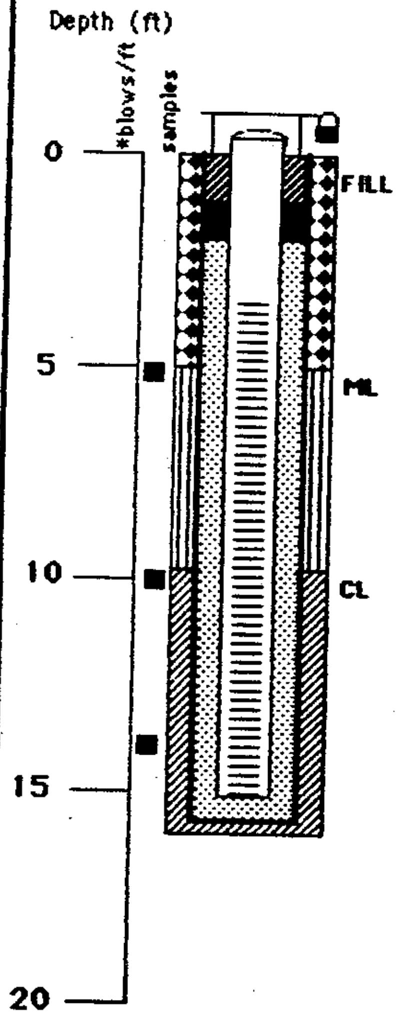
Borehole Diam. -	7"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.54'
Static Water Level Elevation-	9.69'
Date Measured -	1/9/87
Surface Elevation -	11.38'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

FILL Oily crushed stone; (fill)

ML Sandy silt, very fine, dark brown, wet, very soft; oily

CL Silty clay, dark gray, moist, very soft; micaceous

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - D71

Project No. 113-909-032

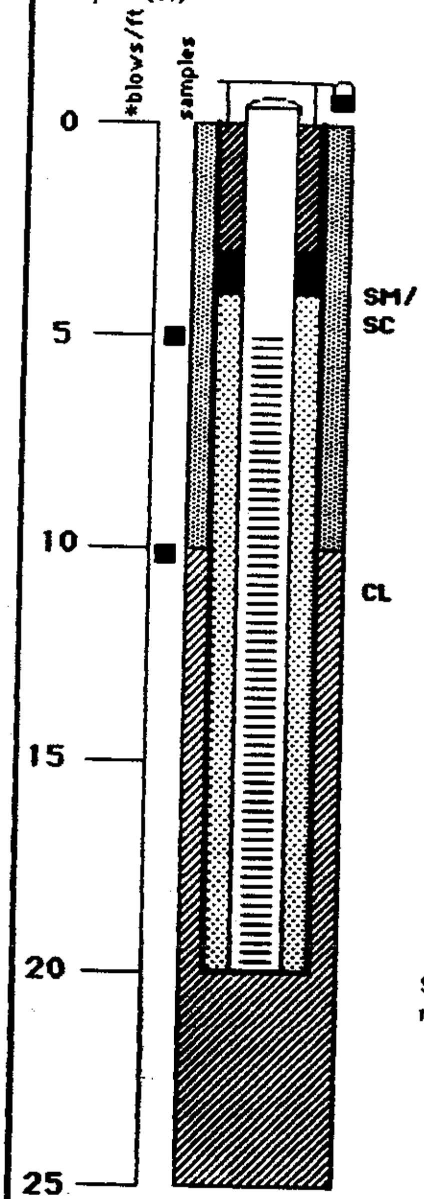
Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist Andre Ivansiu

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	25'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	20'
Screen Setting -	5' - 20'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	13.22'
Static Water Level Elevation -	5.79'
Date Measured -	1/9/87
Surface Elevation -	10.41'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



Silty sand to clayey sand, dark grey to black, moist, soft

Silty clay, dark grey, moist, soft

Silty sand, dark grey, moist, soft

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist T. HELGASON

Boring/Well No. - D72

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	15' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

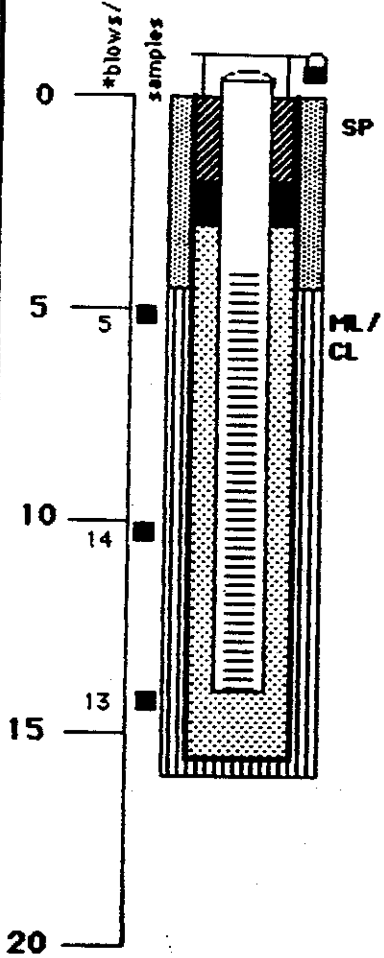
MEASUREMENTS (NGVD)

Top of Casing Elevation -	15.58'
Static Water Level Elevation -	6.54'
Date Measured -	1/9/87
Surface Elevation -	13.76'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) Description



Depth (ft)	Description
0 (SP)	Sand with trace cobbles, fine to coarse, dark brown
5 (ML/CL)	grading to light brown with increased silt content
10	Clayey silt with trace fine sand, light brown, moist
15	Weathered bedrock, tan; mica schist

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

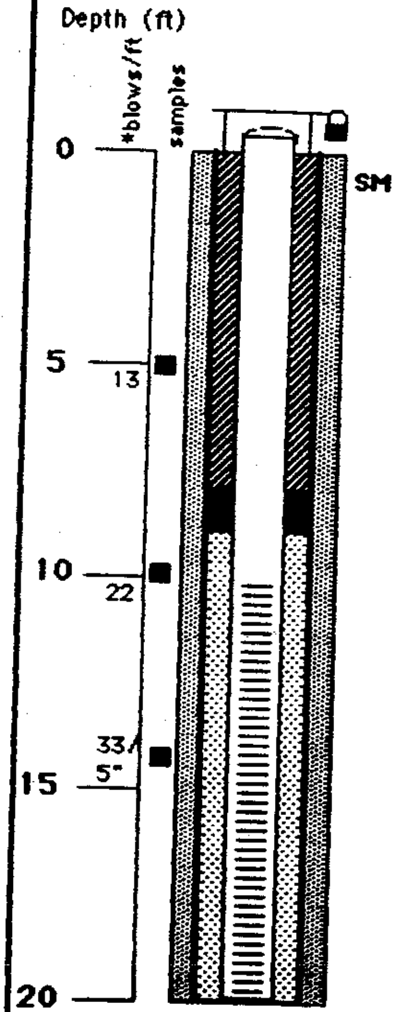
Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist Andre Ivansiu

Boring/Well No. - D73

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	20'
Screen Setting -	10' - 20'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	27.02'
Static Water Level Elevation -	14.72'
Date Measured -	1/9/87
Surface Elevation -	23.97'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

SM Silty sand, yellow

yellowish-orange, dry, soft, loose

wet, very dense

very fine to coarse

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - D107

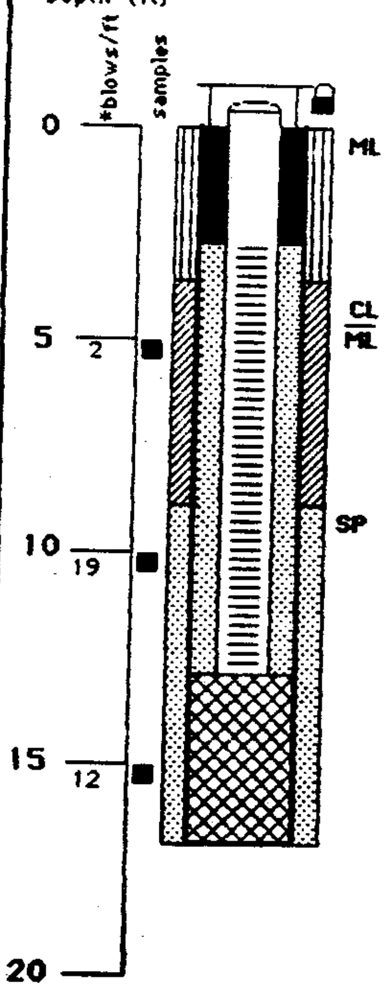
Project No. 113-950-032

Date M.W. completed 10/1/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/1/86
Type of Rig -	Hollow Stem Auger

Description



ML: Silt with little clay, some fine gravel, brown, soft, moist

Grades to grayish - brown increased moisture; very moist

CL/ML: Silt and clay, medium gray, soft to medium stiff, moist; wood debris; micaceous

SP: Medium sand with little silt, trace coarse sand, brown, medium dense, very moist

Decreasing silt; trace silt

CONSTRUCTION DATA

Borehole Diam. -	6"
Borehole Depth -	17'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12.5'
Screen Setting -	2.5' - 12.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	-

MEASUREMENTS(NGVD)

Top of Casing Elevation -	10.27'
Static Water Level Elevation -	4.87'
Date Measured -	1/14/87
Surface Elevation -	7.27'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - D108

Project No.	113-950-032
Date M.W. completed	10/1/86
Supervising D & M Geologist	David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/1/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

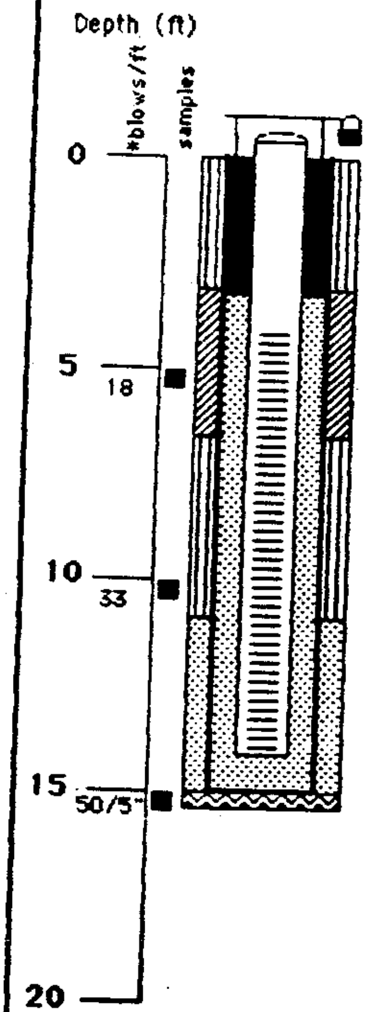
Borehole Diam. -	6"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

MEASUREMENTS(NGVD)

Top of Casing Elevation -	10.87'
Static Water Level Elevation -	5.32'
Date Measured -	1/14/87
Surface Elevation -	8.37'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

ML Silt with little to some clay and trace fine sand, grayish - brown, soft, slightly moist; micaceous

CL Clay with some silt, trace fine to medium sand, trace fine gravel, gray and brown, medium dense, slightly moist increasing sand; some sand

ML Silt with some clay and some fine to medium sand, trace fine gravel, gray and brown, dense, moist

SP Fine sand with some silt and trace to little clay, grayish - brown, dense, saturated

Refusal at 15'; Wissahickon Schist

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

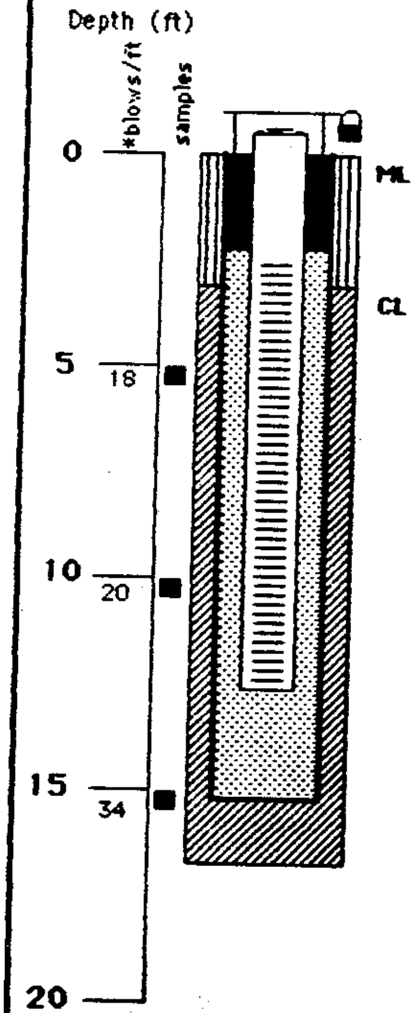
Project : Chevron/Philadelphia Refinery

Boring/Well No. - D109

Project No. 113-950-032

Date M.W. completed 10/2/86

Supervising D & M Geologist David Wagner



Depth (ft)	Description
0	ML Silt with some fine to coarse sand, brown, loose, slightly moist
~3	CL Clay with some coarse mica and trace silt, light brown - orange, soft, slightly moist; weathered Wissahickon Schist
~11	Increasing moisture and density; medium dense, saturated
15	Increasing density; dense

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/2/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	6"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12.5'
Screen Setting -	2.5' - 12.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	-
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	18.31'
Static Water Level Elevation -	14.61'
Date Measured -	1/14/87
Surface Elevation -	16.10'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

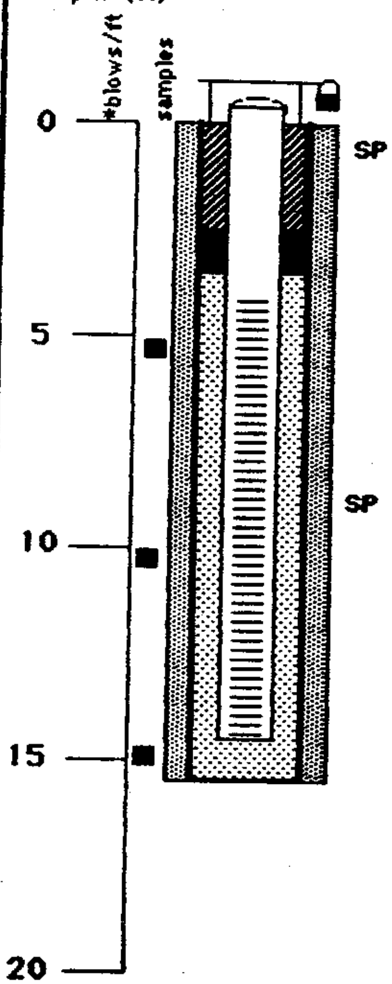
Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist T. Helgason

Depth (ft)



Description

Sandy silt, fine, blackish-grey, moist

coarse sand, trace wood, blackish-grey, moist; fill

Sand, fine to coarse with cobbles, trace silt and wood, blackish-grey, wet; (fill)

Boring/Well No. - S74

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15'6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	14.54'
Static Water Level Elevation -	6.95'
Date Measured -	1/9/87
Surface Elevation -	12.81'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

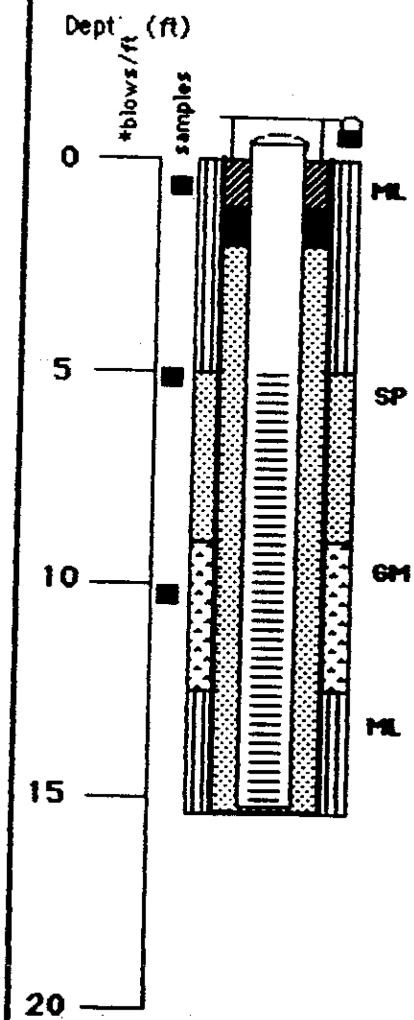
Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer /Geologist T. Helgason

Boring/Well No. - S75

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15' 6"
Screen Setting -	5' 6" - 15' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	13.19'
Static Water Level Elevation -	6.45'
Date Measured -	1/19/87
Surface Elevation -	12.78'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

Sandy silt with trace gravel, fine, blackish-grey, moist

Silty fine sand with trace gravel and wood, blackish-grey, moist

Coarse sandy gravel with silt lenses and trace wood, blackish-grey,

Fine sandy silt, blackish-grey

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOOI

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

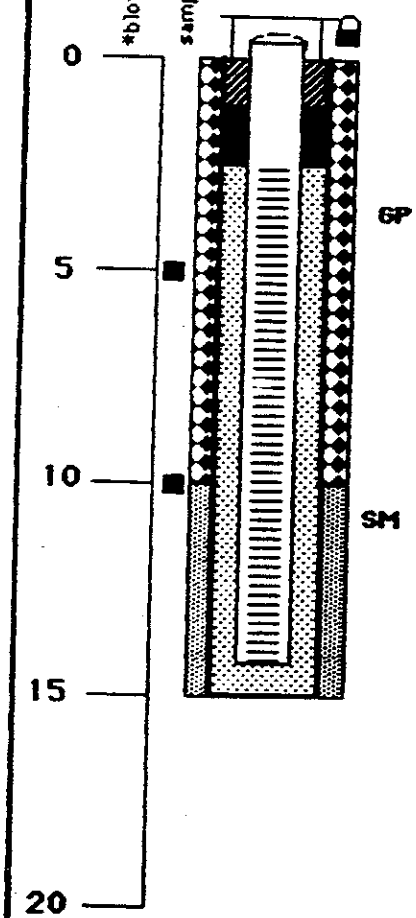
Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Andrei Ivanciu

Boring/Well No. - S76

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.56'
Static Water Level Elevation -	-3.95'
Date Measured -	1/9/87
Surface Elevation -	8.06'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft).-	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Sandy gravel, medium coarse, wet

Silty sand with trace gravel, dark grey, stiff dark grey, stiff

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

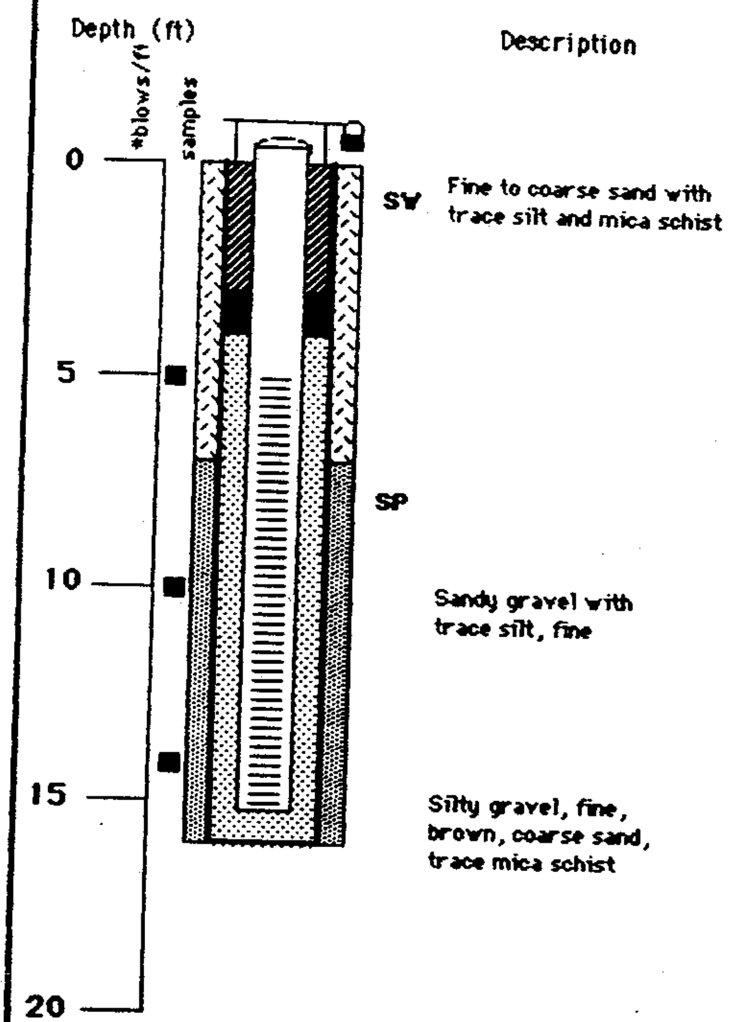
Boring/Well No. - S77

Project No. 113-909-032

Date M.W. completed 2/20/86

Supervising D & M Engineer/Geologist T. Helgason

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/20/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	6.20'
Static Water Level Elevation-	-4.11'
Date Measured -	1/9/87
Surface Elevation -	5.20'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - S78

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	18'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

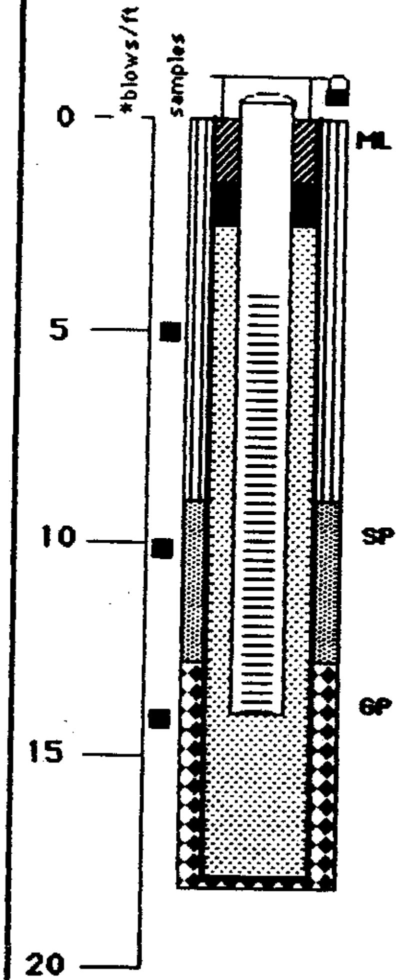
MEASUREMENTS (NGYD)

Top of Casing Elevation -	2.77'
Static Water Level Elevation -	-4.69'
Date Measured -	1/9/87
Surface Elevation -	2.52'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) — Description



Depth (ft)	Class	Description
0	ML	Sandy silt, brown, slightly moist,
5		fine, moist
10	SP	Fine sand with cobbles and some silt lenses, wet
15	GP	Sandy gravel, coarse, brown

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

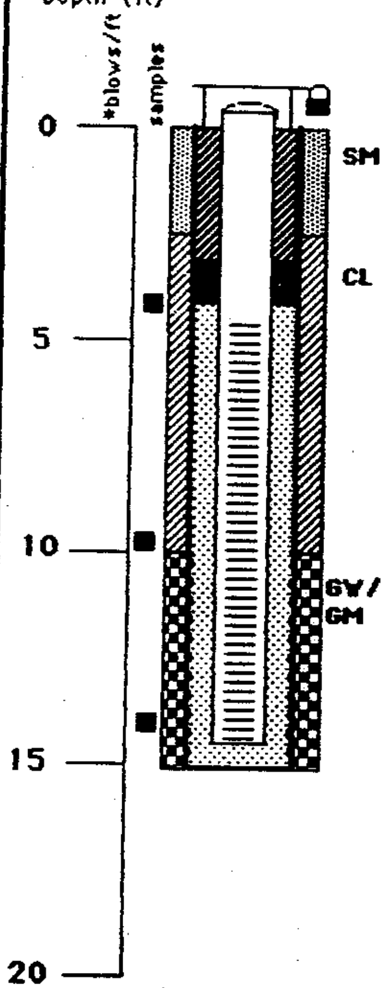
Boring/Well No. - S79

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer /Geologist Andrei Ivanciu

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14' 6"
Screen Setting -	4' 6" - 14' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	3.88'
Static Water Level Elevation -	-3.94'
Date Measured -	1/9/87
Surface Elevation -	3.72'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Depth	Class	Description
0	SM	Sand with trace silt, dark grey to black
	CL	Silty clay, dark grey, moist, soft
		grades to sandy gravel, dark grey, moist
10	GW/GM	Silty gravel, dark grey, wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOO[illegible]

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - S80

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Andrei Ivanciu

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/21/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	20'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	4'8" - 14'8"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

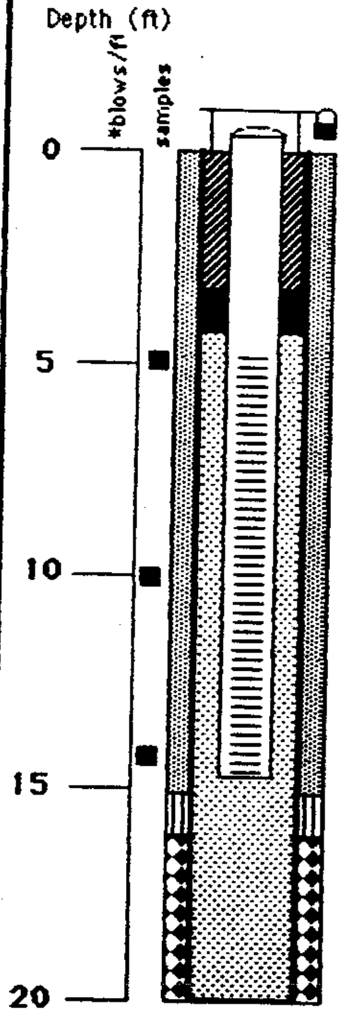
MEASUREMENTS (NGVD)

Top of Casing Elevation -	3.20'
Static Water Level Elevation -	-4.80'
Date Measured -	1/9/87
Surface Elevation -	3.12'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SM Silty sand, dark gray,

some pebbles, dark gray, wet, soft

ML Silty clay, dark grey, wet,

GP Sandy gravel, grey to pink

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/21/86

Supervising D & M Engineer/Geologist Andrei Ivansiu

Boring/Well No. - S81

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/20/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 7"

Borehole Depth - 15'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 13' 3"

Screen Setting - 3' 3" - 13' 3"

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation - 3.57'

Static Water Level Elevation - -4.55'

Date Measured - 1/9/87

Surface Elevation - 1.51'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

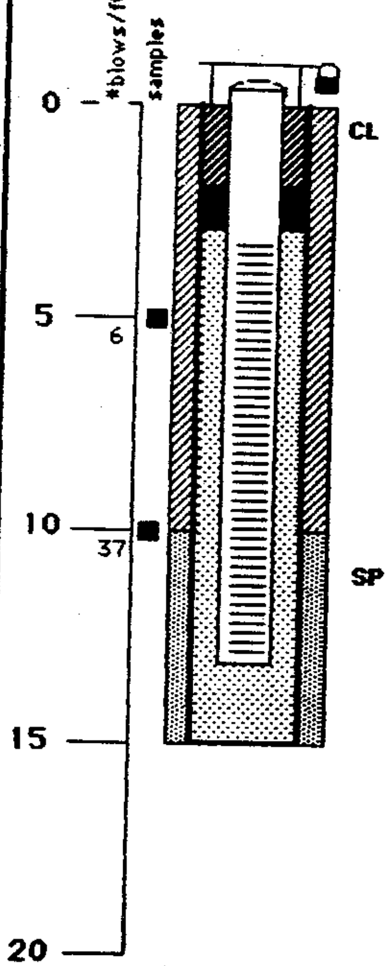
Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Depth (ft)

Description



Clay, brown, plastic, slightly moist

Silty to clayey sand

Sand with gravel, coarse, dark gray to brown, wet, stiff, dense

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOI

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/25/86

Supervising D & M Engineer/Geologist Blake Moyer, Jr.

Boring/Well No. - S82

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/25/86

Type of Rig - Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. - 7"

Borehole Depth - 14'

Casing/Screen Type - PVC

Casing Diam. - 4"

Casing Depth - 13'

Screen Setting - 3' - 13'

Slot Width - 0.02"

Type of Seal - Bentonite

Type of Filterpack - #2 Sand

Type of Grout - Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation - 3.00'

Static Water Level Elevation - 1.30'

Date Measured - 1/9/87

Surface Elevation - 1.76'

TEST DATA

Pump Type -

Depth to Intake (ft) -

Satic Water Level (ft) -

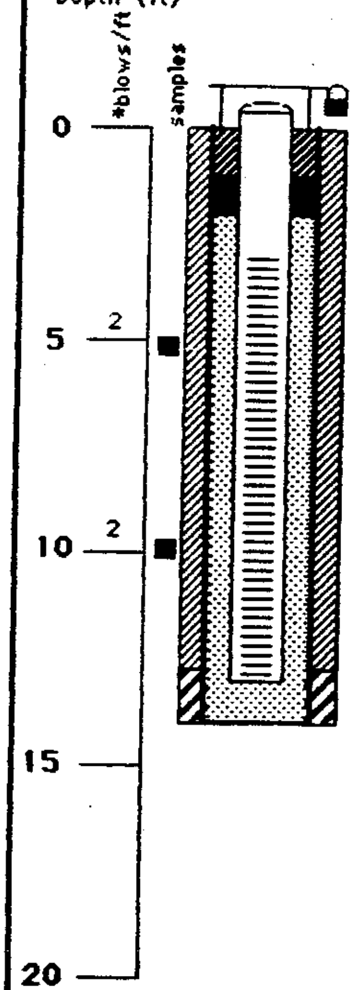
Pumping Water Level (ft) -

Drawdown (ft) -

Length of Test (Hrs) -

Depth (ft)

Description



CL

Silty clay, greyish-black, dry to moist, very loose

moist, soft

SC/CL Silty clay with trace sand, moist to wet, very soft

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/22/86

Supervising D & M Engineer/Geologist T. Helgason

Boring/Well No. - S83

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/22/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	15' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement / Bentonite

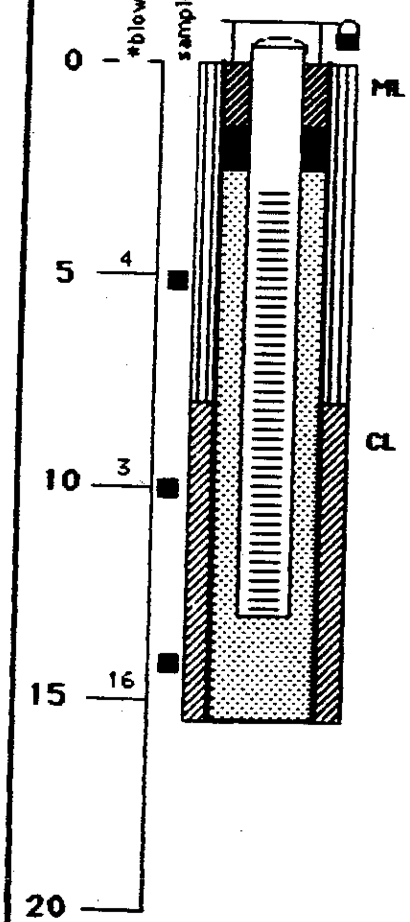
MEASUREMENTS (NGVD)

Top of Casing Elevation -	4.35'
Static Water Level Elevation' -	-0.53'
Date Measured -	1/9/87
Surface Elevation -	3.55'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



ML — Clayey silt, some fine to coarse sand, blackish-grey, moist

CL — Silty clay with some fine sand, blackish-grey, wet

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOOR

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

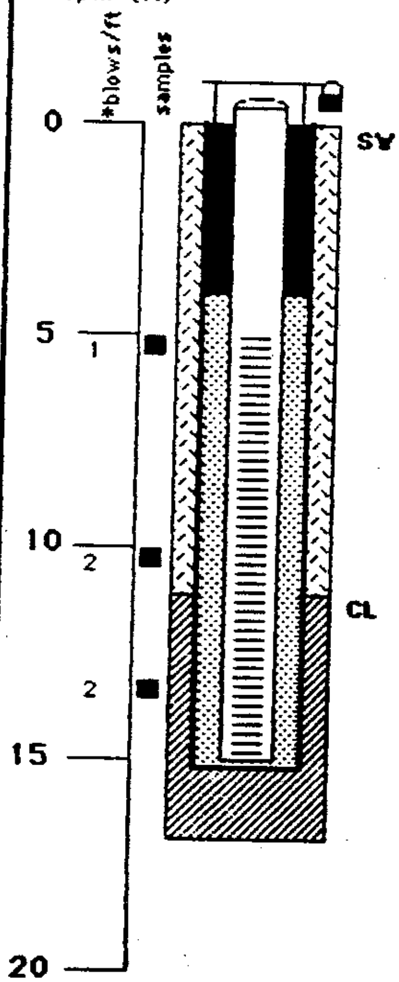
Boring/Well No. - S104

Project No. – 113-950-032

Date M.W. completed 10/3/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/3/86
Type of Rig -	Hollow Stem Auger



Description

SW — Fine to coarse sand with little silt, trace clay, dark brown, loose, moist; glass and ceramic fragments

CL — Clay with little silt, gray, very soft, moist; organics

Increasing organic content, increased silt; clay with some silt

SHELBY TUBE taken from 15' to 17'

CONSTRUCTION DATA

Borehole Diam. -	6"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	15'
Screen Setting -	5' - 15'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

MEASUREMENTS(NGVD)

Top of Casing Elevation -	11.97'
Static Water Level Elevation -	3.17'
Date Measured -	1/14/87
Surface Elevation -	9.25'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- CONCRETE
- CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - S105

Project No.	113-950-032
Date M.W. completed	10/7/86
Supervising D & M Geologist	David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/7/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	70'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	12.5'
Screen Setting -	2.5' - 12.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	2 Sand
Type of Grout -	Bentonite

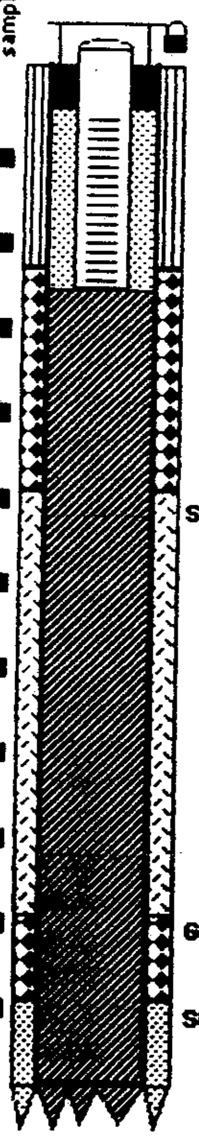
MEASUREMENTS(NGVD)

Top of Casing Elevation -	3.83'
Static Water Level Elevation -	-4.35'
Date Measured -	1/14/87
Surface Elevation -	0.83'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft		Description
0		ML	Silt with little clay and little fine sand, dark brownish-gray, soft, very moist; organics; micaceous
	1		
10	25		
		GP	Fine gravel with little fine to coarse sand and little silt, brown, medium dense, saturated
	15		
20	12		Grading to dark reddish-brown Increased sand: sand and fine gravel
	16	SW	Decreased gravel: some gravel
30	27		Grading to light reddish-brown
	47		Grading to brownish-yellow, dense
40	18		Grading to reddish-brown
	18		Grading to grayish- red- brown
50	64	GP	Increased gravel: fine gravel with little to some sand, light grayish-brown
	26	SP	Grading to yellowish-brown Decreased gravel and coarse sand: fine to medium sand with trace fine gravel
60			

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - S105 (Cont.)

Project No. 113-950-032

Date M.W. completed 10/7/86

Supervising D & M Geologist David Wagner

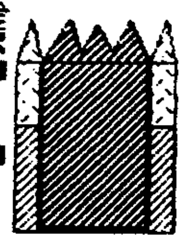
Location - Chevron Refinery

Driller - Lambert, Inc.

Drilling Completed - 10/7/86

Type of Rig - Hollow Stem Auger

Depth (ft)	*blows/ft	samples		Description
60	59	■	SW	Increased gravel and coarse sand: fine to coarse sand with some fine gravel; micaceous
	13	■	CL	Clay with little to some silt and trace fine sand, gray, stiff, moist; micaceous
70				
80				
90				



Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

WELL CONSTRUCTION KEY
- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - S106

Project No. 113-950-032

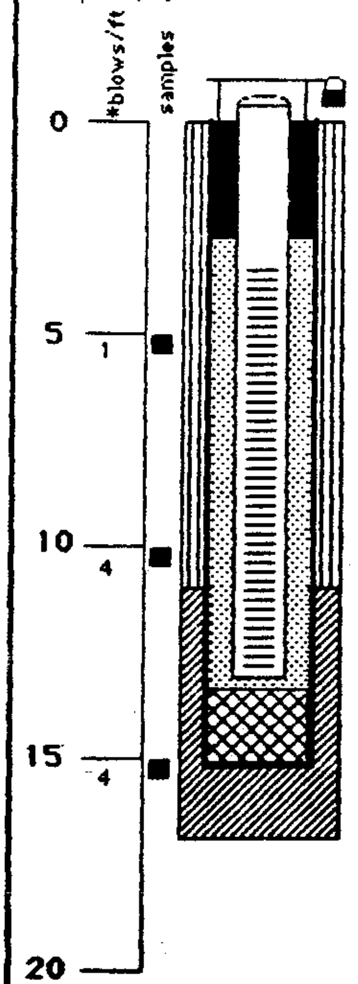
Date M.W. completed 10/2/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/2/86
Type of Rig -	Hollow Stem Auger

Depth (ft)

Description



ML Silt with little clay, trace fine to medium sand, trace fine gravel, dark brown, soft, moist; glass and brick fragments

Increasing moisture; saturated

Increasing gravel; some fine gravel

CL Clay with little silt, trace fine sand, gray, soft, very moist

CONSTRUCTION DATA

Borehole Diam. -	6"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	-

MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.13'
Static Water Level Elevation -	7.04'
Date Measured -	1/14/87
Surface Elevation -	9.13'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Dave Wagner

Boring/Well No. - H85

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/26/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

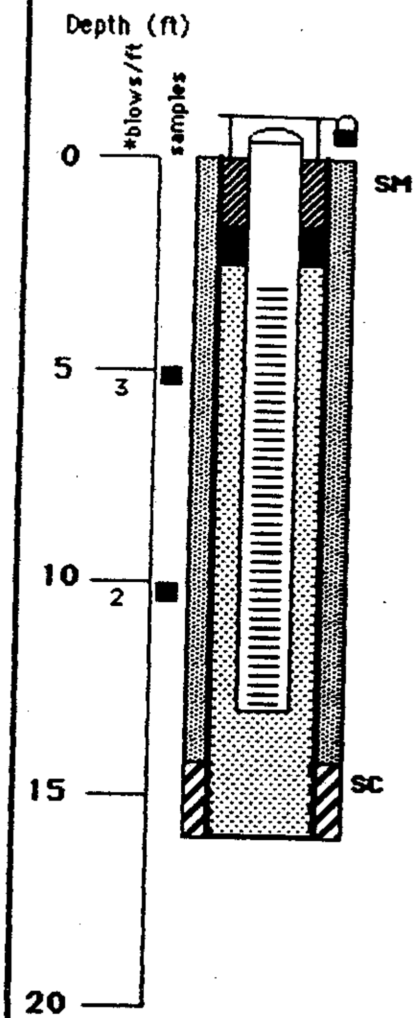
MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.23'
Static Water Level Elevation -	4.37'
Date Measured -	1/9/87
Surface Elevation -	9.92'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Description



SM — Silty sand with trace gravel, brown-black, moist

Silty sand with trace clay, brownish gray, wet, very soft

SC — Silty clay with trace organics, black-brown, wet

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

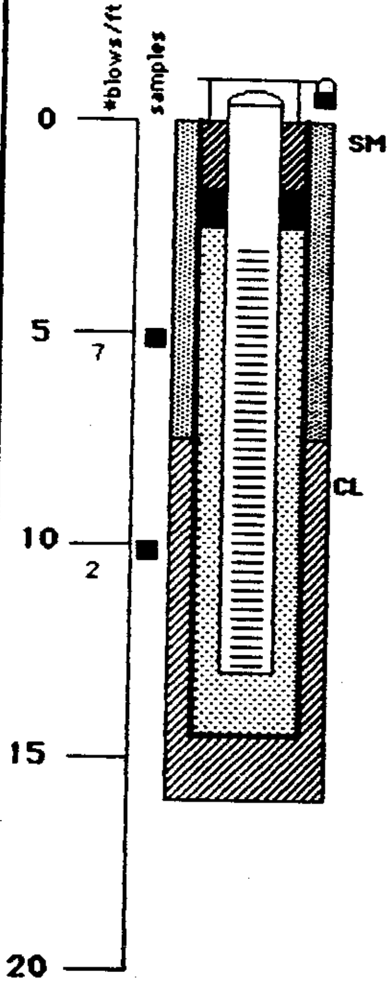
Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Dave Wagner

Depth (ft)

Description



SM: Silty sand with trace gravel and clay, fine, brown-black, moist

CL: Silty clay with trace sand, black-brown, moist

Boring/Well No. - H86

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/26/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	7"
Borehole Depth -	16'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	13.20'
Static Water Level Elevation-	5.94'
Date Measured -	1/9/87
Surface Elevation -	9.86'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- Filter Pack
- Bentonite Seal
- Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist: Dave Wagner

Boring/Well No. - H87

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/26/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

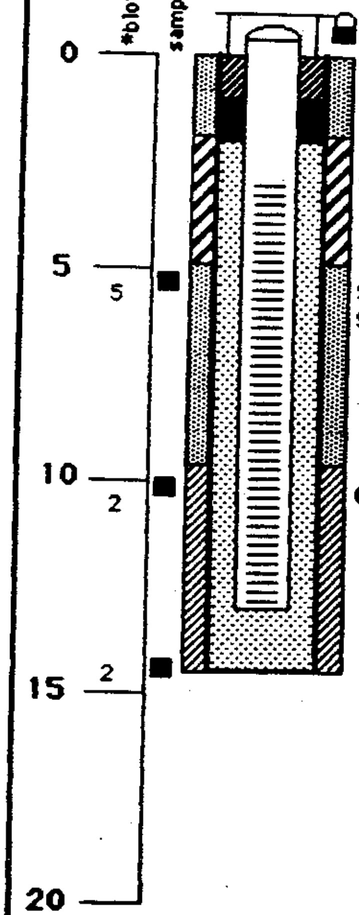
MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.15'
Static Water Level Elevation -	6.06'
Date Measured -	1/9/87
Surface Elevation -	9.59'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



Depth (ft)	*blows/ft	Unit	Description
0		SM	Silty sand with trace gravel, black, moist
		SC	Silty clay, brown-black, moist
5	5	SM/SC	Silty sand with trace gravel, black-brown, moist; free product
10	2	CL	Silty clay, black-brown, wet, loose
15	2		

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/26/86

Supervising D & M Engineer/Geologist Dave Wagner

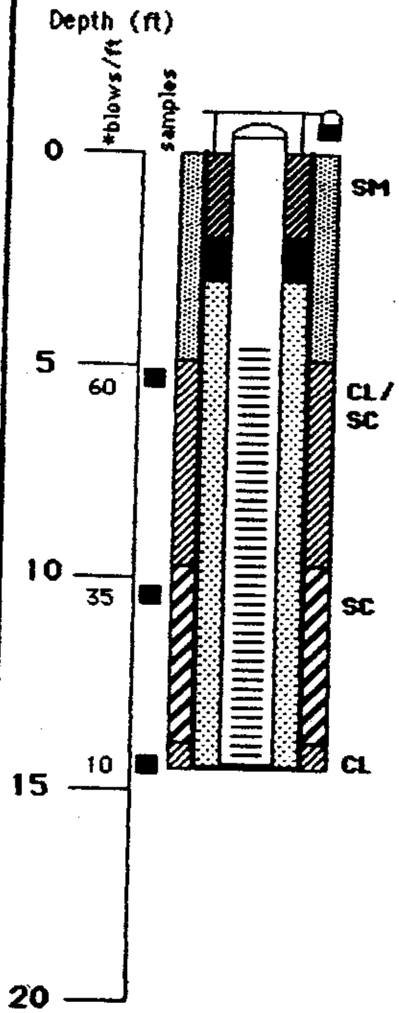
Boring/Well No. -BF88

Location - Chevron Refinery

Driller - Drill Consult

Drilling Completed - 2/26/86

Type of Rig - Hollow Stem Auger



Soil	Description
SM	Silty sand with trace gravel, brown-black, moist, hard
CL/SC	Clayey silt with trace sand, brown, moist
SC	Gravelly medium sand with some silt and clay
CL	Silty clay, gray-brown, moist

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	14' 6"
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14' 6"
Screen Setting -	4'6" - 14' 6"
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	12.93'
Static Water Level Elevation -	2.46'
Date Measured -	1/9/87
Surface Elevation -	9.78'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF89

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer/Geologist T. Helgason

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	13.5'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13.5'
Screen Setting -	3.5' - 13.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

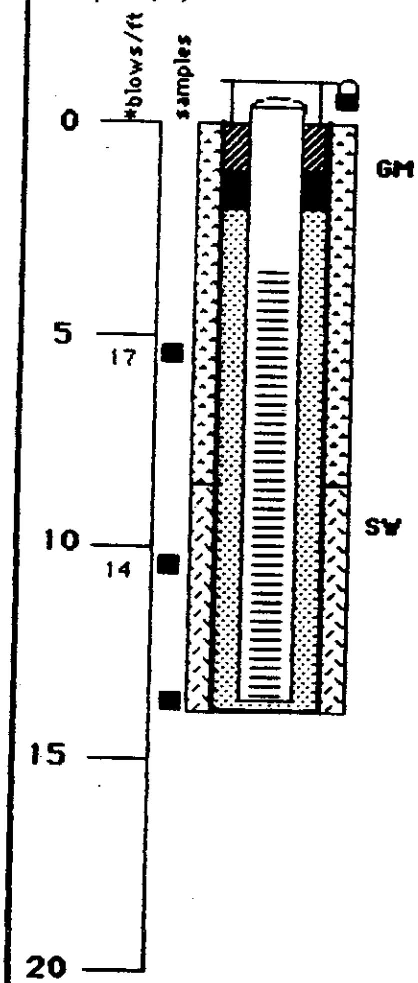
Top of Casing Elevation -	11.81'
Static Water Level Elevation -	2.61'
Date Measured -	1/9/87
Surface Elevation -	11.57'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)

Description



Gravel to crushed stone, light brown

Silty gravel with some course sand, dark brown

Gravel with some white gravel with greenish deposits, reddish brown

Fine to coarse sand with some cobbles, dark brown

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack	
Bentonite Seal	
Cement Grout	

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

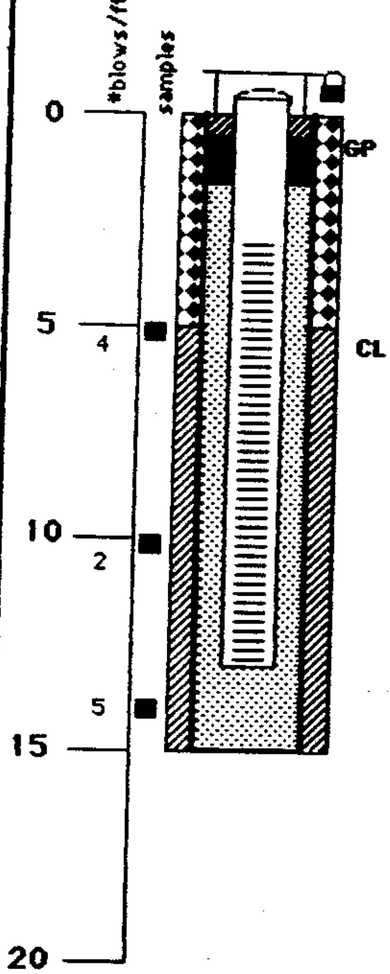
Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M.W. completed 2/19/86

Supervising D & M Engineer /Geologist E. J. Fillo

Depth (ft)



Description

Black oily fill (crushed stone)

Black oily fill

Silty clay with trace fine sand, light brown, wet, soft

Silty clay with plant fragments, brownish gray, wet, very soft

Silty clay with plant fragments, gray, wet, medium stiff

Boring/Well No. - BF90

Location -	Chevron Refinery
Driller -	Drill Consult
Drilling Completed -	2/19/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	7"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.68'
Static Water Level Elevation -	8.33'
Date Measured -	1/9/87
Surface Elevation -	9.44'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

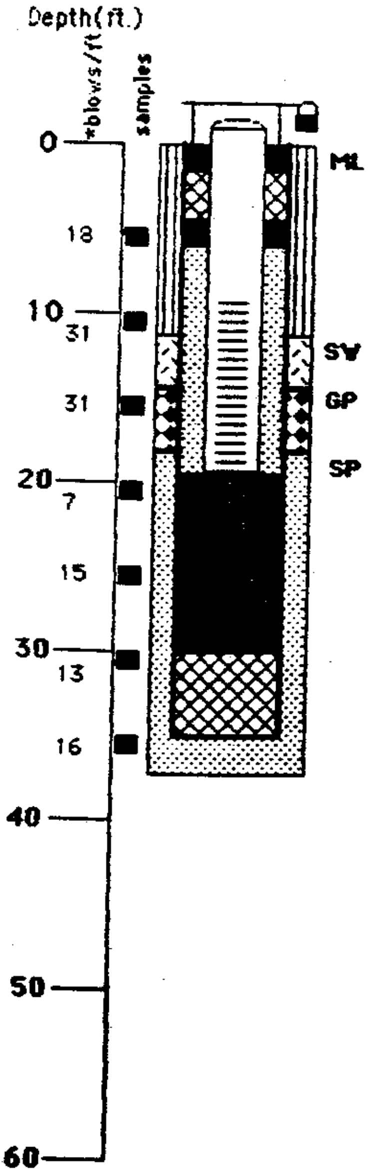
Boring/Well No. - BF99

Project No. 113-950-032

Date M.W. completed 10/21/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/21/86
Type of Rig -	Hollow Stem Auger



Description

Silt with little to some fine sand, trace clay, medium brown, medium dense, moist; organics

Fine to coarse sand with little fine gravel, medium brown, dense, moist; strong petroleum odor

Fine gravel with little fine to coarse sand, trace silt, medium brown, dense, saturated; strong petroleum odor

Fine to medium sand with trace silt, light brown, loose, saturated

Grading to orange-brown

Trace to little clay and gravel; weak petroleum odor

Fine to coarse sand with trace fine gravel, trace silt, orange-brown, medium dense, saturated

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	35'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	19.5'
Screen Setting -	9.5' - 19.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	2 Sand
Type of Grout -	-

MEASUREMENTS(NGVD)

Top of Casing Elevation -	13.37'
Static Water Level Elevation -	2.29'
Date Measured -	1/14/87
Surface Elevation -	12.62'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

BENTONITE GROUT

CAVE IN MATERIAL

CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF100

Project No. 113-950-032

Date M.W. completed 10/17/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/17/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

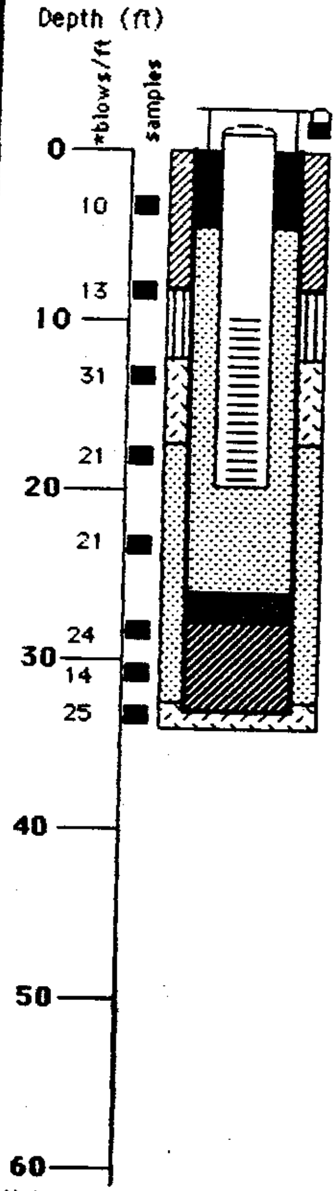
Borehole Diam. -	10"
Borehole Depth -	33'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	19.5'
Screen Setting -	9.5' - 19.5'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	*2 Sand
Type of Grout -	Bentonite

MEASUREMENTS(NGYD)

Top of Casing Elevation -	14.62'
Static Water Level Elevation -	1.79'
Date Measured -	1/14/87
Surface Elevation -	11.46'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	



Description

CL Clay with some silt, trace fine sand, light brown, stiff, moist

ML Silt and clay, trace gravel, medium brown, stiff, moist
Increasing silt; silt with little to some clay

SW Fine to coarse sand with some fine gravel, yellowish-brown, dense, saturated

SP Fine sand with little clay, little silt, light yellowish-brown, medium dense, saturated
Fine to medum sand with trace to little silt, trace clay, grayish-brown, medium dense, saturated
1' clay lense from 29' to 30'; clay with some silt, gray, moist
Decreasing clay; trace clay

SW Fine to coarse sand with trace to little fine gravel, trace silt, orangish-brown, medium dense, saturated

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:
* Blows taken using a 140 lb hammer falling 30 inches.
** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Project No. 113-950-032

Date M.W. completed 10/15/86

Supervising D & M Geologist David Wagner

Boring/Well No. - BF101

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/15/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	59'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

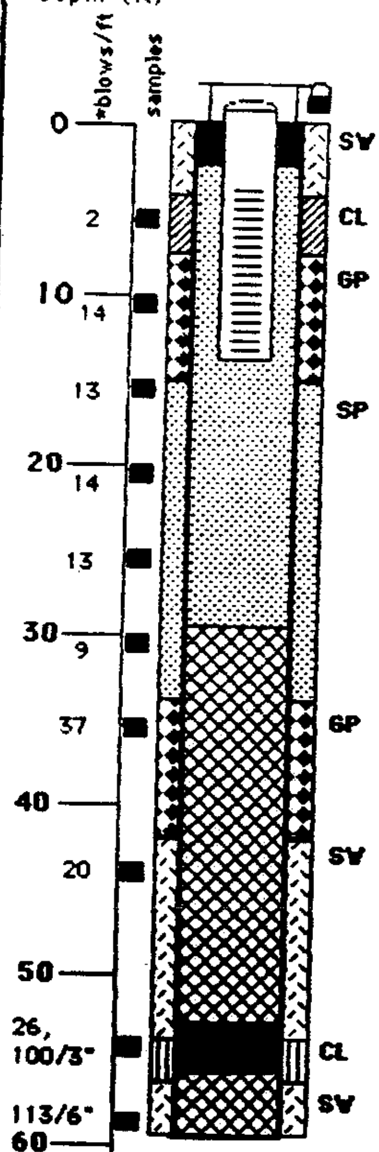
MEASUREMENTS (NGVD)

Top of Casing Elevation -	9.03'
Static Water Level Elevation -	2.19'
Date Measured -	1/14/87
Surface Elevation -	6.12'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft)



Description

- SV — Fine to coarse sand, little to some silt, trace fine gravel, blackish-brown, loose, very moist
- CL — Clay with little to some silt, grayish-brown, soft, moist; abundant organics
- GP — Fine gravel with little to some fine to coarse sand, trace silt, very dense, saturated
- SP — Fine to medium sand with trace silt, light brown, medium dense, saturated
  - Grading to fine sand with little to some silt, trace clay
  - Grading to fine to coarse sand with little to some silt
- GP — Fine gravel with little to some fine to coarse sand, trace silt, brown, dense, saturated
- SV — Fine to coarse sand with little to some fine gravel, trace silt, light brown, medium dense, saturated
  - Increasing gravel; some fine gravel
- CL — Clay with little to some silt, light reddish-brown, very stiff, moist
- SV — Fine to coarse sand with little fine gravel, brown, very dense, saturated

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF102

Project No. 113-950-032

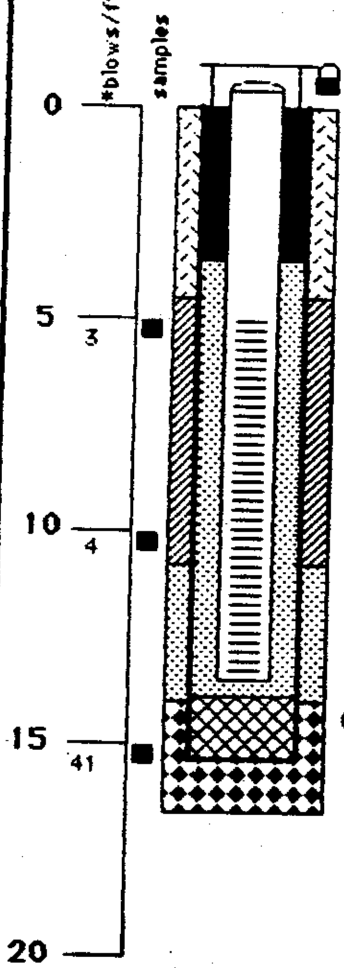
Date M.W. completed 10/10/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/10/86
Type of Rig -	Hollow Stem Auger

Depth (ft)

Description



Class	Description
SW	Fine to coarse sand with little silt, blackish - brown, loose, saturated
CL	Clay with little to trace silt, gray, soft, very moist
	Clay with some silt, trace fine sand, very dark brown, soft, very moist to saturated
	Increased fine sand and silt
SP	Fine sand with little silt and little clay, brown and gray, loose, saturated
GP	Fine gravel with little fine to coarse sand, trace silt, brown and gray, dense, saturated

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	

MEASUREMENTS(NGVD)

Top of Casing Elevation -	8.40'
Static Water Level Elevation -	4.95'
Date Measured -	1/14/87
Surface Elevation -	5.40'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

CONCRETE

CAVE IN MATERIAL

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Boring/Well No. - BF103

Project No. 113-950-032

Date M.W. completed 10/8/86

Supervising D & M Geologist David Wagner

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/8/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	35'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4' - 14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Bentonite

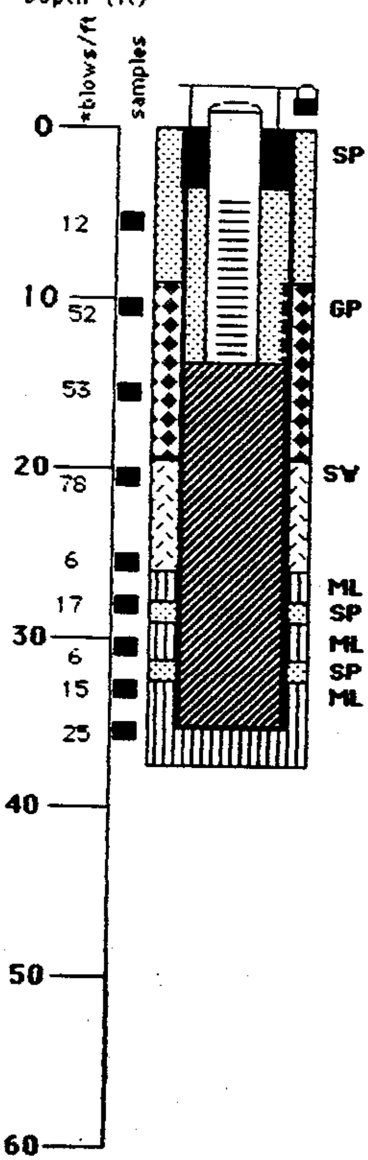
MEASUREMENTS(NGVD)

Top of Casing Elevation -	16.73'
Static Water Level Elevation -	2.09'
Date Measured -	1/14/87
Surface Elevation -	13.88'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Satic Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | Description



SP: Fine to medium sand, some silt, little fine gravel, brownish-black, medium dense, saturated; brick fragments

GP: Fine gravel with little to some fine to coarse sand, trace silt, light brown, very dense, moist

SW: Fine to coarse sand with trace to little silt, little fine gravel, light brown, very dense, saturated

26'-28' Silt with little fine to medium sand, little clay, gray, grading to reddish-brown toward bottom of spoon, medium stiff, saturated; wood fragments

28'-29' Fine to medium sand with trace to little silt, little clay, trace coarse sand, light brown, medium dense, saturated

29'-31' Silt with little fine to medium sand, trace clay, brownish-gray, medium stiff, saturated

31'-32' Fine to medium sand with trace to little silt, little clay, trace coarse sand, light brown, loose, saturated

32'-37' Silt with little clay, trace to little fine sand, gray, soft, saturated

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE GROUT
- CAVE IN MATERIAL
- CONCRETE

DAMES & MOORE

Unified Soil Classification System

Major Divisions			*Graph Symbol*	*Letter Symbol*	*Typical Descriptions*
Coarse Grained Soils More than 50% of material is LARGER than No.200 sieve size	Gravel and Gravelly Soils More than 50% of coarse fraction RETAINED on No.4 sieve	Clean Gravels (Little or no fines)		GW	Well graded gravels, gravel - sand mixtures, little or no fine
				GP	Poorly graded gravels, gravel - sand mixtures, little or no fine
		Gravels with Fines (Appreciable amount of fines)		GM	Silty gravels, gravel - sand - silt mixtures
				GC	Clayey gravels, gravel - sand - clay mixtures
	Sand and Sandy Soils More than 50% of coarse fraction PASSING No.4 sieve	Clean Sand (Little or no fines)		SW	Well - graded sands, gravelly sands, little or no fines
				SP	Poorly-graded sands, gravelly sands, little or no fines
		Sands with Fines (Appreciable amount of fines)		SM	Silty sands, sand - silt mixtures
				SC	Clayey sands, sand - clay mixtures
Fine Grained Soils More than 50% of material is SMALLER than No.200 sieve size	Silts and Clays	Liquid limit LESS than 50		ML	Inorganic silts and very fine sands or clayey silts with slight plasticity
				CL	Inorganic clays of low to medium plasticity
				OL	Organic silts and organic silty clays of low plasticity
	Silts and Clays	Liquid limit GREATER than 50		MH	Inorganic silts, micaceous or diatomaceous fine sand or silty soils
				CH	Inorganic clays of high plasticity, fat clays
				OH	Organic clays of medium to high plasticity, organic silts
Highly Organic Soils				PT	Peat, humus, swamp soils with high organic contents

Notes:

1. Dual symbols are used to indicate borderline classifications.
2. When shown on the boring logs, the following terms are used to describe the consistancy of cohesive soils and the relative compactness of cohesionless soils.

Cohesive Soils

	(approximate shearing strength in KSF)
very soft	less than 0.25
soft	0.25 to 0.5
medium stiff	0.5 to 1.0
stiff	1.0 to 2.0
very stiff	2.0 to 4.0
hard	greater than 4.0

Cohesionless Soils

very loose
loose
medium dense
dense
very dense

These are usually based on an examination of soil samples, penetration resistance, and soil density data.

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APPENDIX B-1

SLURRY WALL REPORT

REPORT
SLURRY WALL DESIGN AND SPECIFICATIONS
CHEVRON-GULF REFINERY
PHILADELPHIA, PENNSYLVANIA
DAMES & MOORE JOB #16000-019

APRIL 29, 1988

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APPENDICES

1.0 INTRODUCTION

This report presents the results of Dames & Moore's geotechnical design for a downgradient, slurry cut-off wall. The proposed slurry wall is to be constructed at areas where liquid hydrocarbons have migrated through the existing sheet-pile wall at the Chevron-Gulf refinery in Philadelphia, Pennsylvania.

The results are based upon available site and laboratory data. The design inputs and specifications focus on soil-bentonite backfilled walls. Hydrogeologic site data are based on a previous Site Assessment Investigation at the Chevron-Gulf refinery, summarized in Dames & Moore's May 18, 1987, report.

The Chevron-Gulf refinery is located approximately 5 miles southwest of center city Philadelphia, as shown in Figure 1. The Main Plant and the Schuylkill River Tank Farm are located in a heavily industrialized area (primarily petrochemical) adjacent to the Schuylkill River. Two areas of product breakthrough were reportedly observed within Area A of the Main Plant, near wells A20 and A21 (Figure 2).

2.0 OBJECTIVE AND SCOPE OF WORK

The objective of the project is to provide detailed designs and specifications for the remedial action program within the area shown in Figure 2. This program is designed to intercept the liquid hydrocarbons that have previously discharged through the existing sheet-pile wall. Technical specifications for construction of a partially penetrating slurry cut-off wall are provided.

In order to meet the project objective, the following tasks were completed:

Task 1 - Site Background Data Review

To characterize the site stratigraphy and hydrogeologic conditions along the proposed slurry wall alignment, we reviewed our report entitled "Site Assessment Investigation," dated May 18, 1987.

Task 2 - Laboratory Testing For Slurry Wall

The design of the soil-bentonite backfill mix was based on a series of results obtained from laboratory testing on potential backfill materials. The laboratory testing program was performed in order to identify a mix that would meet the specified permeability requirement (1×10^{-7} cm/sec or less) for the completed wall.

Based on Dames & Moore's previous study at the site, the in-situ soils along the proposed slurry wall alignment were judged to be unsuitable for use in a soil-bentonite backfill mix. Therefore, suitable borrow sources were contacted for samples of silty sand.

The laboratory testing program and procedures implemented during design of the slurry cut-off wall are presented in Section 4.0 of this report.

Task 3 - Preliminary Assessment of Slurry Wall Compatibility

Field and laboratory data and case histories of slurry wall performance were evaluated to assess the integrity of the slurry wall. The analysis included a review of available literature and analysis of compatibility testing performed under Task 2. The laboratory compatibility testing was required in order to assess observed changes in permeability as a result of slurry wall exposure to site contaminants.

Task 4 - Slurry Wall Specifications and Design

Technical specifications for the slurry wall design were selected based on evaluation of site hydrogeology and laboratory data. Design criteria include wall alignment, width, depth, slurry mix, and construction procedures.

During the course of this investigation, Chevron requested Dames & Moore to identify three contractors for construction of the proposed slurry wall. The results of this investigation and the results of Tasks 1 through 4 are presented in this report.

3.0 BACKGROUND DATA

Sections 3.1 and 3.2 present the results of our background data review. The source of background information reviewed included Dames & Moore's report, "Site Assessment Investigation," dated May 18, 1987.

3.1 SITE HYDROGEOLOGY

From the ground surface downward, the four stratigraphic units present at the site are:

- Non-indigenous fill material
- Salt marsh deposits
- Farrington Sand (Cretaceous)
- Mica schist bedrock

The fill material ranges from 0 to 10 feet in thickness and consists of sand, silt, and gravel mixtures. Underlying the fill material are 20 to 70 feet of marsh deposits that consist of silt and clay of low permeability. The silt and clay layer hydrogeologically restricts flow between the upper and lower aquifers.

The thicknesses of these geologic units along the proposed slurry wall are shown on cross section B-A-B' (Figure 3). The location of the cross section is shown in Figure 2. Boring logs and monitoring well construction details of soil borings along the proposed slurry wall are presented in Appendix A.

Ground water is present under water table conditions within the fill at the site. The depth to ground water at the proposed slurry wall location is approximately 2 to 5 feet below the ground surface. Fluctuations recorded in wells monitored at the site during a tidal study previously performed by Dames & Moore did not reflect tidal fluctuations. The average permeability of the upper aquifer at the site is 1.53×10^{-5} ft/sec. The vertical permeability of the silty clay layer ranges from 9.51×10^{-9} cm/sec to 7.91×10^{-7} cm/sec, with an average permeability of 3.27×10^{-7} cm/sec. The head difference between the upper and lower aquifers at the site ranges from 6.29 to 7.48 feet. The estimated vertical leakage rate is 0.15 ft/year. The average velocity of the horizontal ground water flow was estimated at 0.43 ft/year.

3.2 LIQUID HYDROCARBONS

Liquid hydrocarbons exist on the ground water table in the area of the proposed slurry wall. Monitoring well A20 contained liquid accumulations less than 1 foot thick. The thickness of the liquid hydrocarbon in well A21, which is near the slurry wall alignment, was not determined due to the high viscosity of the liquid hydrocarbon that coated the measuring instrument.

4.0 LABORATORY INVESTIGATION

A laboratory testing program was conducted to provide data for design of the soil-bentonite backfill mix. The procedures involved in this design process are described in this section. Additional data and descriptions of laboratory testing apparatus are included in Appendices B and C.

4.1 LABORATORY TESTING PROCEDURES

Laboratory procedures used to establish the mix criteria for the soil-bentonite slurry wall were in accordance with the methods outlined in Table 1.

4.1.1 Material Evaluation

The initial portion of the laboratory testing program included evaluation of off-site soil borrow sources for incorporation as part of the soil-bentonite backfill mix. Due to the heterogeneous nature of the fill material at the site and liquid hydrocarbon contamination of the soils that exists along the proposed slurry wall location, the in-situ soils at the site were found to be unsuitable for use in a soil-bentonite backfill mix.

Five borrow sources were identified as potential backfill sources for the slurry wall mix. The results of the borrow source investigations are presented in Section 5.0. Representative samples of materials present at these sources were subjected to a series of sieve analyses for the percent fines (passing No. 200 sieve) and hydrometer analyses of these fractions for clay content. Results of these tests are included in Appendix B. The results were used to evaluate the number of sources and materials for additional testing. The borrow selected for use in the soil-bentonite backfill mix consisted of fine silty sand with 25 percent fines. Other soil tests performed on the selected borrow material included water content, compaction, and permeability. The results of these tests are summarized in Table 2. The grain-size analysis and compaction test data are included in Appendix C.

In order to evaluate the suitability of selected borrow material for capping the slurry wall, the material was compacted to a density of 95 percent of the maximum density as determined by ASTM D-1557. The permeability obtained was 1.06×10^{-4} cm/sec. This value is three orders of magnitude greater than the specified permeability (1×10^{-7} cm/sec or less) for the cap material; therefore, this material will not be used for capping.

During the course of this investigation, several sources of Wyoming bentonite provided by different manufacturers were evaluated. We concluded that Volclay Saline Seal 100 (SS-100), manufactured by American Colloid Company of Skokie, Illinois, is most suitable for the proposed site. Saline Seal 100 is specifically formulated for use where the fluid to be controlled contains relatively high concentrations of contaminants. The physical properties of SS-100 are provided in Table 3.

4.1.2 Slurry Mix Design

The bentonite slurry was prepared by gradually introducing dry bentonite into a specific volume of distilled water. The slurry was then fully blended with a mechanical mixer. Viscosity was frequently examined during the operation. Bentonite was continuously added and the viscosity was recorded until a 40-second Marsh viscosity was obtained. The amount of bentonite at this viscosity is 8 percent by weight of the slurry. The slurry was then subjected to a density test and filtrate-loss examination. Tests were performed in accordance with procedures outlined in API 13B. Test results are presented in Table 4.

4.1.3 Soil-Bentonite Backfill Mix Design

The soil-bentonite backfill mix was prepared with 6 percent and 8 percent dry bentonite, and was then sluiced with slurry. Trial batches were performed until a slump of 3 to 7 inches was obtained. Physical properties were then determined. The results of grain-size analysis are summarized in Table 5.

4.1.4 Permeability/Compatibility Tests

The selected design mix, which incorporates a mixture of off-site borrow soil, dry bentonite, and slurry, was evaluated using permeability tests. Initial permeability was determined with a fixed-wall, double-ring permeameter and the selected mix was permeated with distilled water. The selected mix was saturated with back-pressure and the permeability was determined with an applied constant head. The permeability was defined after several consistent values had been obtained. The final permeability evaluation was performed with a flexible-wall permeameter. The selected mix was permeated with water, back-pressured to saturation, and then consolidated with a pressure of 2 psi. This pressure is similar to conditions that will be encountered in the field. A hydraulic gradient of 100 was then applied to expedite the pore volume exchange. Site hydrocarbon/ground water was then introduced as the permeant, and changes in permeability were recorded after an exchange of two pore volumes of the permeant. The test results are presented in Table 6. The information obtained from these procedures was used in evaluating slurry wall compatibility.

4.2 RESULTS OF SLURRY WALL LABORATORY TESTING

Laboratory testing results are summarized in Table 6. The results of the testing program are integrated with Section 6.0, Slurry Wall Design. Laboratory analysis shows that:

- Borrow soils selected for use in the soil-bentonite backfill mix consist of silty sands with 25 percent fines.

- Permeability, as determined from tests performed on borrow soils, is 3.07×10^{-4} cm/sec. The material will have a permeability of 1.06×10^{-4} cm/sec when compacted to 95 percent of the maximum density.

- The results of slurry wall backfill permeability testing using distilled water indicate that a mix consisting of off-site borrow soils with 25 percent fines, and a total of 10 and 12 percent bentonite yield permeabilities of 7.78×10^{-8} cm/sec, and 4.49×10^{-9}, respectively.

- As a result of passing two pore volumes of site hydrocarbon/ground water through the mix, the permeabilities increased to 9.03×10^{-8} cm/sec and 7.64×10^{-9} cm/sec, respectively.

5.0 BORROW MATERIALS

An investigation was made to identify sand borrow sources by contacting private material suppliers in the Philadelphia, Pennsylvania, and Camden, New Jersey, areas. Based on interviews with sand pit operators, five sand borrow sources were identified. Table 7 presents the names and locations of these sources.

Representative bulk soil samples collected from these sources were subjected to a series of sieve analyses for the percent fines (passing No. 200 sieve sizes). Results of these analyses are included in Appendix B. Based on the results, borrow sand from two sources (Continental Sand and Gravel in Camden, New Jersey, and Rustic Materials in Monmouth, New Jersey) appears to meet the requirements for this project. The samples obtained from Rustic Materials were not further evaluated because of the source's distant location. Therefore, Continental Sand and Gravel was selected as a borrow source.

Continental Sand and Gravel operates a borrow pit in Erial-Williamstown, New Jersey. The thickness of the silty, clayey sand strata as reported by the sand pit operator is 4 to 5 feet and covers an approximate area of 2-1/2 to 3 acres.

6.0 PURPOSE AND GENERAL SPECIFICATIONS FOR SLURRY WALL DESIGN CRITERIA

The purpose of the downgradient slurry wall is to intercept the liquid hydrocarbons floating on top of the ground water table that have discharged through the existing sheet-pile wall into the Schuylkill River. The slurry wall will extend below the ground water table to intercept the liquid hydrocarbons. Based on previous studies performed at the site, ground water elevations appear to fluctuate due to seasonal effects. Since detailed site-specific data on ground water fluctuations are not available, the slurry wall will extend from the ground surface to 3 feet below mean sea level (Figure 6). Mean sea level was selected because the ground water table is not expected to drop below this point. The 3-foot extension below mean sea level allows for possible depression of the water table due to the weight of the liquid hydrocarbons on the water table. Based on ground elevations recorded previously during the site investigation, the ground elevation ranges from elevation +8.5 to elevation +9 feet (NGVD). Therefore, the total depth of the slurry wall will be approximately 12 feet.

The slurry wall will be constructed in a trench excavated against the existing sheet-pile wall. Construction of the proposed slurry wall against the existing sheet-pile wall will not endanger the stability of the sheet-pile wall, because:

1. The depth of the sheet piling is much greater than the depth of the proposed slurry wall. Therefore, the trench excavation will not extend below the base of the existing sheet piling.

2. The trench will be excavated while being kept filled with bentonite slurry; hence, the sheet piling will not be left unsupported.

3. The unit weight of the proposed slurry wall will be similar to the unit weight of existing soil against the sheet-pile wall. This condition indicates that there will not be changes in lateral earth pressure.

The slurry wall will extend approximately 480 feet along the sheet-pile wall. The slurry wall location is shown on Figure 4, and a representative cross section is shown on Figure 5. The slurry wall will be approximately 3 feet in width and have an in-place permeability of 1×10^{-7} cm/sec.

The liquid hydrocarbons that are migrating toward the river will be intercepted behind the slurry wall. To collect the liquid hydrocarbons that may accumulate behind the slurry wall, recovery wells should be incorporated as part of the remedial action program. Note that the slurry wall alone will not completely stop liquid hydrocarbon migration into the Schuylkill

River. The effectiveness of the slurry wall can be dramatically increased by incorporating recovery wells equipped with an oil recovery system. The need for these wells upgradient and adjacent to the slurry wall, and their design, are discussed in Section 8.0 of this report.

The proposed slurry wall location is generally 35 to 50 feet from the existing structures and utilities (Figure 4). This distance will facilitate access by construction equipment. The slurry wall alignment along the existing sheet-pile wall will require the removal of two stairways and relocation of the existing telephone pole located between the boat house and sheet-pile wall. The slurry wall will extend between the boat house and sheet-pile wall. Note that special excavating equipment may be needed to fully reach behind the boat house to the required depth. The alignment of the slurry wall will require the removal of any existing underground utility line located within 4 feet of the sheet-pile wall.

6.1 SLURRY MIX

The slurry mix introduced into the trench excavation will be suitable to provide for trench wall stability and the creation of a filter cake along the trench walls. The slurry is prepared outside of the trench in ponds or other appropriate mixing basins by using on-site tap water and high-sodium montmorillonite bentonite (SS-100).

Water used to hydrate the bentonite is to be low in hardness, near neutral or slightly higher pH, and low in dissolved solids. Suggested maximum limits are:

Hardness	50 ppm
Total Dissolved Solids	500 ppm
Organics Content	50 ppm
Free of oil or other substances	
pH	approximately 7

Mixing of the bentonite slurry will ensure that the bentonite is fully hydrated. The slurry will be introduced into the trench when the following specifications have been met for each batch:

Viscosity	>40 seconds Marsh @ 68^{o}
Unit Weight	65 to 85 pcf (1.04-1.36 g/cm^3)
Filtrate Loss	30 cc in 30 min at 100 psi
Bentonite Content	8 percent

If significant slurry loss is observed in the trench (i.e., slurry level falling below 3 feet beneath the top of the trench), slurry viscosity may be increased if the slurry does not interfere with excavation efforts and placement of the backfill. Slurry additives to improve slurry gel strength, filter cake formation, and resistance to flocculation may be introduced in accordance with the bentonite manufacturer's recommendations, but only after approval of the construction engineer. After achieving the parameters described in this section, the slurry may be introduced into the excavation.

After placement, the density of the fresh slurry will probably increase. Therefore, the fresh slurry should be mixed at the lower limits of unit weight unless in-place testing indicates the need for a heavier slurry.

6.2 BACKFILL MIX

The backfill mix for the slurry wall construction will be off-site soils and sodium bentonite. These soils will be mixed at the site and placed into the slurry trench in accordance with guidelines described in Section 7.0.

The backfill should consist of off-site soils, dry bentonite, and bentonite slurry. The gradation and materials used for the backfill shall be such that the slurry wall achieves an in-place permeability of less than 1×10^{-7} cm/sec with liquid hydrocarbon as the permeant. Our final design criteria for the mix are:

$\geq$ 25%	Fines content in off-site soils
$\geq$ 8%	Dry bentonite
$\geq$ 12%	Total bentonite content in the backfill
3.5 inches	Slump
$\geq$ 32%	Total fines content
$\geq$ 100 pcf	Density

The result of permeability testing of the recommended backfill mix, with distilled water as a permeant, is 4.49×10^{-9} cm/sec. When site ground water/liquid hydrocarbon was used as a permeant, the permeability increased to 7.64×10^{-4} cm/sec. Detailed test results are presented in Section 5.0 and Appendix C.

7.0 SPECIFICATIONS FOR CONSTRUCTION OF SLURRY WALL

7.1 STANDARDS AND DEFINITIONS

7.1.1 Standards

This specification includes references to our requirements for meeting or adhering to certain Standard Specifications or Tentative Specifications of the American Petroleum Institute or the American Society for Testing Materials. In these specifications, the letters "API" or "ASTM" shall mean the latest revision of those Standard Specifications or Tentative Specifications of the API or ASTM.

7.1.2 Definitions

a. OWNER

In these specifications, the word "OWNER" shall mean Chevron or any individual appointed by Chevron and charged with technical acceptance of the work for the OWNER, or his authorized agents, engineers, assistants, and inspectors acting severally within the scope of the particular duties and authorities delegated to them.

b. CONTRACTOR

In these specifications, the word "CONTRACTOR" shall mean the firm hired by Chevron and charged with the preparation of the site, excavation of the slurry trench, and construction of the slurry cut-off wall as required by this specification.

7.2 EXCAVATION OF SLURRY TRENCH

7.2.1 Excavation Equipment

Excavation of the slurry wall should be accomplished by use of suitable earth-moving equipment or combination thereof, such as backhoe or clamshell. The required trench width should be carried to its final depth of cut continuously along the trench line from the starting point to the finishing point. Total depth of the excavation is anticipated to be approximately 12 feet.

The CONTRACTOR shall have personnel, equipment, and materials ready to raise the slurry level at any time. The CONTRACTOR shall have personnel on call to raise the slurry level, weekends and/or holidays included.

The total depth of the wall will be approximately 12 feet. The OWNER reserves the right to modify the elevations, lines, and cross sections on the drawings as may be determined in the field.

7.2.2 Trench Excavation and Slurry Placement

Trenching may be conducted in two steps. During Step 1, the trench shall be excavated through the unsaturated zone to and slightly under the ground water table, without introducing bentonite slurry into the trench. This configuration will allow the accumulated liquid hydrocarbons to enter the trench.

The liquid hydrocarbons will then need to be removed. In this manner, a significant volume of liquid will be effectively removed from the plume.

During Step 2, the trench shall be deepened to the designed final depth; and at the same time, slurry shall be introduced and maintained within the trench to provide stability. The slurry level shall be maintained at least 3 feet above the ground water table in order to provide hydrostatic pressure necessary to hold the trench open. The slurry level shall not be more than 3 feet below the top of the slurry trench. The CONTRACTOR shall maintain the stability of the excavated trench at all times for its full depth.

Once the trench excavation is underway, slurry placement and backfill will be performed simultaneously. The end of the excavation slope shall precede the toe of the backfill by not less than 50 feet, in order to permit inspection and measurement.

The depth of the excavation shall be controlled by direct measurements taken along its length. This procedure will verify that the trench has been excavated to the required design depth. Details of quality control procedures are contained in Section 7.4.

7.2.3 Slurry Mixture

a. Materials

Bentonite - The bentonite powder or granules used in the slurry shall be natural, high-swelling, montmorillonite-base product. The material shall be Volclay Saline Seal 100 as manufactured by American Colloid Company, 5100 Suffield Court, Skokie, Illinois 60066.

Water - The water shall be clean, fresh, and free of oil, acid, alkali, organic matter, or other deleterious substances. The CONTRACTOR shall obtain all required water from approved water supply systems. It is the responsibility of the CONTRACTOR that the slurry resulting from the water that is used meets the standards in this specification.

Additives - No additives of any kind shall be used without the written approval of the OWNER.

Bentonite Slurry - The bentonite slurry shall consist of a stable colloidal suspension of sodium bentonite in water and shall be controlled in accordance with API RP 13B, Sections 1, 2, 3, 4, 5, and 6 "Standard Procedure for Testing Drilling Fluids," and to these requirements:

- At the time of introduction of the slurry into the trench, the initial slurry shall be a mixture of not less than 12.5 pounds per barrel (42 gallons) of bentonite and water. Additional bentonite may be required, depending on the hardness and temperature of the water. This slurry mixture shall have a minimum apparent viscosity of 15 centipose or 40 seconds reading through a Marsh Funnel Viscosimeter, a maximum filtrate loss of 30 cubic centimeters in 30 minutes at 100 psi, and a pH of not less than 8.

- The slurry mixture in the trench shall have a maximum filtrate loss of 30 cubic centimeters in 30 minutes at 100 psi, and shall have a density not less than 65 pcf (1.03 gm/cc) and not greater than 85 pcf (1.40 gm/cc), or as approved by the OWNER.

- The bentonite slurry shall be pumped out from the pond area to trenching operations as required. If the density of the slurry in the trench exceeds the specified limits, or the slurry becomes unworkable, the excess solids shall be removed from the slurry by airlift pump, clamshell, or other methods approved by the OWNER.

- The CONTRACTOR shall correlate with the bentonite manufacturer to ensure that the bentonite is properly hydrated with fresh water prior to being introduced into the trench, and that it is processed in a manner to achieve full performance to seal against future seepage.

7.2.4 Slurry Batching Plant

All slurry for use in the trench shall be prepared using a suitable mixer. No slurry is to be made in the trench. Mixing of water and bentonite shall continue until bentonite particles are fully hydrated and the resulting slurry appears homogeneous. The slurry plant shall include the necessary equipment, such as a mixer capable of producing a colloidal suspension of bentonite in water, sumps, pumps, valves, hoses, supply lines, small tools, and all other equipment that may be required in order to adequately supply slurry to the trench.

Storage ponds shall be provided to store initially mixed slurry and allow hydration, and to serve as a reserve if substantial loss from the trench through underlying pervious zones occurs. The slurry shall be occasionally agitated or recirculated in the storage ponds in order to maintain a homogenous mix or as requested by the OWNER.

7.3 BACKFILLING OF SLURRY TRENCH

7.3.1 Backfill Equipment

The equipment for the mixing and placing of backfill material shall be any type of light earth-moving or grading equipment, such as bulldozers or blade graders for mixing adjacent to the trench, a central mixing plant and sealed body trucks for hauling to the trench, or a portable mixing plant that discharges backfill directly into the trench.

7.3.2 Backfill Placement

No backfill shall be placed until the trench has been inspected and approved by the OWNER. Once the trench excavation has proceeded for a distance that will not result in backfill material being re-excavated, backfill placement can begin. A minimum distance of 50 feet between the end of the active excavation slope and the toe of the backfill shall be maintained. The CONTRACTOR shall demonstrate to the satisfaction of the OWNER that the excavated wall extends to the required design depth.

Backfill shall be placed in the trench by displacing the bentonite slurry. Initially, the backfill shall be placed by lowering the material to the bottom of the trench by means of clamshell buckets or approved equipment, from one location only, until the backfill emerges from below the slurry surface and until its natural angle of repose is achieved from the bottom of the trench to the surface. An alternate means employing a starter trench shall be acceptable for beginning backfilling operations. This system includes starting the backfilling near the ground surface in a temporary trench that leads to the specified trench and that increases in depth from ground surface until it reaches the required depth. Free-dropping of backfill material directly into the slurry-filled trench, or another backfilling operation that segregates the material, will not be permitted.

The remaining backfill material shall be placed in such a manner that the initial slope shall be maintained. The new backfill material shall be placed in the trench at the starting point, and shall then be caused to slump the previously placed backfill. The backfill below the slurry surface shall be pushed along the trench.

If installed during cold temperatures, the backfill material shall be free from ice inclusions or frozen lumps during the placement operation.

7.3.3 Backfill Mix

The backfill mix shall consist of suitable off-site soil containing a minimum of 25 percent fines and a minimum of 8 percent by weight dry bentonite to bring the total amount of bentonite in the backfill mix to approximately 12 percent. The slurry mixed with backfill material shall meet the requirements of the initial slurry introduced into the trench. All particles shall be coated with slurry. The backfill shall be mixed to form a homogeneous mass. The materials shall not be segregated. The mass shall be free of large lumps of clay or silt, and pockets of slurry or sand and gravel. Sluicing with water shall not be permitted. The consistency of the backfill mix shall be such to produce a slump cone reading of 3 to 7 inches of slump when measured with a standard concrete slump cone in accordance with the latest ASTM C143.

7.3.4 Capping

Protection of the completed slurry trench is provided by covering with compacted clay backfill. The clay backfill cap details are shown in Figure 5. It is anticipated that standard earth-moving equipment can be utilized for cap construction. Equipment will consist of a compactor, bulldozer, and loader to move and place the clay. Compaction of clay to achieve design permeabilities can be accomplished with an adequate compaction device. The CONTRACTOR shall be responsible for providing and transporting clay to the site. The slurry wall must settle completely before the clay backfill cap are placed. We anticipate approximately 1 week for the slurry wall to settle. As consolidation might occur during the first few months, additional clay layers may be added. The clay backfill over the slurry wall should have a moisture content of 2 percent wet of optimum. In-field testing will be required to ensure proper placement of the clay.

7.3.5 Cleanup

After completion of the backfill and capping, excavated spoil material and slurry shall be removed or spread, and the surface shall be cleaned and leveled as directed by the OWNER. The excess slurry shall be disposed of by spreading it in thin layers on adjacent areas designated by the OWNER. No slurry shall be left in ponds, and all ponds shall be pumped dry and backfilled.

7.4 QUALITY CONTROL AND TESTING

An independent soils laboratory with supervisory engineers and laboratory technicians shall be retained by the OWNER to perform the quality control testing.

The primary areas of interest for this project are to ensure that the:

1) Total depth of the slurry wall meets the requirements of the design

2) Bentonite slurry meets the specification requirements

3) Backfill meets the specification requirements and is thoroughly mixed and properly placed

7.5 QUALITY CONTROL TESTING

a. <u>Material Requirements</u>

The quality of bentonite powder, the quality of the initial slurry at the time of introduction into the trench, and the quality of slurry mixture in the trench shall be controlled by tests carried out by the Quality Control personnel with the cooperation of the CONTRACTOR. Filter press, pH, and density tests shall be performed as required, with at least one series of tests per shift. The quality control of the slurry in the trench shall be performed at the location of trenching with at least one series of tests per shift.

A slump cone test and bentonite content determination shall be performed on the backfill mix as required with at least one test per 200 cubic yards of backfill material placed in the trench. Grain-size determinations shall be performed as required to ensure compliance.

The CONTRACTOR shall cooperate fully with the OWNER or his representatives in the conduct of these tests. The OWNER's interpretation of test results shall be final and conclusive in determining compliance with the specifications.

The laboratory shall contain, as a minimum, the following equipment:

1 Mold for Slump Test
2 Marsh Funnel Sets
1 Standard Filter Press
2 Mud Balances (direct reading of density)
1 Slurry Sampler
2 No. 200 Sieves

The testing frequency and specified values are identified in Table 8. At least one permeability test shall be performed each day on a representative sample of backfill. The permeability shall be 1 x 10^{-7} cm/sec or lower. In addition, as sections of the wall are completed, at least four undisturbed samples of mid-depth of the wall shall be obtained and tested in a flexible-walled permeameter.

b. Depth Requirement

During the excavation, the depth of excavation shall be visually observed and compared to the depth required in the design (Figure 4). The depth excavated shall be probed on 50-foot centers to ensure that the depth excavated is verified and that caving of the side walls has not occurred. The depth probing shall be performed immediately before backfilling.

7.6 QUALITY CONTROL PERSONNEL

The Slurry Wall Quality Control Personnel shall be a Construction Engineer, Soils Laboratory Supervisor, and Field/Laboratory Technician working as a unit to form the Field Quality Control Group.

7.7 QUALIFICATIONS OF CONTRACTOR

The CONTRACTOR shall be required to submit evidence that he is competent to construct a slurry trench. This evidence shall ensure that the CONTRACTOR or his subcontractor shall have sufficient competent personnel to carry out the operations specified, and that such personnel (as approved by the OWNER prior to award of the Contract) have previous experience in this type of construction. In particular, a construction and slurry specialist(s) shall be used to supervise the construction, slurry preparation, and quality control.

Based on Chevron's request, Dames & Moore has identified three contractors for construction of the proposed slurry wall:

- Engineer Construction International
  10 Duff Road
  Pittsburg, Pennsylvania 15235
  Telephone: (412) 243-1705
  Contact: Bob Conneybeer

- Case International
  450 Parkway
  P.O. Box 338
  Broomall, Pennsylvania 19008
  Telephone: (215) 353-0600
  Contact: Jim Cahill

- Franki Foundation Company
  P.O. Box 3487
  Crofton, MD 21114
  Telephone: (617) 935-1122
  Contact: Rob Harris

8.0 <u>LIQUID HYDROCARBON MONITORING AND RECOVERY</u>

A wedge of liquid hydrocarbon will probably accumulate on the upgradient side of the slurry wall. To prevent the migration of liquid hydrocarbon around or beneath the wall, the vertical and horizontal extent of the liquid will be monitored; if necessary, the liquid will be removed.

To effectively monitor the accumulation of liquid hydrocarbon on the upgradient side of the slurry wall, we propose to install seven 4-inch-diameter wells, one at each end of the wall, and five along the length of the wall, approximately 75 feet apart. The wells will initially be used to monitor liquid accumulations. However, these wells will be designed so that they can also be used to recover liquid.

The wells will be constructed of 4-inch-diameter, continuous-slot, schedule 40 PVC Johnson well screen. To allow for seasonal fluctuations in the ground water table and for the drawdown that is necessary for operation of some of the recovery systems, 10 feet of screen will be installed. The screen will be placed 8 feet below and 2 feet above the water table. To evaluate the most efficient slot size and gravel pack size for the wells, soil samples should be collected from these areas for grain-size analysis. The proposed wells will be sealed above the filter pack with bentonite pellets and a slurry (4:1 cement/bentonite) mix. They will also be fitted with lockable caps and protective posts. Recovery systems that can be installed in the wells, if necessary, will be presented under separate cover.

Liquid hydrocarbon thickness should be measured weekly in all seven wells for the first few months after installation. Thereafter, the liquid thickness can be monitored monthly. The liquid thickness measurements should be reviewed immediately to evaluate the need for recovery.

9.0 REFERENCES

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TABLE 1

LABORATORY TESTING PROCEDURE FOR SOIL-BENTONITE BACKFILL MIX DESIGN

TEST TYPE		METHODS
Material Evaluation		
Off-Site Soil _ _	Sieve/Hydrometer Analysis	D 422
	Water Content	D 2216
	Proctor Density	D 1557
	Permeabilities	Fixed-wall, double-ring permeameter
Bentonite _ _ _	Atterberg Limits	
Slurry Design		
	Viscosity	API Standard 13B
	Unit weight	API Standard 13B
	Filtrate loss	API Standard 13B
SB Backfill Mix Design		
	Trial batch and slump tests	ASTM C143
	Density	ASTM C138
	Moisture	ASTM D2216
	Sieve/Hydrometer analysis	ASTM D422
Permeability Test on SB backfill mix		Fixed-wall, double-ring permeameter using distilled water as permeant
		Flexible-wall (triaxial cell) permeameter with consolidation using distilled water as permeant
Permeability/Compatibility with		Flexible-wall (triaxial cell) permeameter using site ground water/liquid hydrocarbon as permeant.

TABLE 2

SUMMARY OF LABORATORY TEST RESULTS
MATERIAL CHARACTERISTICS - CONTINENTAL SAND AND GRAVEL
BLACKWOOD, NEW JERSEY
BORROW SOURCE

Sample Description	%Fines	Unit Weight (pcf)	Moisture Content (%)	Optimum Water Content (%)	Maximum Dry Density (pcf)	Permeability @ 20%C (cm/sec)
Bulk Soils (silty sand)	25	100.0	18.9	13.6	109.3	3.79×10^{-4}

2208R

TABLE 3

SUMMARY OF PHYSICAL PROPERTIES OF BENTONITE

Bentonite Type	Natural Moisture (%)	Liquid Limit	Plastic Limit	Plasticity Index	Clay Content (%)	Specific Gravity
American Colloid Saline Seal SS-100	10.4	459	42	417	70.2	2.5

TABLE 4

SUMMARY OF LABORATORY TEST RESULTS
FOR
BENTONITE SLURRY

Bentonite Type	% of Bentonite Contained (%)	Unit Weight (g/cm^3)	Viscosity	Filtrate Loss	Thickness of Filter Cake
American Colloid Saline Seal SS-100	8.0	1.05	40 Sec-Marsh @ 20°C	9 ml in 30 min @ 100 psi	1.0 mm after 30-min filtration @ 100 psi

TABLE 5

SUMMARY OF LABORATORY GRAIN-SIZE ANALYSIS
FOR BENTONITE SLURRY BACKFILL MIX DESIGN

Sample No.	Sample Type	Total Bentonite Content (%)	Test Method	%Fines
1	Bulk Soils (off-site)	0	Sieve/Hydrometer Analysis	25.0
	(1) + 10% Bentonite	10	Sieve/Hydrometer Analysis	31.0
	(1) + 12% Bentonite	12	Sieve/Hydrometer Analysis	31.5

TABLE 6

SUMMARY OF LABORATORY PERMEABILITY TEST RESULTS FOR BENTONITE SLURRY BACKFILL MIX DESIGN

Sample No.	Sample Type	Total Bentonite Content (%)	Slump (in.)	Bulk Density (PCF)	Initial Moisture Content (%)	Permeant	Permeability @ 20°C (cm/sec)
1	Bulk Soils (off-site)	0	---	100.0	18.9	Distilled Water	3.79×10^{-4}*
2	(1) with 95% Compaction	0	---	122.7	18.3	Distilled Water	1.06×10^{-4}*
3	(1) + 10% bentonite	10	3.6	100.0	56.0	Distilled Water	9.24×10^{-8}*
	(1) + 10% bentonite	10	3.6	102.7	56.0	Distilled Water	7.78×10^{-8}+
	(1) + 10% bentonite	10	3.6	102.7	56.0	Liquid/Ground Water	9.03×10^{-8}+
4	(1) + 12% bentonite	12	3.5	100.0	54.4	Distilled Water	4.49×10^{-9}**
	(1) + 12% bentonite	12	3.5	100.0	56.1	Liquid/Ground Water	7.64×10^{-9}+

* Permeability determined with fixed-wall, double-ring permeameter.
** Permeability determined with API permeameter.
\+ Permeability determined with flexible-wall permeameter.

TABLE 7

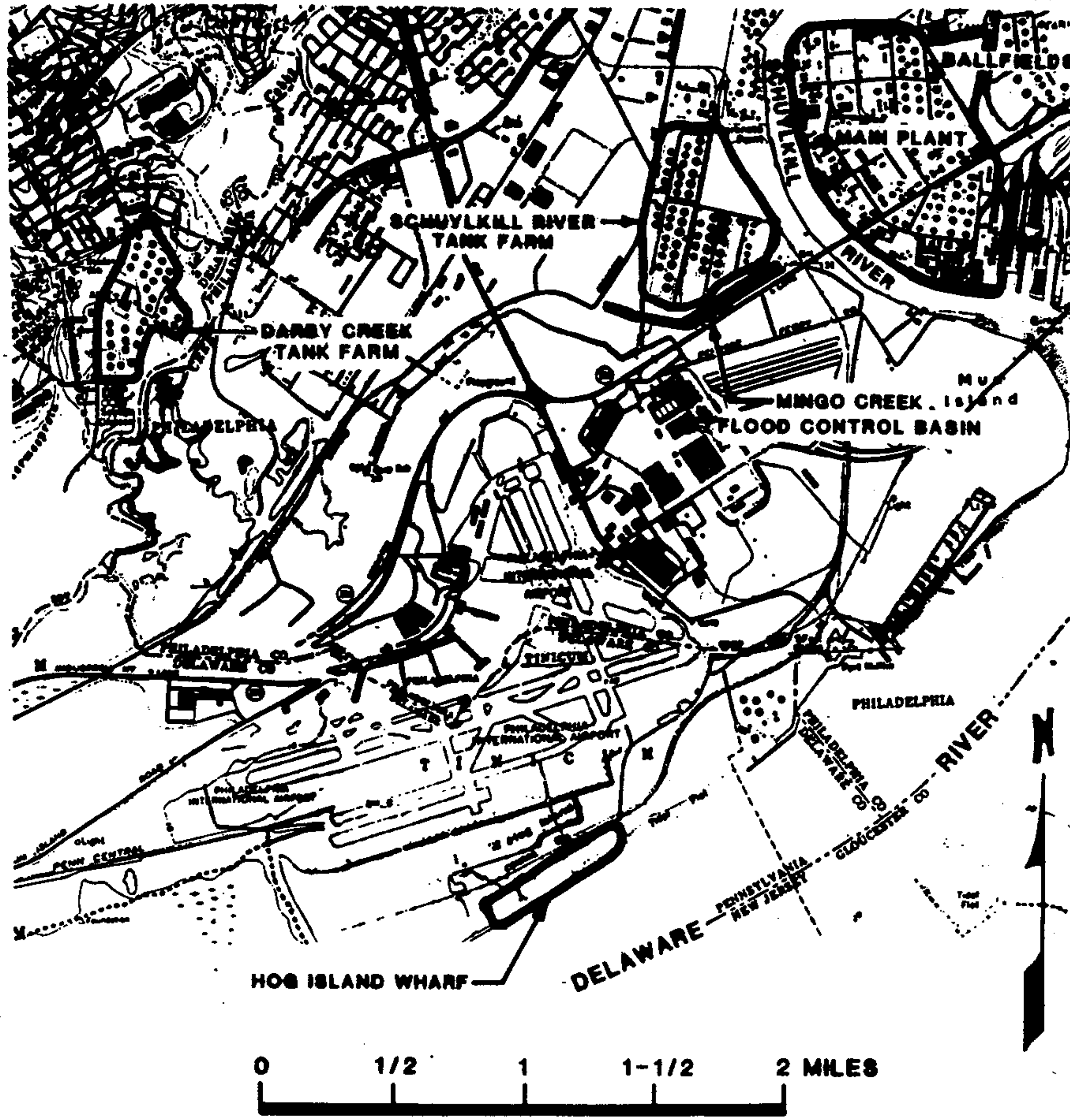
SAND BORROW SOURCES - BACKFILL MIX

No.	Borrow Source Location (County)	Supplier	Material	% Fines	Approximate Distance From The Site (Miles)	Remarks
1	Camden, NJ	Continental Sand and Gravel	Silty and clayey sand	25	<25	Suitable quality and quantity
2	Camden, NJ	Peter Seeger	Sand with little fines	3	<25	Not suitable quality
3	Camden, NJ	Dun Rite	Silty Sand	6	<25	Not suitable quality
4	Camden, NJ	George F. Pettinos, Inc.	Silty Sand	10	<25	Not suitable quality
5	Monmouth, NJ	Rustic Material	Silty and Clayey Sand	28	>60	Suitable quality and quantity

TABLE 8

SLURRY WALL
QUALITY CONTROL PROGRAM

Subject		Standard	Type of Test	Frequency	Specified Values
Materials	Water	-	- Total Dissolved Solids - Chloride - pH - Total Hardness	Per water source or as changes occur	As required to properly hydrate bentonite with approved additives
	Additives	-	Manufacturer Certificate of Compliance		As approved by Owner
	Bentonite	API 13A	Manufacturer Certificate of Compliance		Saline Seal 100
	Off-Site Soils (Silty and Clayey Sand)	-	Sieve Analysis	1 test per 500 c.y. of backfill	$\geq$25% passing No. 200 0% $\geq$4"
Slurry	In Pond	API 13B Sec. 6 Sec. 1 Sec. 3 Sec. 2	- pH - Unit Weight - Filtrate Loss - Viscosity	1 set per day minimum or per pond change	pH $\geq$ 8 s.g. = 1.03 - 1.30 Loss $\leq$ 30 cc in 30 min. or @ 100 psi V $\geq$40 sec-Marsh @ 20°C
	In Trench	API 13B Sec. 1 Sec. 3	- Unit Weight - Filtrate Loss	1 set per day at point of trenching	s.g. = 1.03 - 1.30 Loss $\leq$ 25 cc in 30 min. @ 100 psi
Backfill Mix	At Trench	ASTM C 143	- Slump	1 set per 200 c.y.	Slump 3" - 7"
			- Gradation and Bentonite Content	1 test per 200 c.y.	Consistent with design mix ($\geq$ 25 passing #200 sieve; $\geq$ 8% dry bentonite which will bring the total bentonie content to approximately 12%)
			- Density	1 test per 200 c.y.	$\geq$ 100 pcf
			- Triaxial Hydraulic Conductivity Test	1 test per 1,200 c.y.	$\leq$ 1x10^{-7} cm/sec

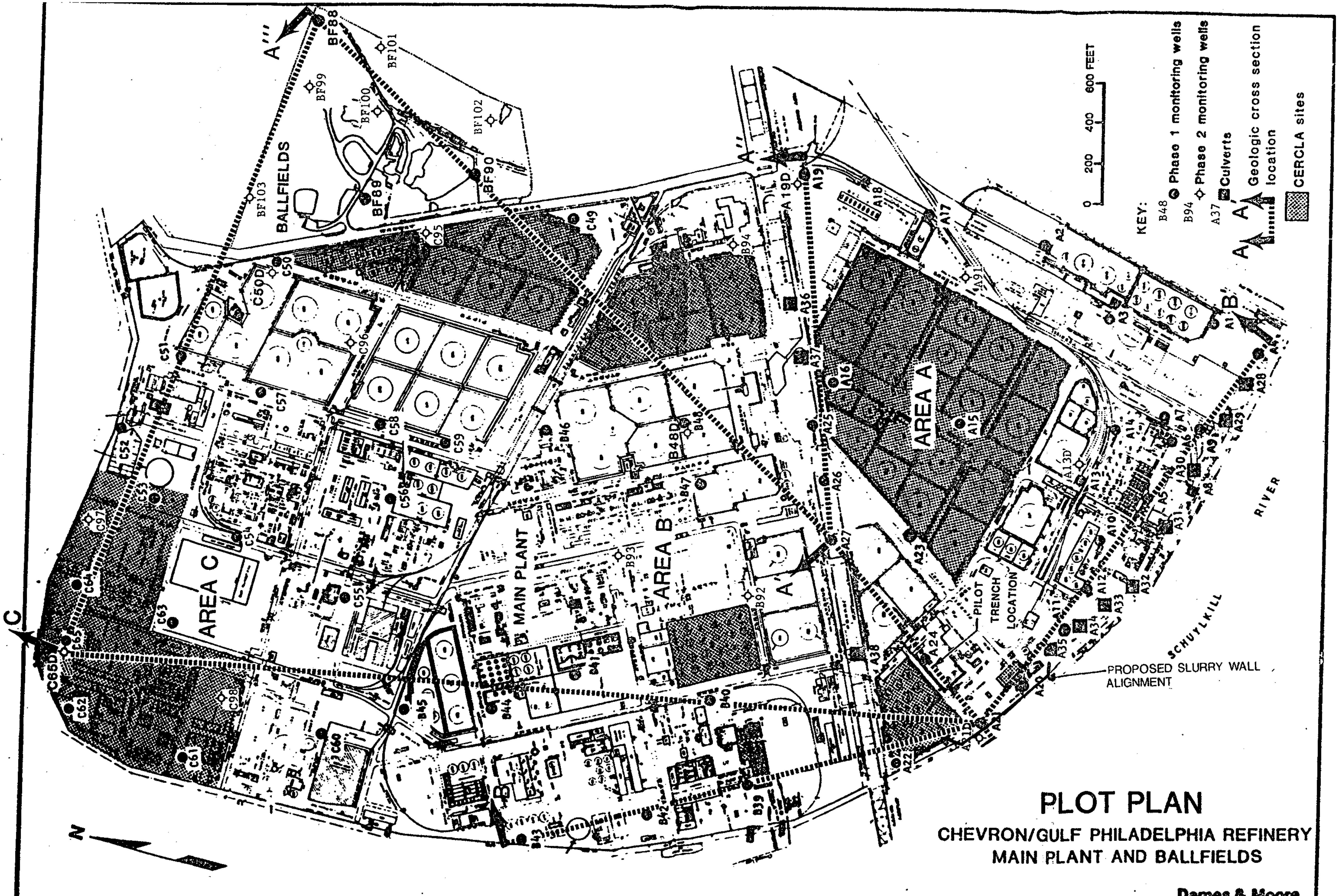


SITE VICINITY MAP

CHEVRON/GULF PHILADELPHIA REFINERY
PHILADELPHIA, PENNSYLVANIA

Dames & Moore

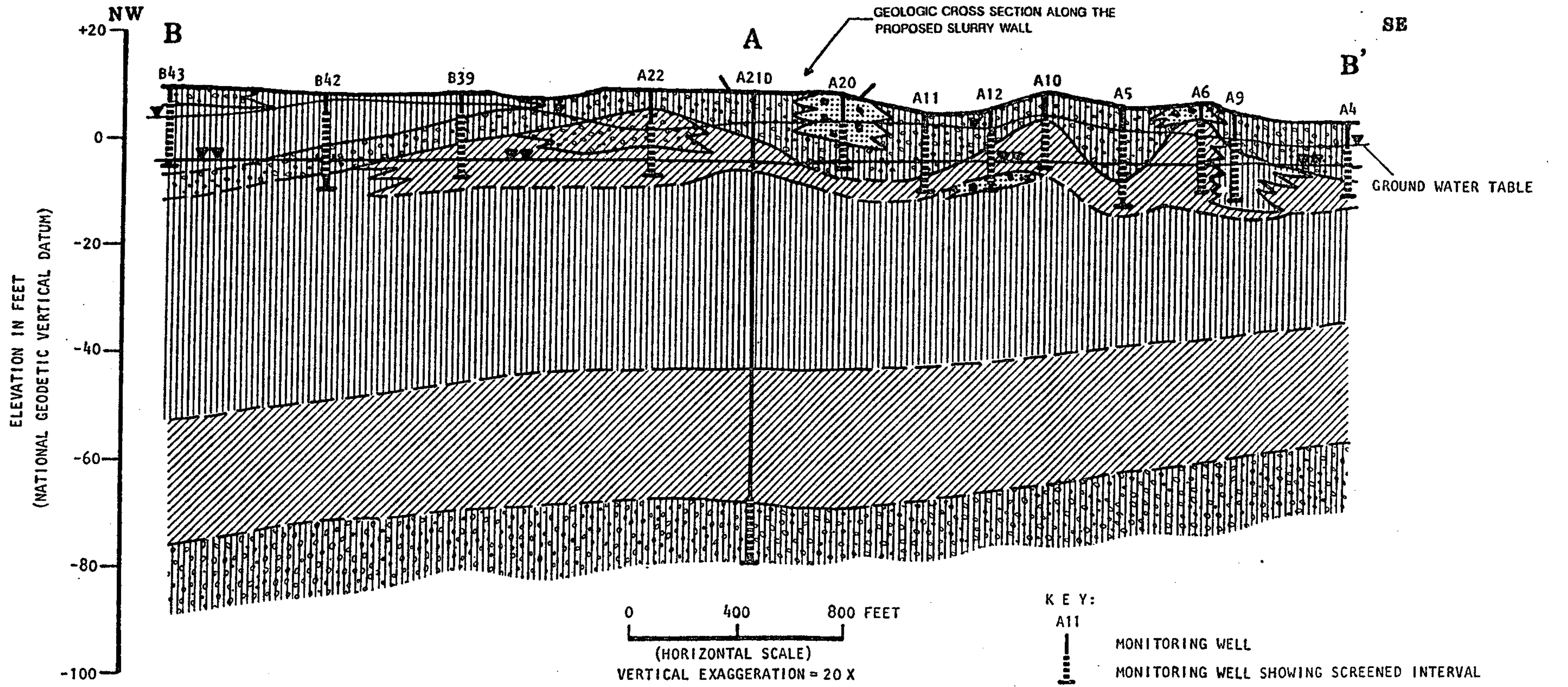
FIGURE 1



PLOT PLAN

CHEVRON/GULF PHILADELPHIA REFINERY
MAIN PLANT AND BALLFIELDS

FIGURE 2



KEY:

A11

MONITORING WELL

MONITORING WELL SHOWING SCREENED INTERVAL

LITHOLOGIC BOUNDARIES; DASHED WHERE ESTIMATED

POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES

SILTY SANDS, SAND-SILT-GRAVEL MIXTURES

CLAYEY SANDS, SAND-CLAY MIXTURES

INORGANIC SILTS AND VERY FINE SANDS, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY

INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, SILTY CLAYS

WATER TABLE IN UPPER UNCONSOLIDATED AQUIFER

PIEZOMETRIC SURFACE IN LOWER UNCONSOLIDATED AQUIFER

GENERALIZED GEOLOGIC CROSS SECTION B-A-B'

CHEVRON/GULF PHILADELPHIA REFINERY MAIN PLANT

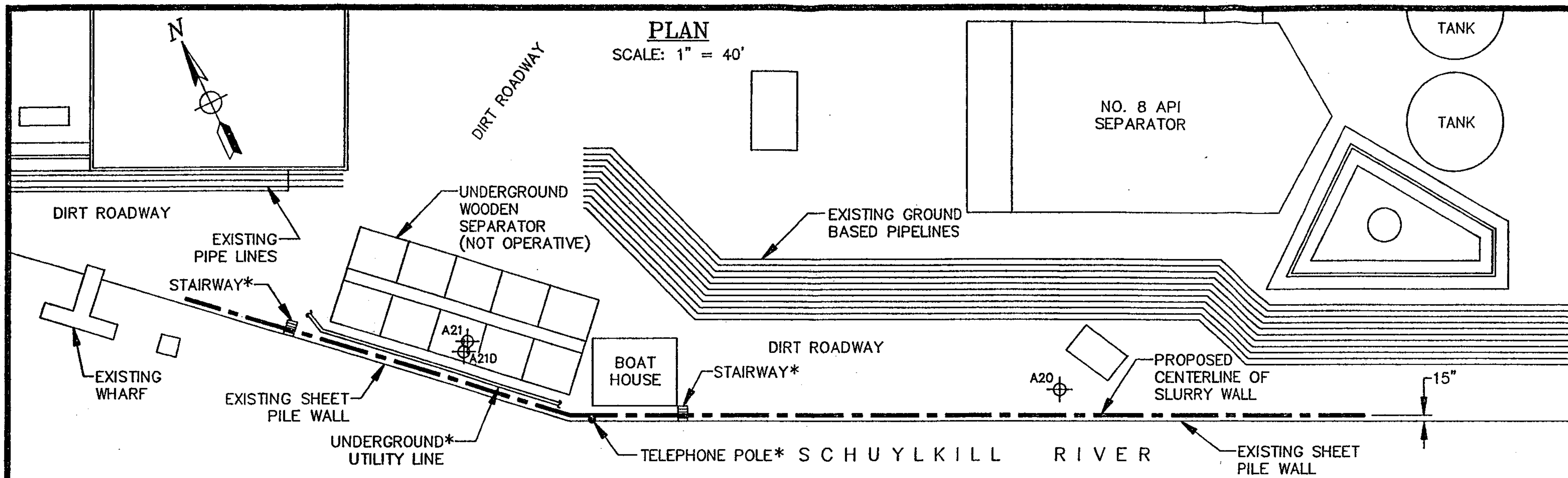
NOTE: THE SUBSURFACE SECTION SHOWN REPRESENTS OUR EVALUATION OF THE MOST PROBABLE CONDITIONS BASED UPON INTERPRETATION OF PRESENTLY AVAILABLE DATA. SOME VARIATIONS FROM THESE CONDITIONS MUST BE EXPECTED.

DAMES & MOORE

FIGURE 3

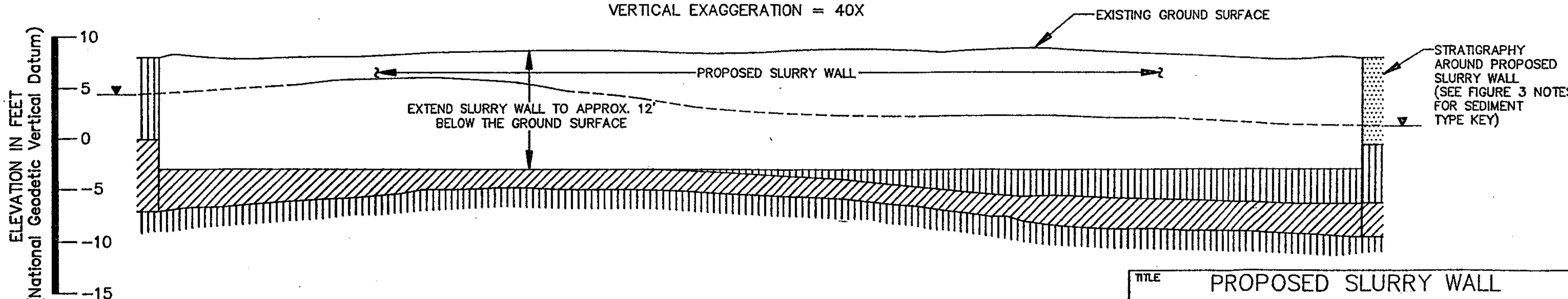
PLAN

SCALE: 1" = 40'



PROFILE

SCALE: HORIZONTAL 1" = 40'
VERTICAL EXAGGERATION = 40X



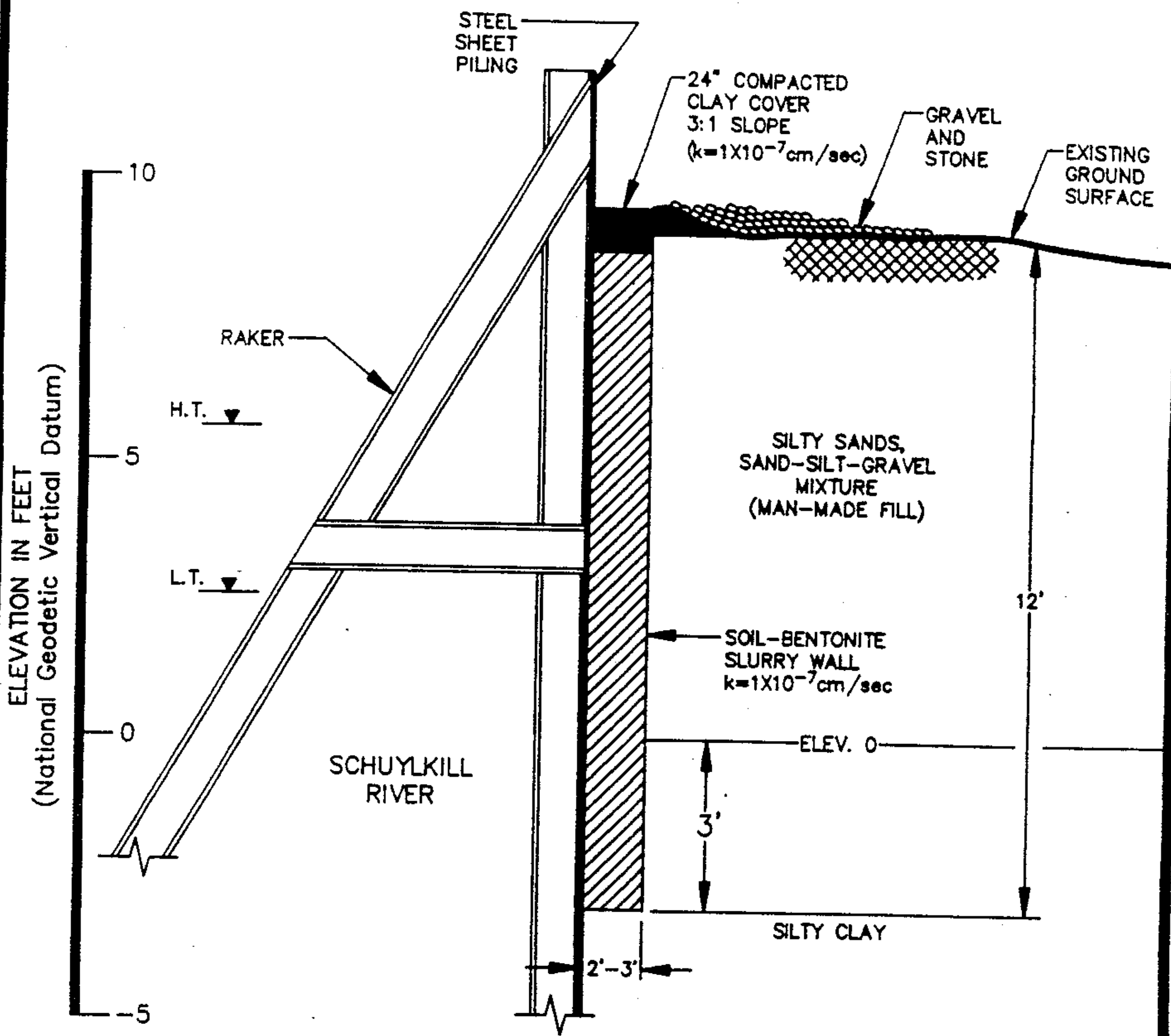
NOTES:

1. LOCATIONS OF STRUCTURES AND PIPELINES ARE APPROXIMATE.
2. * INDICATES EXISTING STRUCTURES TO BE REMOVED OR DESTRUCTED.
3. MONITORING WELL A20 NO LONGER EXISTS.
4. DEPTH TO GROUND WATER MEASUREMENTS TAKEN ON 1-14-87.

KEY:

- ▭ EXISTING STRUCTURE
- A21 ⌖ MONITORING WELL
- ▼ GROUND WATER TABLE (dashed where estimated)

TITLE	PROPOSED SLURRY WALL PLAN & PROFILE		
PROJECT	CHEVRON/GULF PHILADELPHIA REFINERY PHILADELPHIA, PENNSYLVANIA		
	Dames & Moore TREVOSE, PENNSYLVANIA		
SCALE AS NOTED	DWN. BY R.G.B.	JOB NO. 16000-019	
DATE 4-28-88	APPR. BY F.B.	FIG. NO. 4	



NOTE:
1. SLURRY WALL TO EXTEND APPROXIMATELY 12 FEET BELOW GROUND SURFACE (ELEVATION -3 FEET NGVD).
2. DEPTH TO SILTY CLAY LAYER VARIES ALONG THE PROPOSED SLURRY WALL.

TITLE PROPOSED SLURRY WALL DETAIL		
PROJECT CHEVRON/GULF PHILADELPHIA REFINERY PHILADELPHIA, PENNSYLVANIA		
Dames & Moore TREVOSE, PENNSYLVANIA		
SCALE AS NOTED	DWN. BY R.G.B.	JOB NO. 16000-019
DATE 4-28-88	APPR. BY F.B.	FIG. NO. 5

APPENDIX A

APPENDIX A

Logs of Borings and Monitoring Well
Construction Details

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project Chevron/Philadelphia Refinery

Project No. 113-909-032

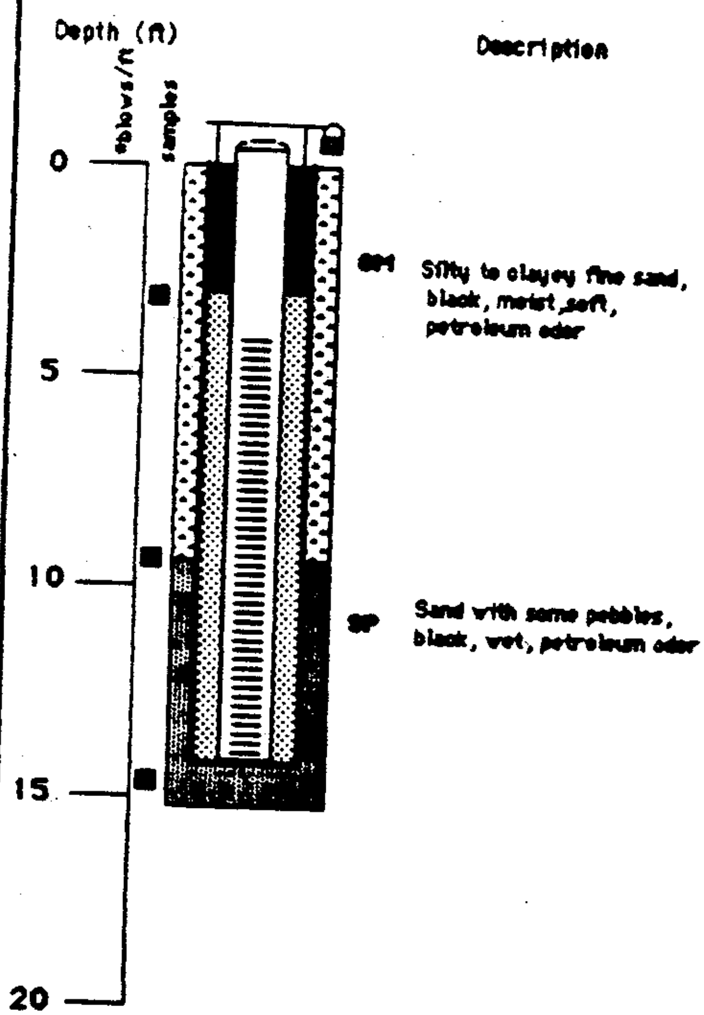
Date M.W. completed 2/24/86

Supervising D & M Engineer/Geologist Andrew Ivansiu

Boring/Well No. - A20

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	15'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	14'
Screen Setting -	4'-14'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	8.81'
Static Water Level Elevation -	4.08'
Date Measured -	1/13/87
Surface Elevation -	8.73'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Static Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) *blows/ft samples Description



WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOO

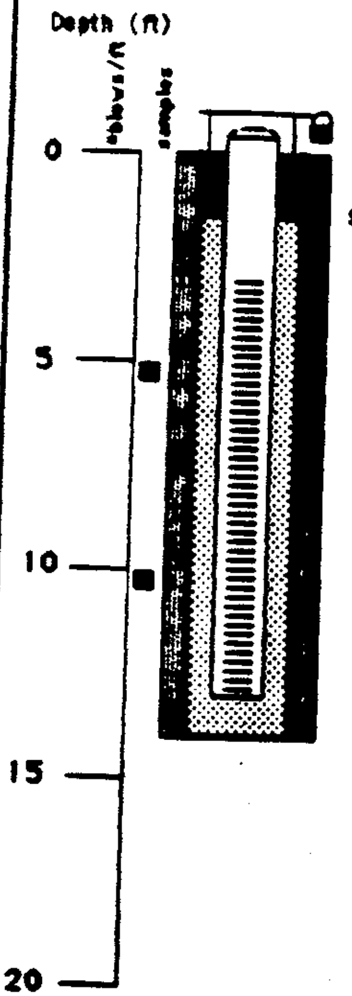
LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project : Chevron/Philadelphia Refinery

Project No. 113-909-032

Date M Y completed 2/25/86

Supervising D & M Engineer /Geologist Mark Robertson



Description

SM Silty sand with some gravel and cobble

grades to black, strong petroleum odor

decreasing gravel and cobbles

Boring/Well No. - A21

Location -	Chevron Refinery
Driller -	Warren George
Drilling Completed -	2/25/86
Type of Rig -	Hollow Stem Auger
CONSTRUCTION DATA	
Borehole Diam. -	10"
Borehole Depth -	13'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	13'
Screen Setting -	3' - 13'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement /Bentonite
MEASUREMENTS (NGVD)	
Top of Casing Elevation -	9.84'
Static Water Level Elevation -	Not Available
Date Measured -	1/13/87
Surface Elevation -	9.02'
TEST DATA	
Pump Type -	
Depth to Intake (ft) -	
Static Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

WELL CONSTRUCTION KEY

Filter Pack

Bentonite Seal

Cement Grout

DAMES & MOO

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project - Chevron/Philadelphia Refinery

Project No. 113-950-032

Date M W completed 10/28/86

Supervising D & M Geologist David Wagner

Boring/Well No. - A21D

Location -	Chevron Refinery
Driller -	Lambert, Inc.
Drilling Completed -	10/28/86
Type of Rig -	Hollow Stem Auger

CONSTRUCTION DATA

Borehole Diam. -	10"
Borehole Depth -	85'
Casing/Screen Type -	PVC
Casing Diam. -	4"
Casing Depth -	85'
Screen Setting -	75' - 85'
Slot Width -	0.02"
Type of Seal -	Bentonite
Type of Filterpack -	#2 Sand
Type of Grout -	Cement/Bentonite

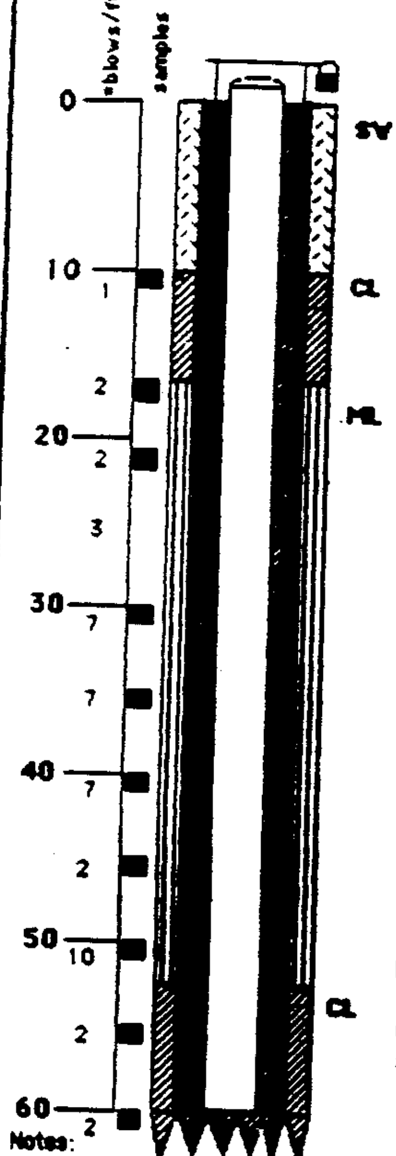
MEASUREMENTS(NGVD)

Top of Casing Elevation -	12.18'
Static Water Level Elevation -	-4.13'
Date Measured -	12/22/86
Surface Elevation -	8.48'

TEST DATA

Pump Type -	
Depth to Intake (ft) -	
Static Water Level (ft) -	
Pumping Water Level (ft) -	
Drawdown (ft) -	
Length of Test (Hrs) -	

Depth (ft) | *blows/ft | samples | Description



SW Fine to coarse sand with some silt, little fine gravel, very dark brown, soft, very moist; wood debris, brick, wire, etc.; petroleum odor; oily

CL Clay with little silt, trace fine sand, very dark brown, soft, saturated; very strong petroleum odor; oily

ML Silt with some clay, trace fine sand, medium gray, soft, saturated; trace mica; trace organics; petroleum odor

Decreasing clay; little clay, weak petroleum odor

SHELBY TUBE taken from 19' to 21'

Decreasing clay and increasing fine sand; trace to little clay, little fine sand

2" sand lense at 36'; fine to medium sand with little clay, medium gray, trace mica

Silt with little to some clay, little fine sand, dark gray, soft, saturated; wood debris

Increasing clay and decreasing fine sand; some clay, trace fine sand

Decreasing clay: little clay

No petroleum odor

CL Clay with little silt, dark gray, soft, saturated; trace mica

WELL CONSTRUCTION KEY

- FILTER PACK
- BENTONITE SEAL
- BENTONITE/CEMENT
- CAVE IN MATERIAL
- CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

LOG of BORING and MONITORING WELL CONSTRUCTION DETAILS

Project: Chevron/Philadelphia Refinery

Boring/Well No. - A21D (Cont.)

Project No. 113-950-032

Date M.W. completed 10/28/86

Supervising D & M Geologist David Wagner

Location - Chevron Refinery

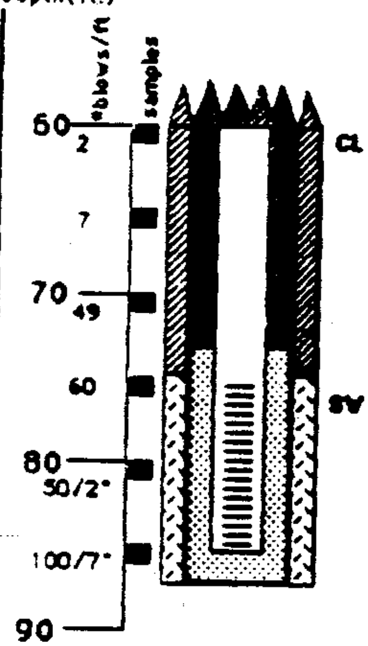
Driller - Lambert, Inc.

Drilling Completed - 10/28/86

Type of Rig - Hollow Stem Auger

Depth(ft.)

Description



Increasing silt: some silt

6" lense of fine to medium sand with little coarse sand at 66', grayish-brown, saturated

Clay with some silt, trace to little fine sand, dark-gray, soft, saturated

Little to some fine gravel and little fine to coarse sand

Fine to coarse sand with some fine gravel, brownish-gray, very dense, saturated

Fine to coarse sand with some fine gravel, trace clay(white), very light gray, very dense, saturated

Weathered bedrock: Wissahickon Schist

WELL CONSTRUCTION KEY

FILTER PACK

BENTONITE SEAL

BENTONITE/CEMENT

CAVE IN MATERIAL

CONCRETE

Notes:

* Blows taken using a 140 lb hammer falling 30 inches.

** All soils classified by visual inspection.

DAMES & MOORE

APPENDIX B

Laboratory Testing Equipment and Borrow Pits Laboratory Data

APPENDIX B

TESTING APPARATUS

B-1 — FLEXIBLE-WALL PERMEAMETER

The flexible-wall permeameter used for this study is a triaxial-type apparatus manufactured by Brainard-Kilman. As shown in Figure B-1, the system consists of triaxial cell, pressure control panel, permeant-interface-device (PID) and pressure supply. The system is operated with compressed air and can handle corrosive permeants. At each inlet and outlet, two PIDs are used as permeant containers and a Viton membrane is installed at the permeant-water interface. The advantages of this system are that the pore fluid is completely isolated from the volume measuring devices, thus minimizing the hazard to personnel. Both inflow and outflow can be measured accurately.

B-2 — FIXED-WALL DOUBLE RING PERMEAMETER

The fixed-wall permeameter used for this study is a double-ring type originally developed by Anderson et al (1985) and manufactured by Trantwein (Figure B-2). It is a modified version of the conventional fixed-wall permeameter. It has a provision to separate the outflow that occurs through the central portion of the sample from the outflow that occurs along the sidewall. Accurate measurements on permeability thus can be made by overcoming the problems of sidewall leakage.

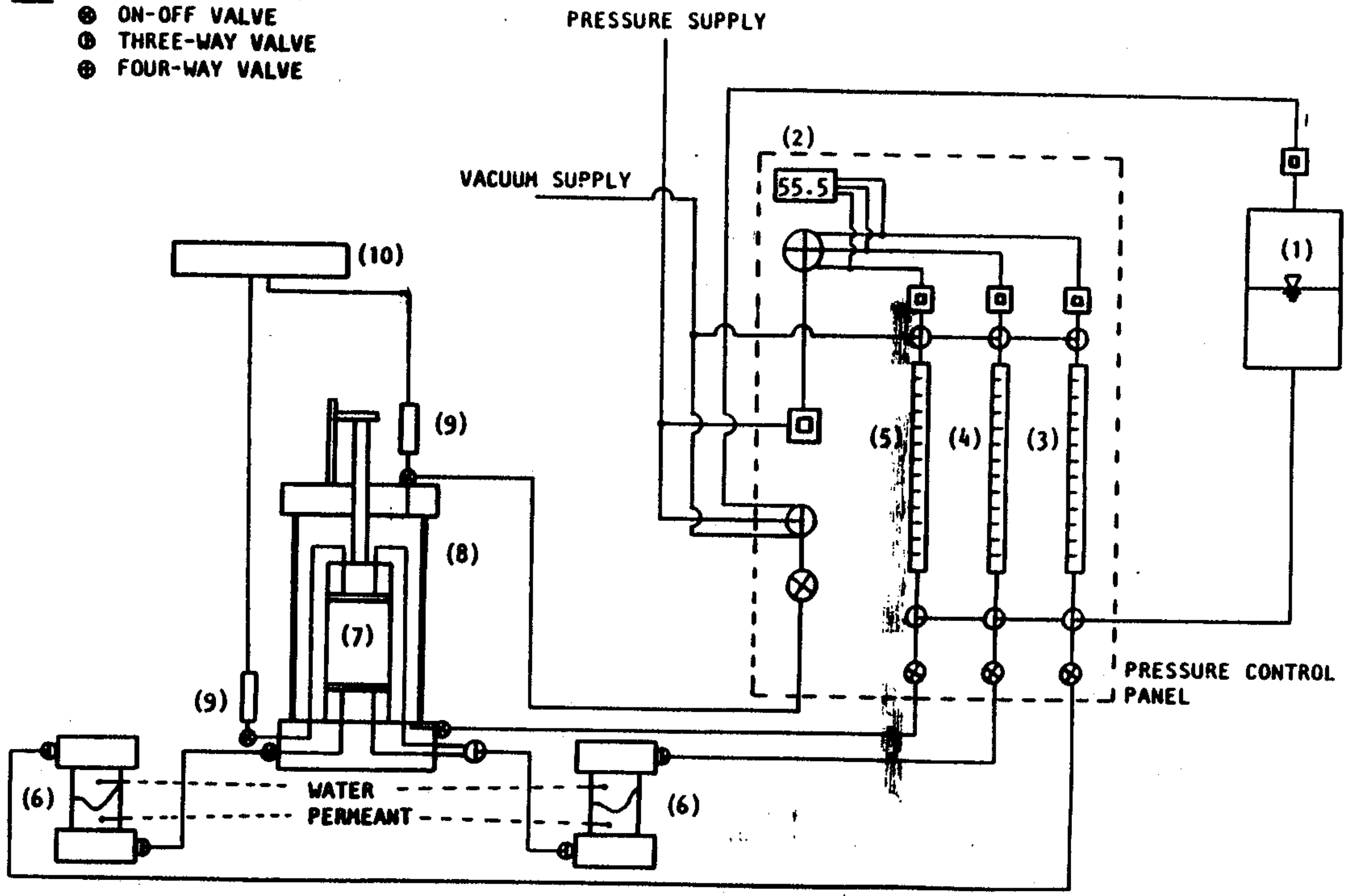
B-3 — VISCOSITY

The viscosity of the slurry is determined by a marsh funnel viscometer, as recommended by API. The marsh funnel and measuring cup are made of rugged, break-resistant plastic. The funnel is 6 inches in diameter at the top, and 14 inches long. The 1,000 cc measuring cup, graduated in cubic centimeters and fluid ounces, is designated specifically for use with the marsh funnel. Molded lines clearly mark 350 ml and one quart (32 fl. oz.).

B-4 — DENSITY

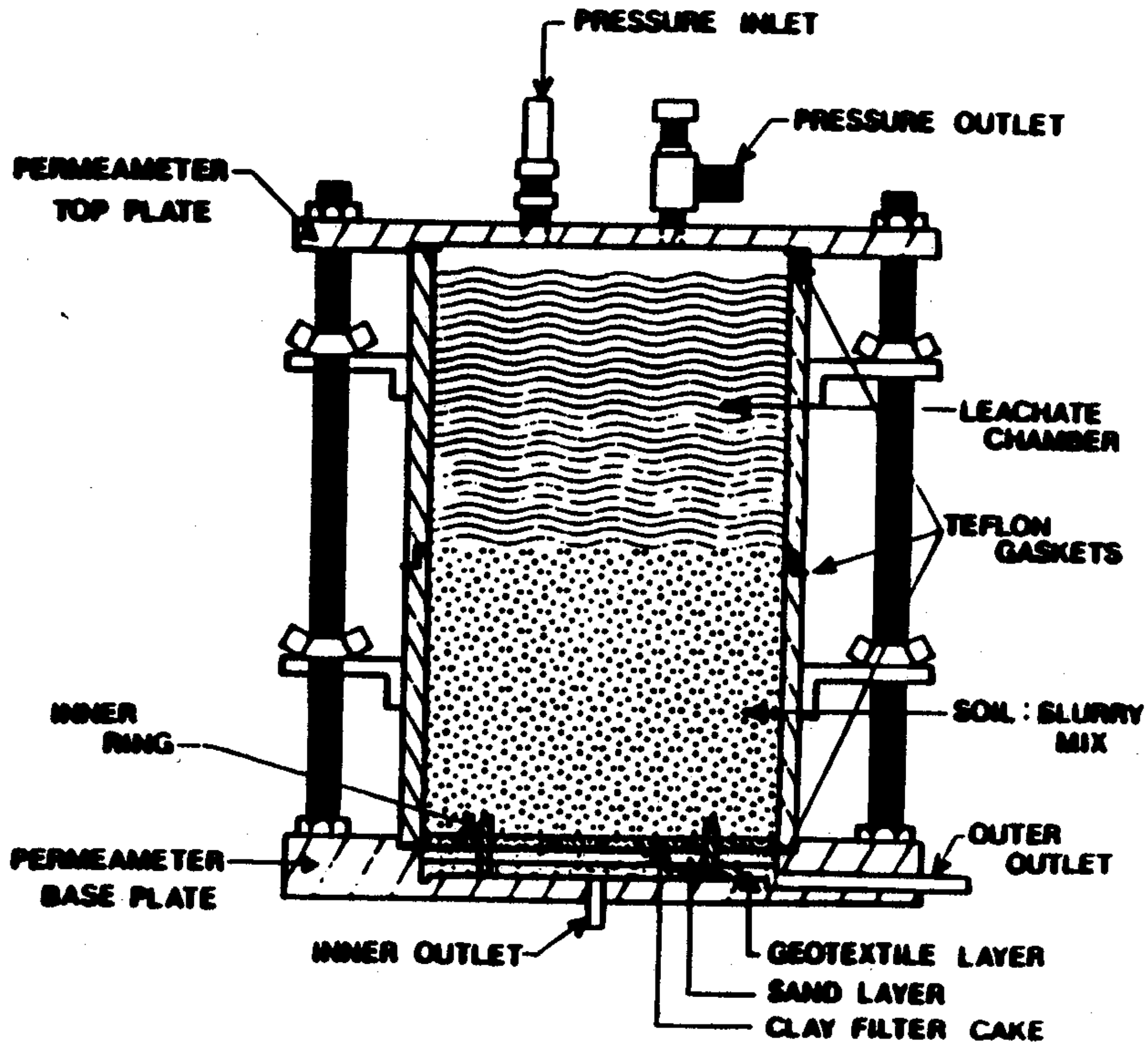
The density of the slurry is determined by a mud balance as specified in API RP 13B. The mud balance is designed such that the mud cup, at one end of the beam, is balanced by a fixed counterweight at the other end, with a sliding-weight rider free to move along a graduated scale. A level-bubble is mounted on the beam to allow for accurate balancing.

KEY: PRESSURE REGULATOR
ON-OFF VALVE
THREE-WAY VALVE
FOUR-WAY VALVE



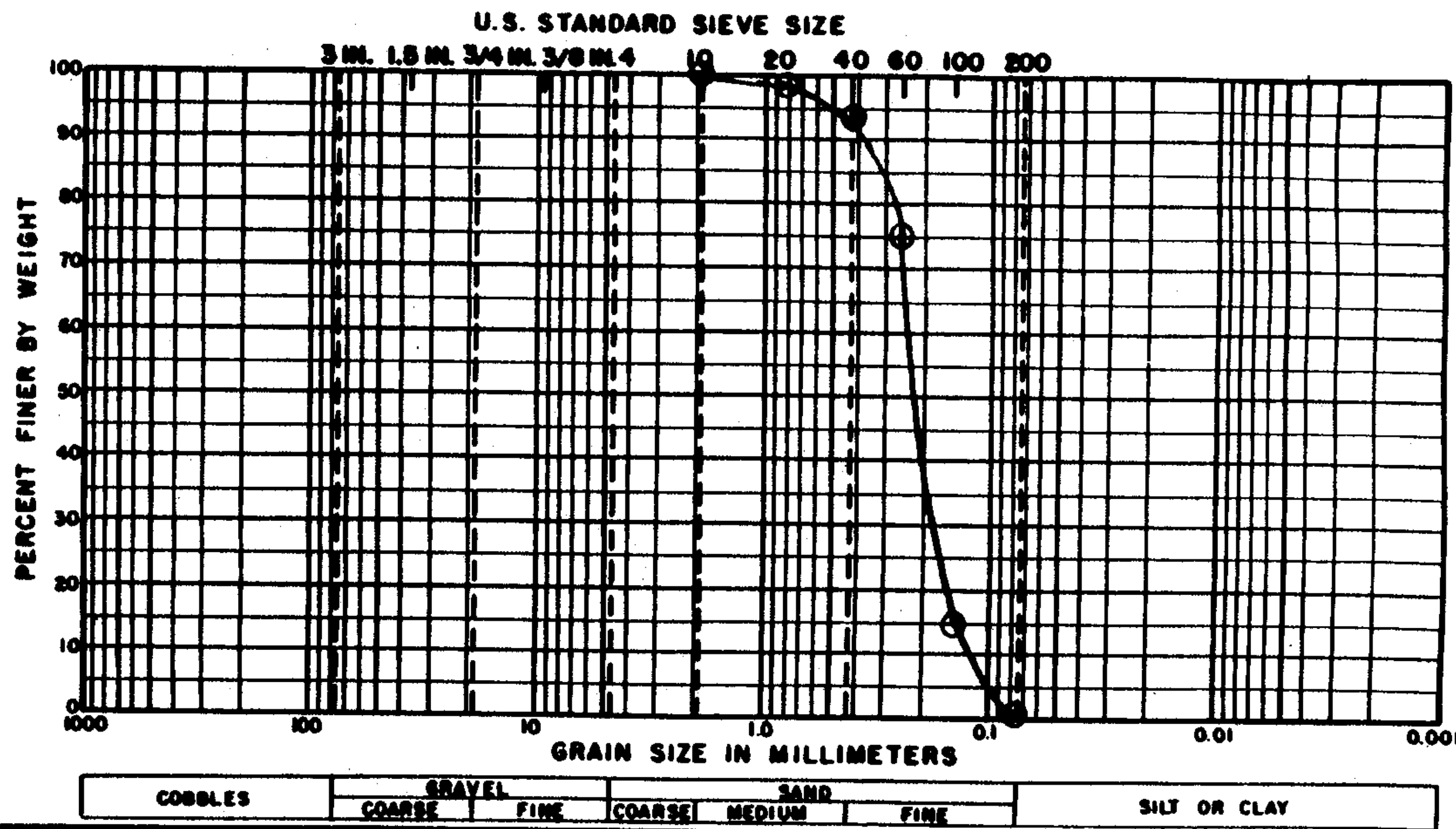
LEGEND:
(1) WATER RESERVOIR
(2) PRESSURE INDICATOR
(3) INFLOW MEASUREMENT
(4) OUTFLOW MEASUREMENT
(6) PERMEANT-INTERFACE-DEVICE (PID)
(7) SOIL SPECIMEN
(8) FLEXIBLE-WALL PERMEAMETER
(9) PRESSURE TRANSDUCER

Dames & Mo
FIGURE B-



SCHEMATIC OF A DOUBLE RING PERMEAMETER

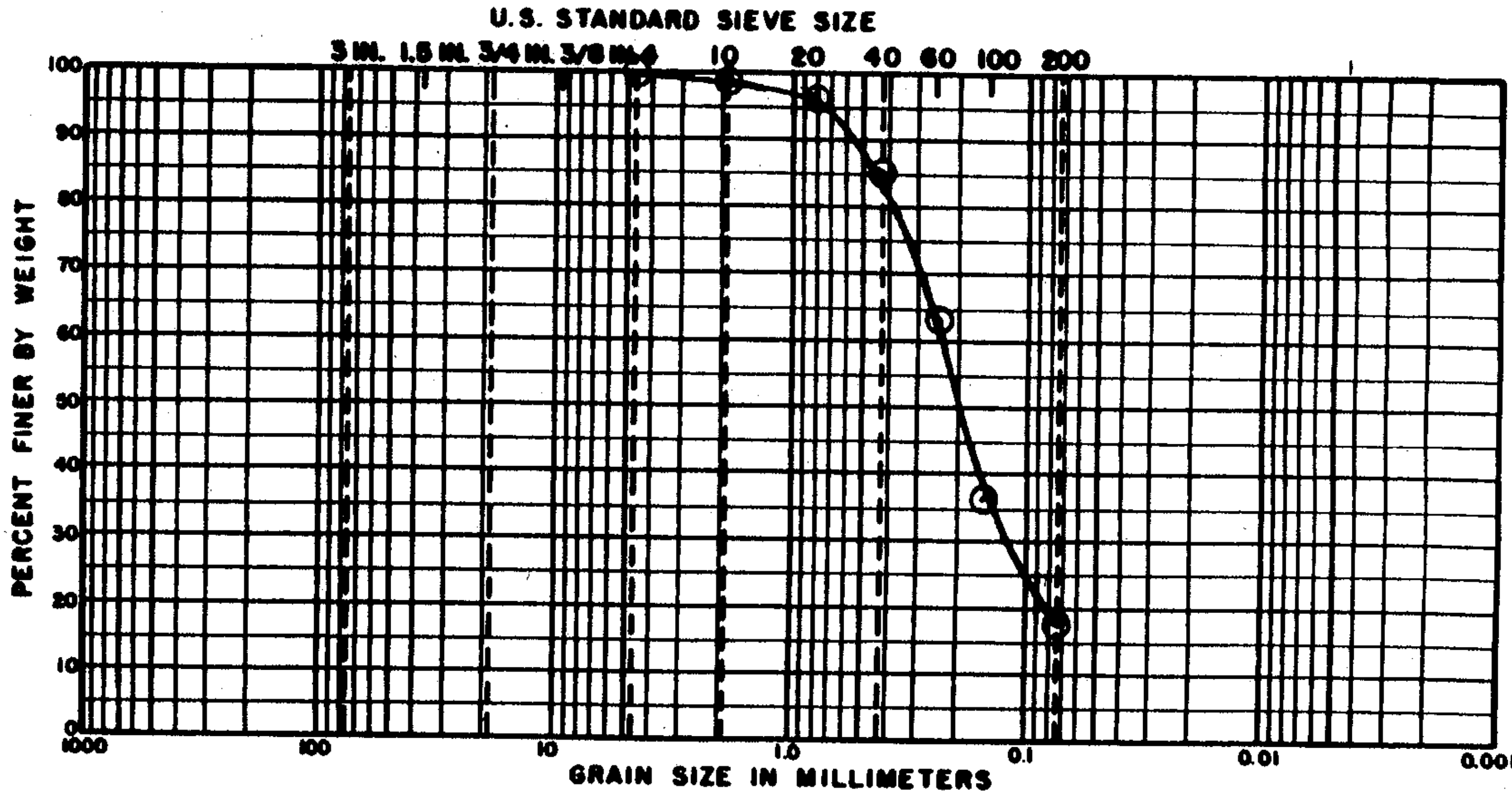
Dames & Mo
FIGURE B-2



	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	

BULK SOILS - SAMPLE A1

GRADATION CURVE

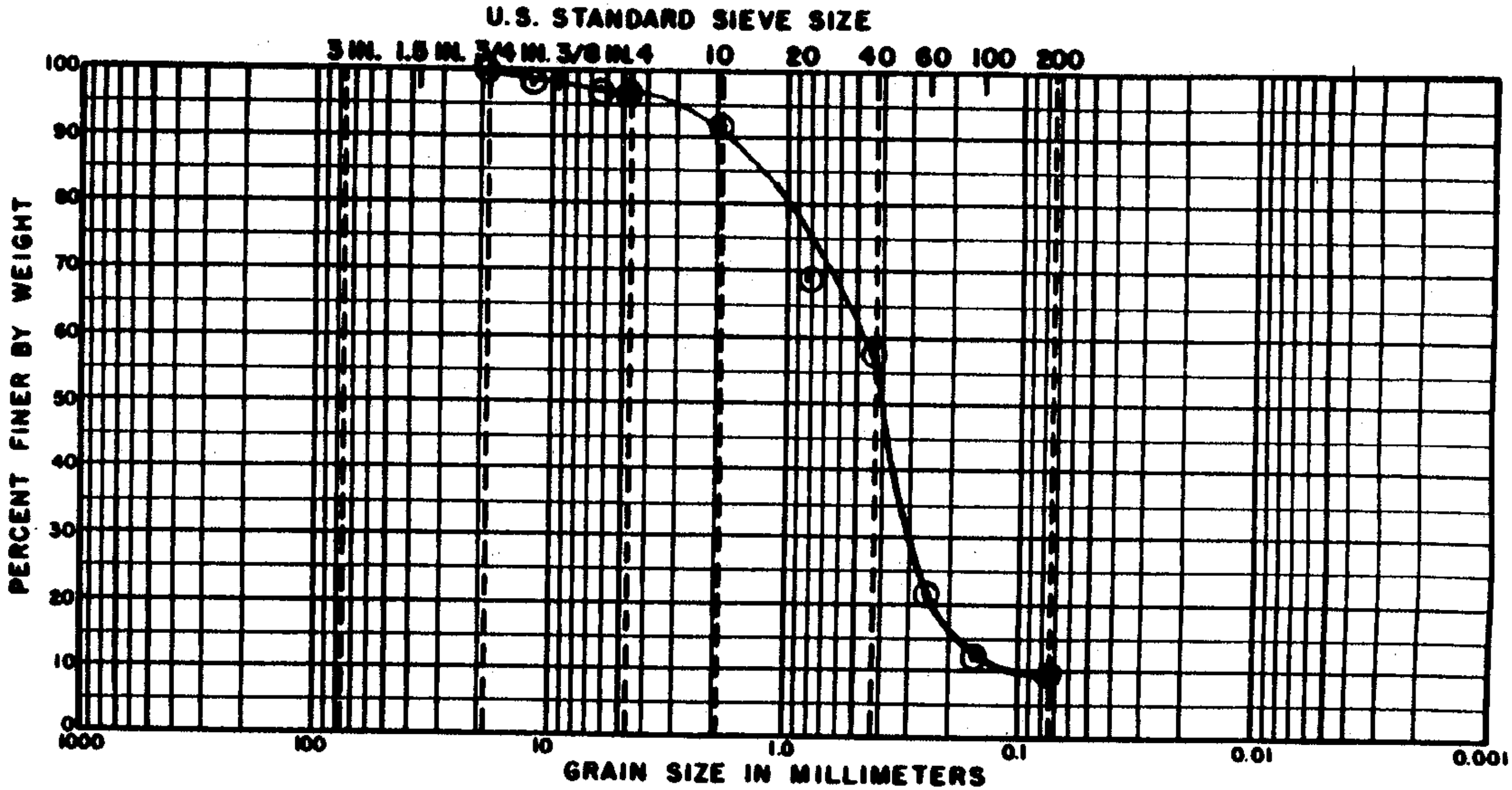


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS - SAMPLE A2

GRADATION CURVE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

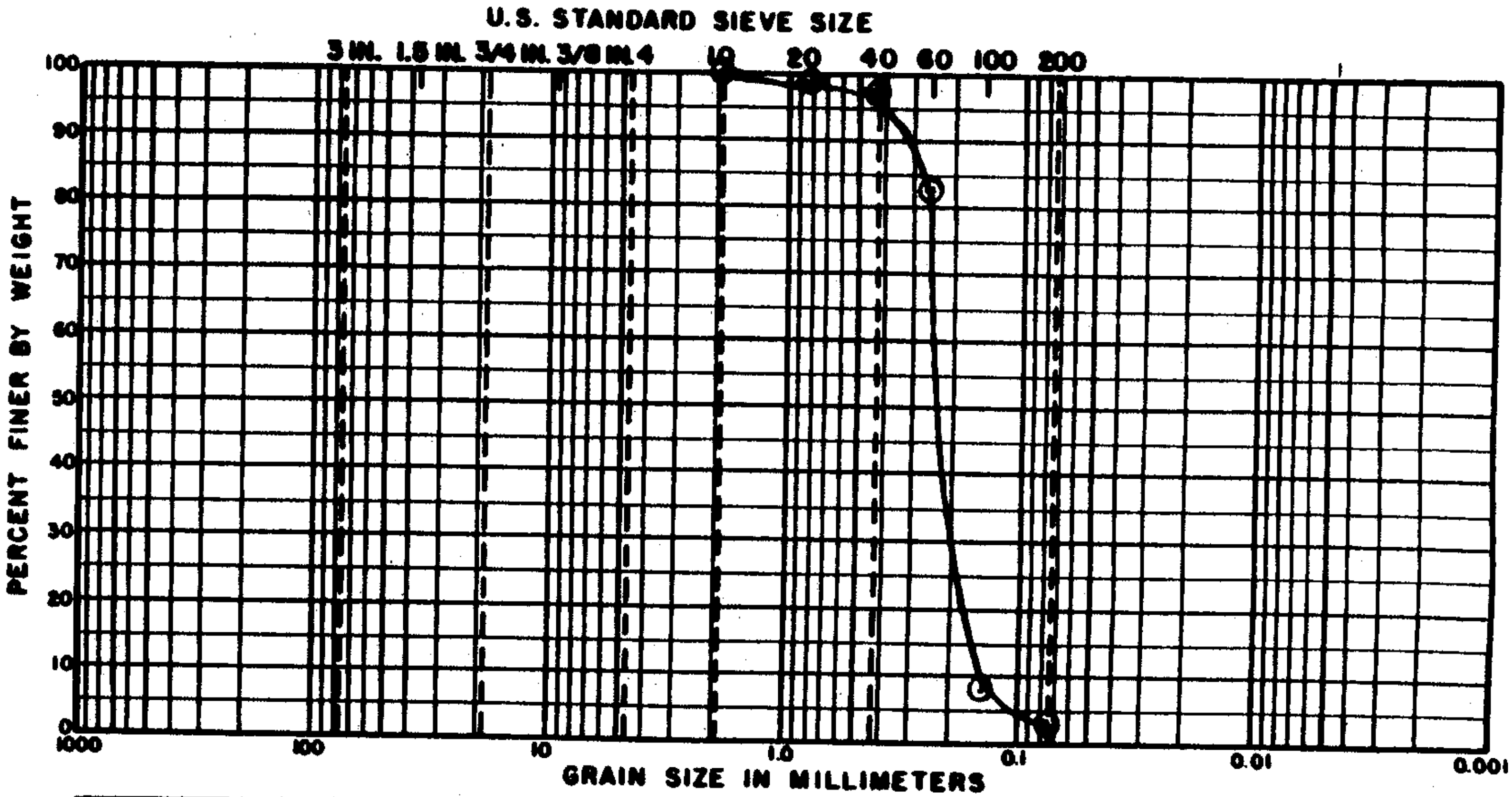
	DEPTH	CLASSIFICATION		NAT WC	LL	PL	PI	

BULK SOILS - SAMPLE D

GRADATION CURVE

757.2 (REV. 4-62)

FILE	REVIEW
BY ______ DATE ______	BY ______ DATE ______
CHECKED BY ______ DATE ______	BY ______ DATE ______
	PLATE ______ OF ______



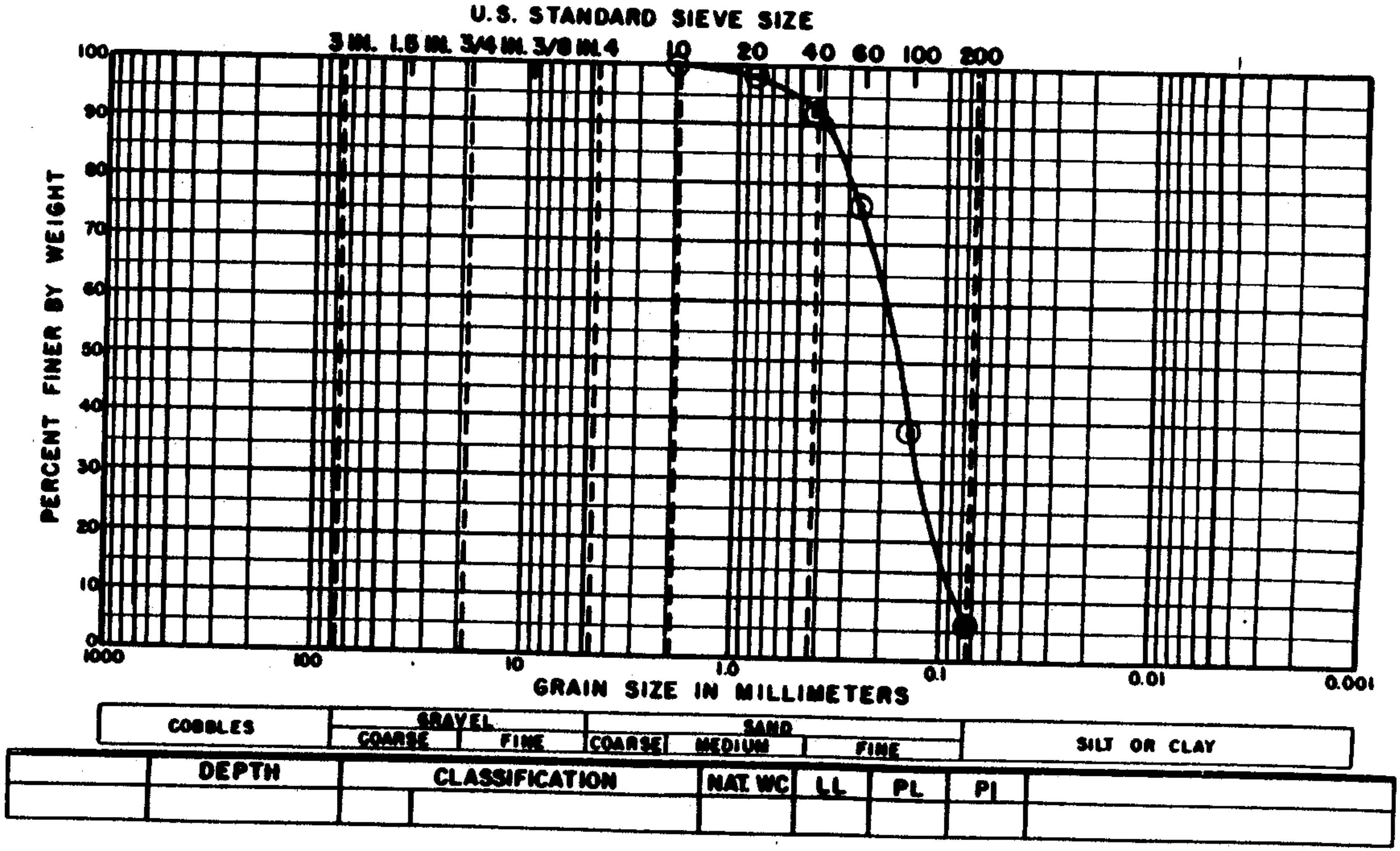
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION	NAT. WC	LL	PL	PI	

BULK SOILS - SAMPLE B

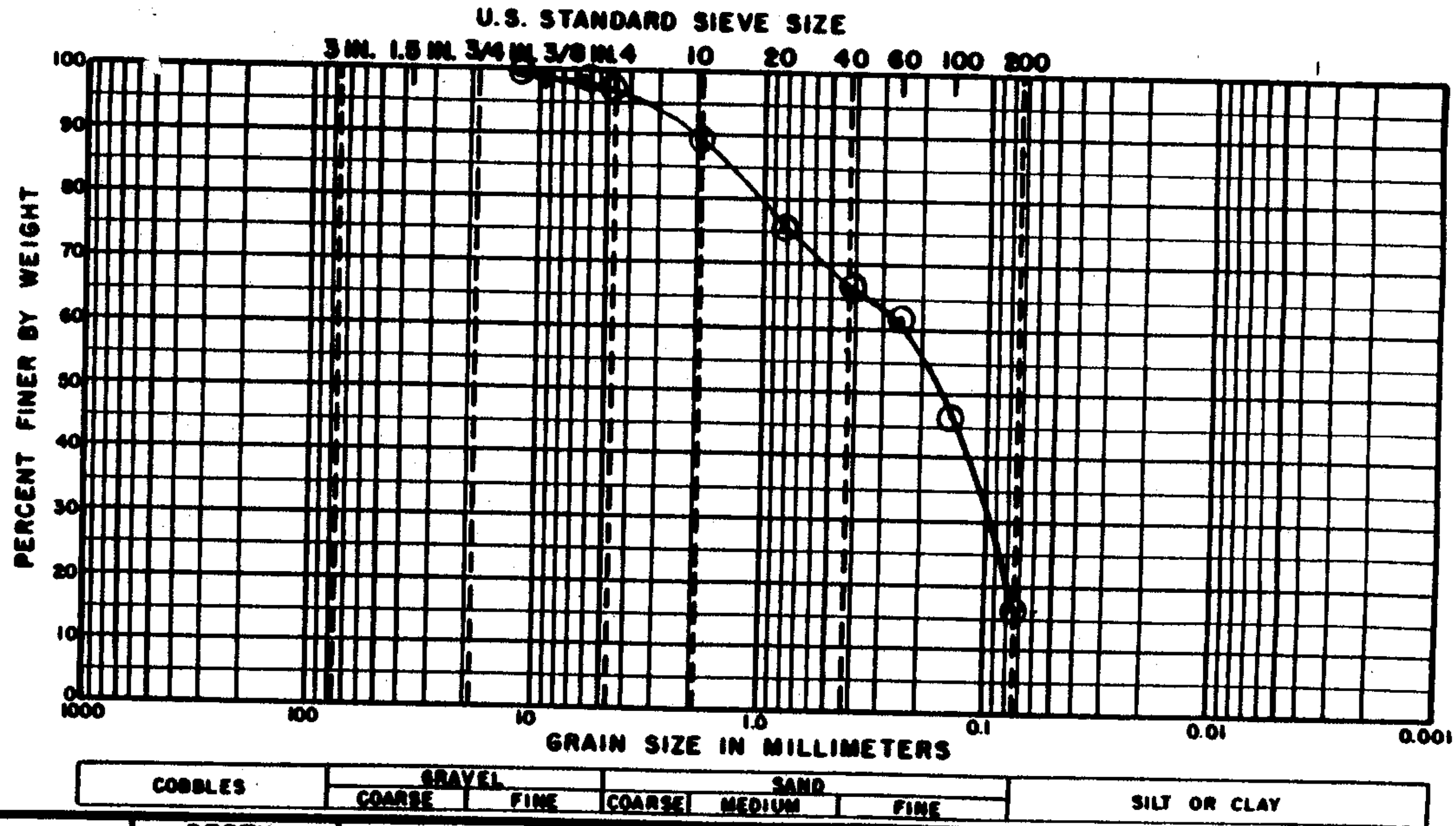
GRADATION CURVE

Dames & Moore



BULK SOILS - SAMPLE C

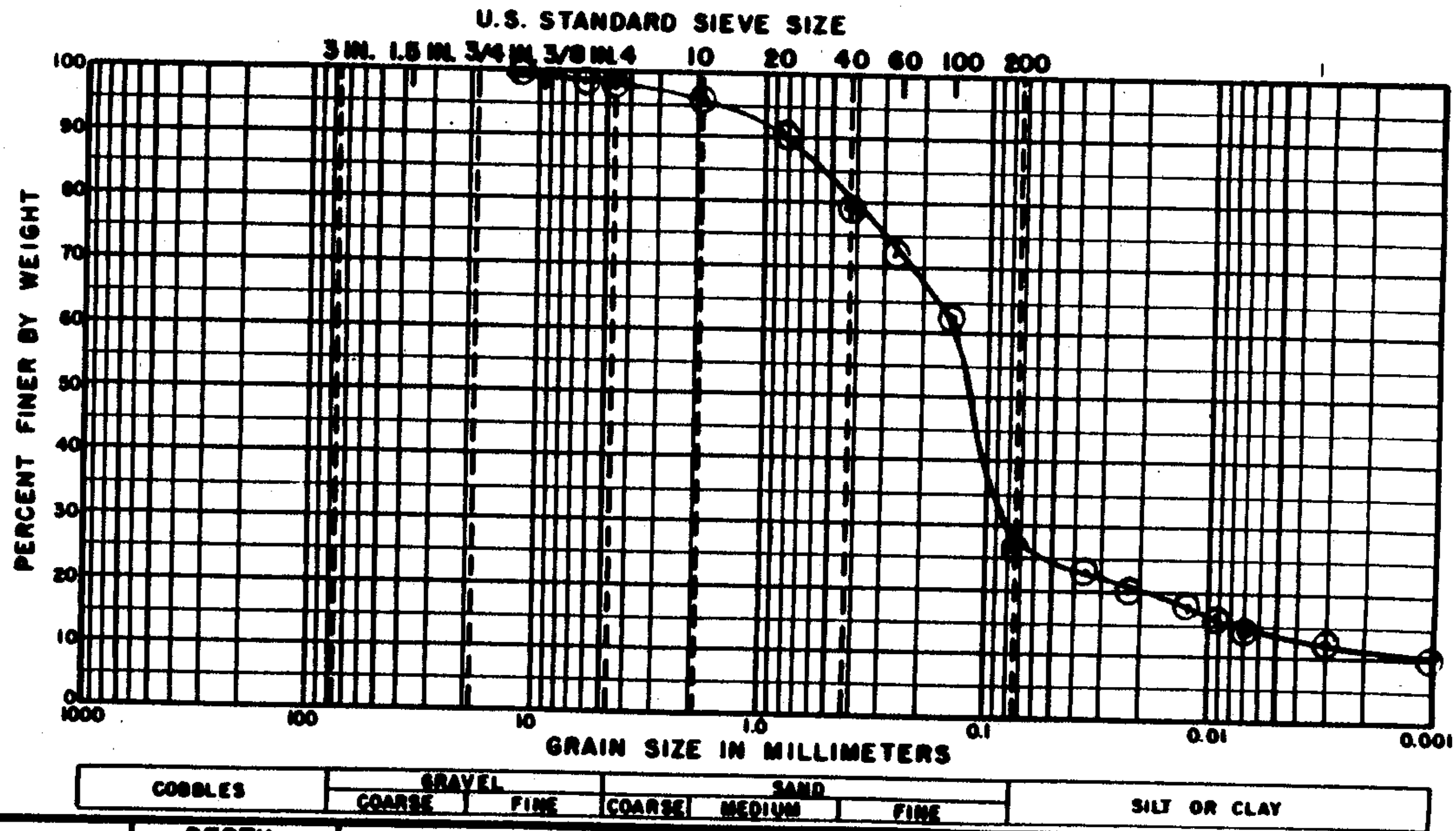
GRADATION CURVE



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS - SAMPLE E1

GRADATION CURVE



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS - SAMPLE E2

GRADATION CURVE

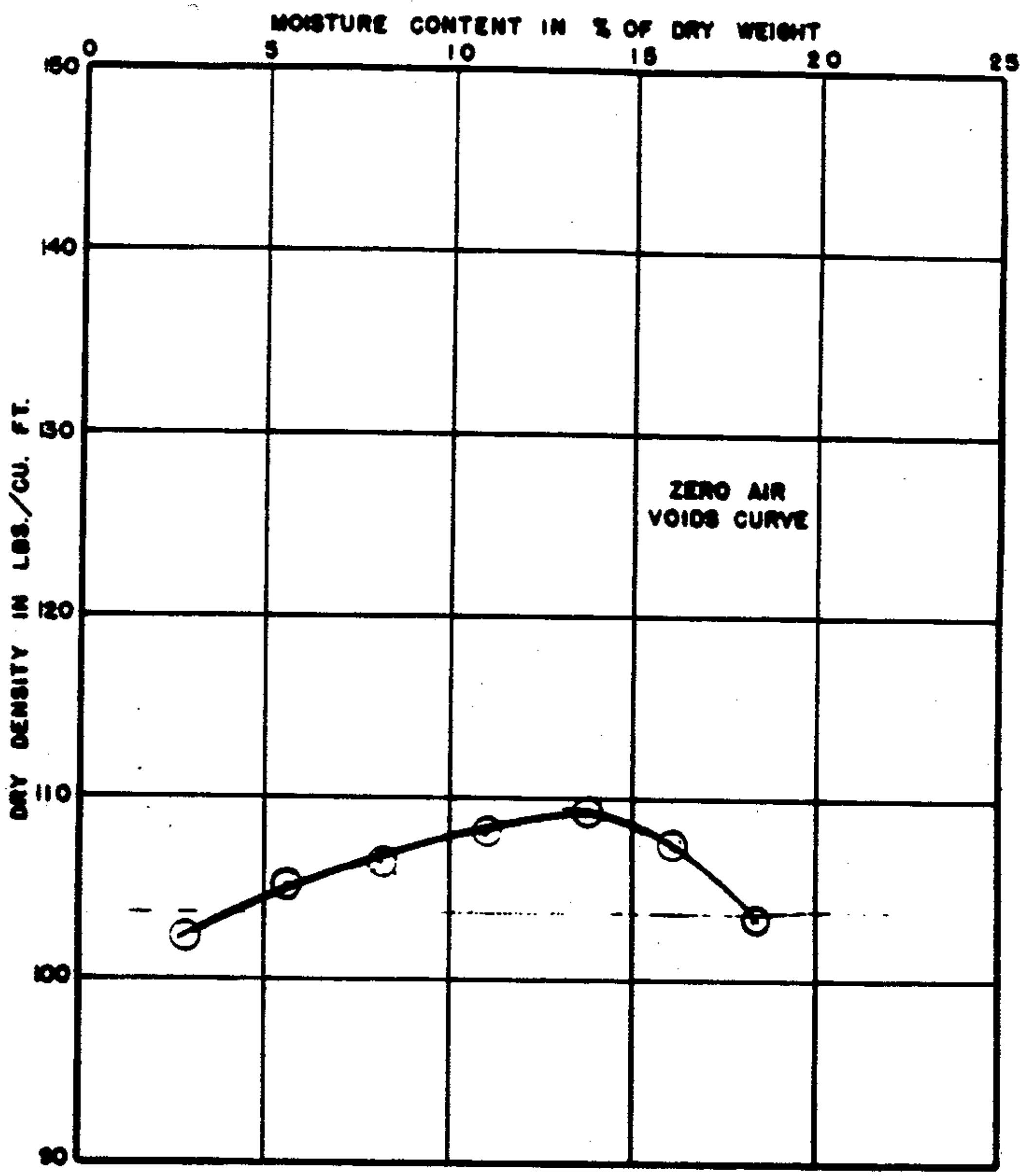
Dames & Moore

APPENDIX C

APPENDIX C

Additional Laboratory Data

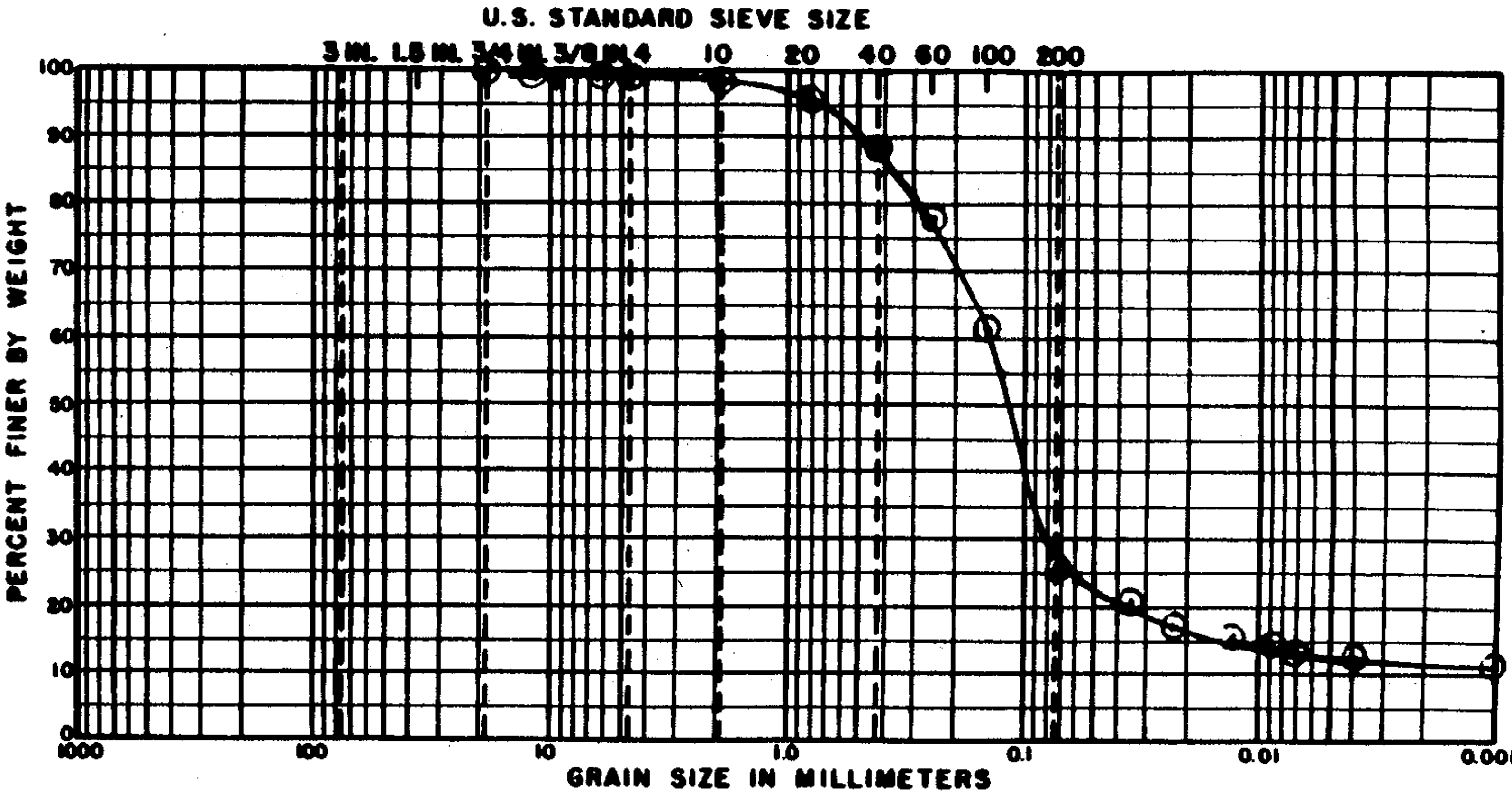
SAMPLE NO. A DEPTH ELEVATION
SOIL Yellowish Brown silty clayey fine sand
LOCATION Continental Sand & Gravel
OPTIMUM MOISTURE CONTENT 13.6%
MAXIMUM DRY DENSITY 109.3 lbs per cu ft
METHOD OF COMPACTION Standard Proctor



COMPACTION TEST DATA

Dames & Mo

PLATE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS

GRADATION CURVE

757.2 (REV. 4-62)

Dames & Moore

757.2 (REV. 4-82)

FILE

BY DATE

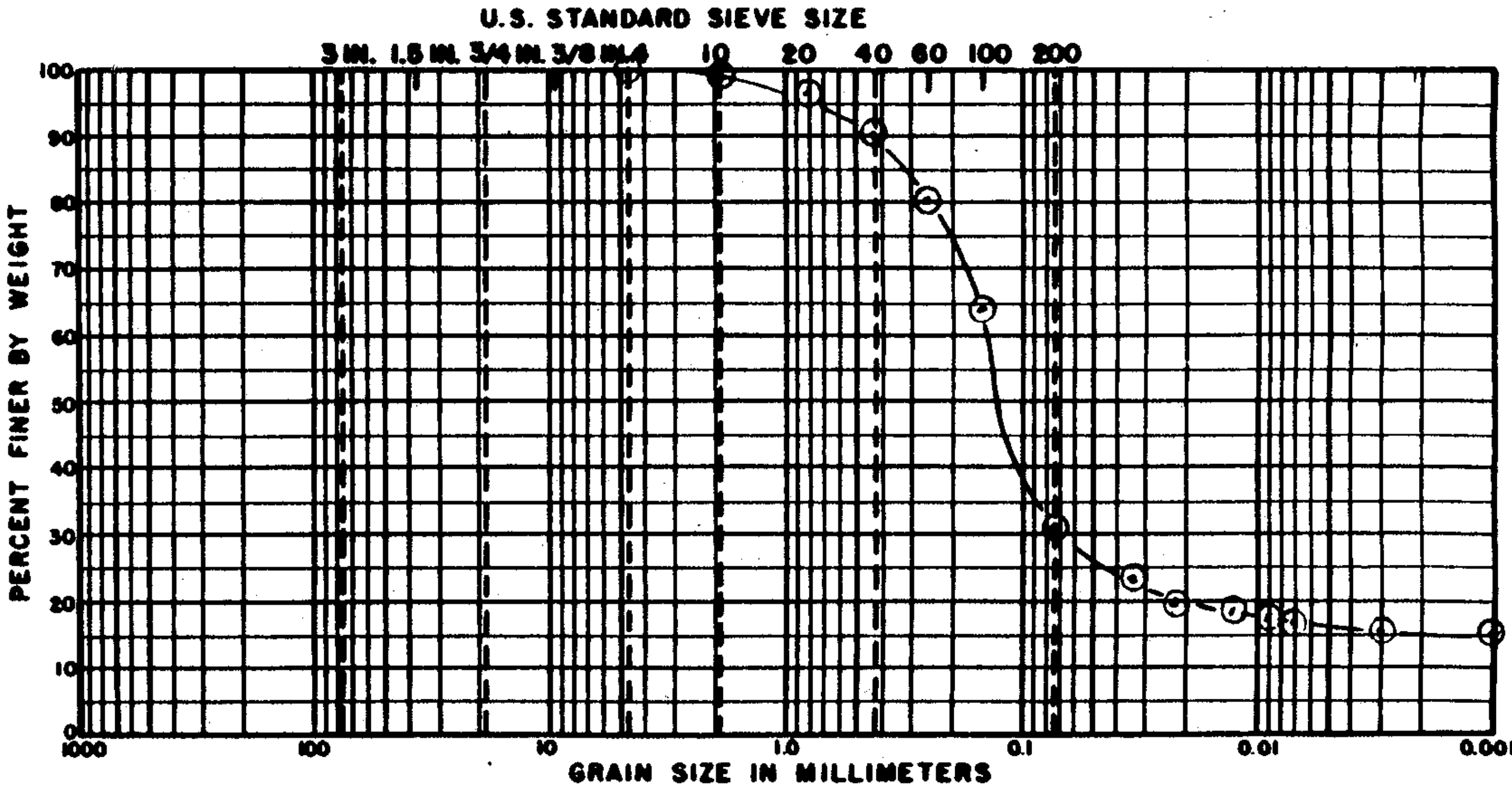
CHECKED BY DATE

REVIEW

BY DATE

BY DATE

PLATE OF

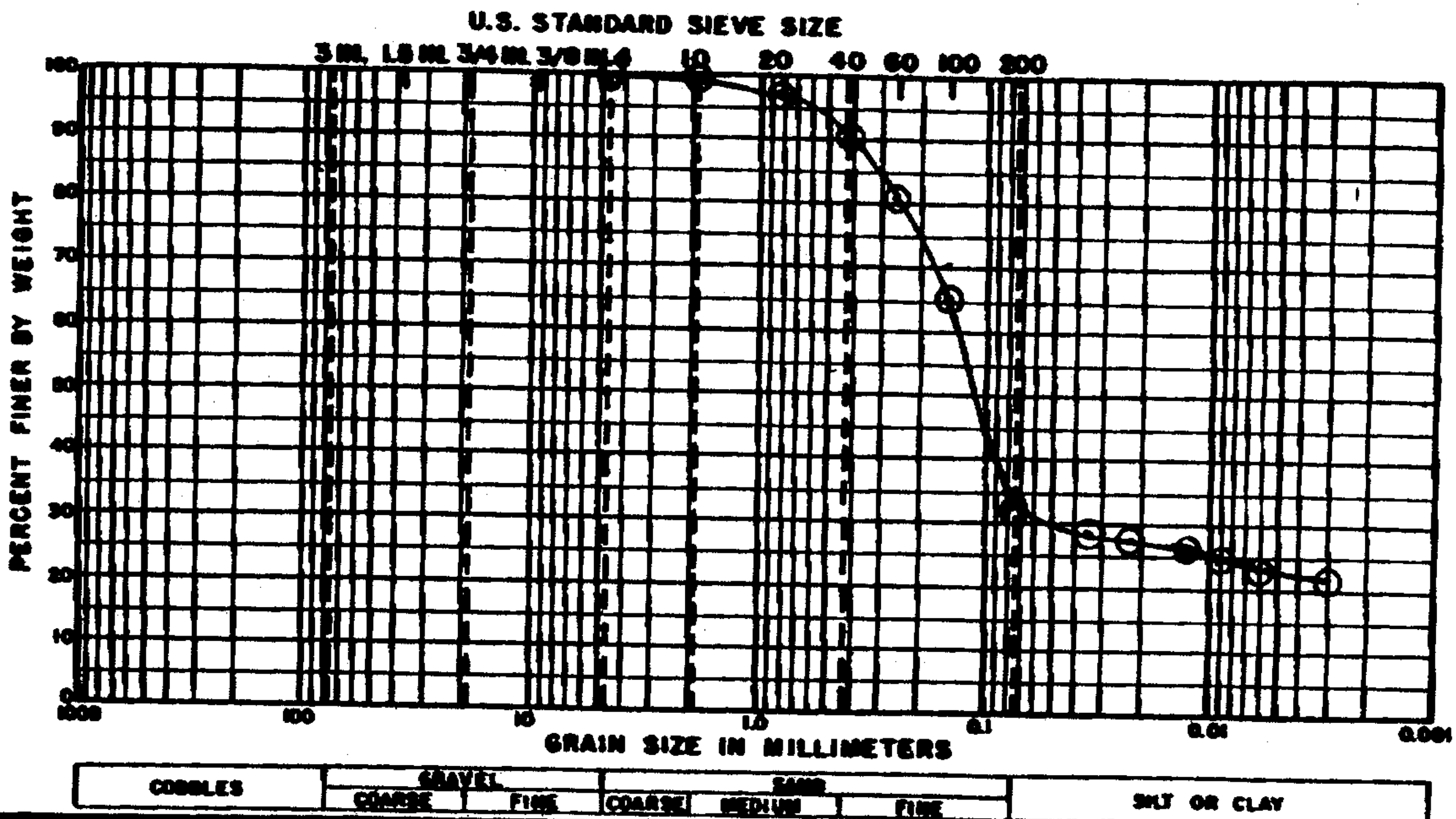


COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS & 10% TOTAL BENTONITE

GRADATION CURVE



	DEPTH	CLASSIFICATION		NAT. WC	LL	PL	PI	

BULK SOILS & 12% TOTAL BENTONITE

GRADATION CURVE

DAMES & MOORE

APPENDIX B-2

SLURRY WALL/OIL RECOVERY SYSTEM REPORT

GROUNDWATER
TECHNOLOGY, INC.

Chadds Ford West, Rt. 1, Chadds Ford, PA 19317 (215) 388-1466
Fax: (215) 388-6298

October 2, 1989

Mr. Michael Reeve, P.E.
Chevron USA, Inc.
Philadelphia Refinery
P.O. Box 7408
Philadelphia, PA 19101

Dear Mike:

This correspondence is to document the installation of five (5) groundwater monitoring wells and two (2) separate-phase hydrocarbon recovery wells along the upgradient side of the slurry wall at the Philadelphia Refinery.

1. Monitoring Well Installation

On April 17, 1989, five (5) groundwater monitoring wells were installed using hollow stem augering techniques. All wells were constructed of 4-inch I.D., 0.010" continuous slot, Johnson PVC well screen and casing. The wells were completed above grade within 6-inch protective steel casing (Appendix A: Drilling Logs).

The wells were placed at regular intervals along the slurry wall as field conditions allowed, and are complemented by existing monitoring wells A-21 and A-21D, which were installed by a previous consultant (Figure 1). The function of these wells is to monitor the occurrence of separate-phase hydrocarbons along the upgradient side of the slurry wall.

2. Recovery Well Installation

On June 27-28, 1989 and on July 14, 1989, two (2) separate-phase hydrocarbon recovery wells were installed at each end of the slurry wall, to act as recovery points for potentially migrating separate-phase hydrocarbons around the slurry wall termini (Figure 1).

On June 27-28, 1989, excavation was initiated at the upstream (Schuylkill River) end of the slurry wall, designated SRW-1 (Figures 1 and 2). The trench was excavated to an average depth of 13.5 feet, and a total length of approximately 18 feet.

A 30-inch I.D., 0.010" continuous slot, Johnson galvanized well screen was installed within the trench, and a backfill of 3/4-inch washed stone was deposited around the well to a depth of approximately 8 inches below grade (Appendix A: Drilling Logs).

To counteract the influence of surface water into the trench, a 30-mil impermeable liner was placed horizontally over the excavation. Additional backfill was then placed on this liner to bring the excavation up to the level of the existing grade.

On July 14, 1989, excavation was initiated at the downstream end of the slurry wall, designated SRW-2 (Figures 1 and 3). The trench construction was similar to that of SRW-1, but with the inclusion of a downgradient impermeable liner placed vertically within the excavation.

3. Recovery Equipment Installation

Two (2) Oil Recovery System (ORS) Filter Scavengers® are presently on site awaiting connection with a hard line input to the waste oil tank system. Upon connection, two (2) product flow meters will be installed in-line at each of the two recovery points.

4. Site Survey

On August 18, 1989 a site survey was performed to provide elevational and horizontal control of the monitoring and recovery wells. All wells were correlated to Mean Sea Level, National Geodetic Vertical Datum, as noted in records for groundwater monitoring well A-21D (elevation 12.18 feet). The following elevations were calculated:

WELL	**ELEVATION (top of PVC Casing)**
SW-1	10.51
SW-2	10.65
SW-3	10.78
SW-4	10.35
SW-5	11.83
SWR-1	9.05
SWR-2	10.65

5. Monitoring Well Gauging

On July 13, 1989 and August 23, 1989 all slurry wall wells were gauged. The tabular results are presented in Appendix B: Liquid Levels. A schematic cross section of the August 23, 1989 groundwater elevations is presented in Figure 4.

6. Summary and Recommendations

Presently, liquid levels along the slurry wall indicate a groundwater low in the proximity of well SW-4 and near SWR-2. This appears to be a result of tidal influences coupled with the preferential permeability of the fill material. During trench excavation and installation of the two recovery wells, separate-phase hydrocarbons were observed entering the well bore and surrounding backfill.

The corresponding groundwater high near well SW-2 appears to be caused by the same influences described above.

Based upon Groundwater Technology, Inc.'s knowledge of the hydraulic properties at the site, it appears that active groundwater depression is required to induce separate-phase hydrocarbons into the recovery well bore. The natural hydraulic gradient along the slurry wall is from SWR-1 to SWR-2; eventually, separate-phase hydrocarbons may passively intercept the recovery trench at SWR-2. However, to ensure effective hydraulic control, a water table depression system must be employed.

If you have any questions, please feel free to contact me at this office.

Sincerely,
GROUNDWATER TECHNOLOGY, INC.

Christopher D. Carlson
Project Geologist

Enclosures

cc: Mark Wrigley
Project File (300-175-3527)

FIGURES

GROUNDWATER TECHNOLOGY, INC.

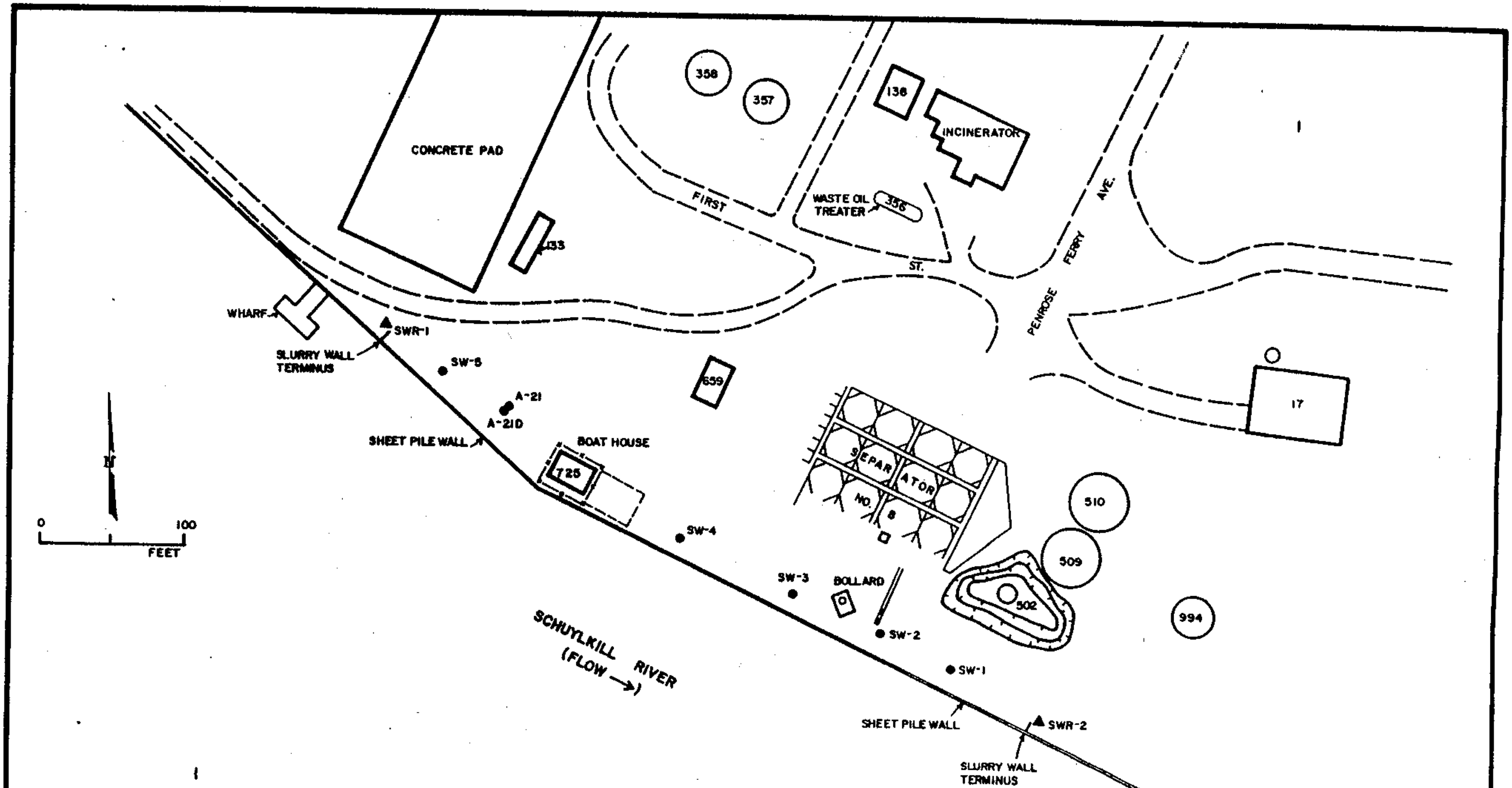


FIGURE 1
SITE MAP
SLURRY WALL WALLS
CHEVRON USA, INC.
PHILADELPHIA REFINERY
PHILADELPHIA, PA.

GROUNDWATER

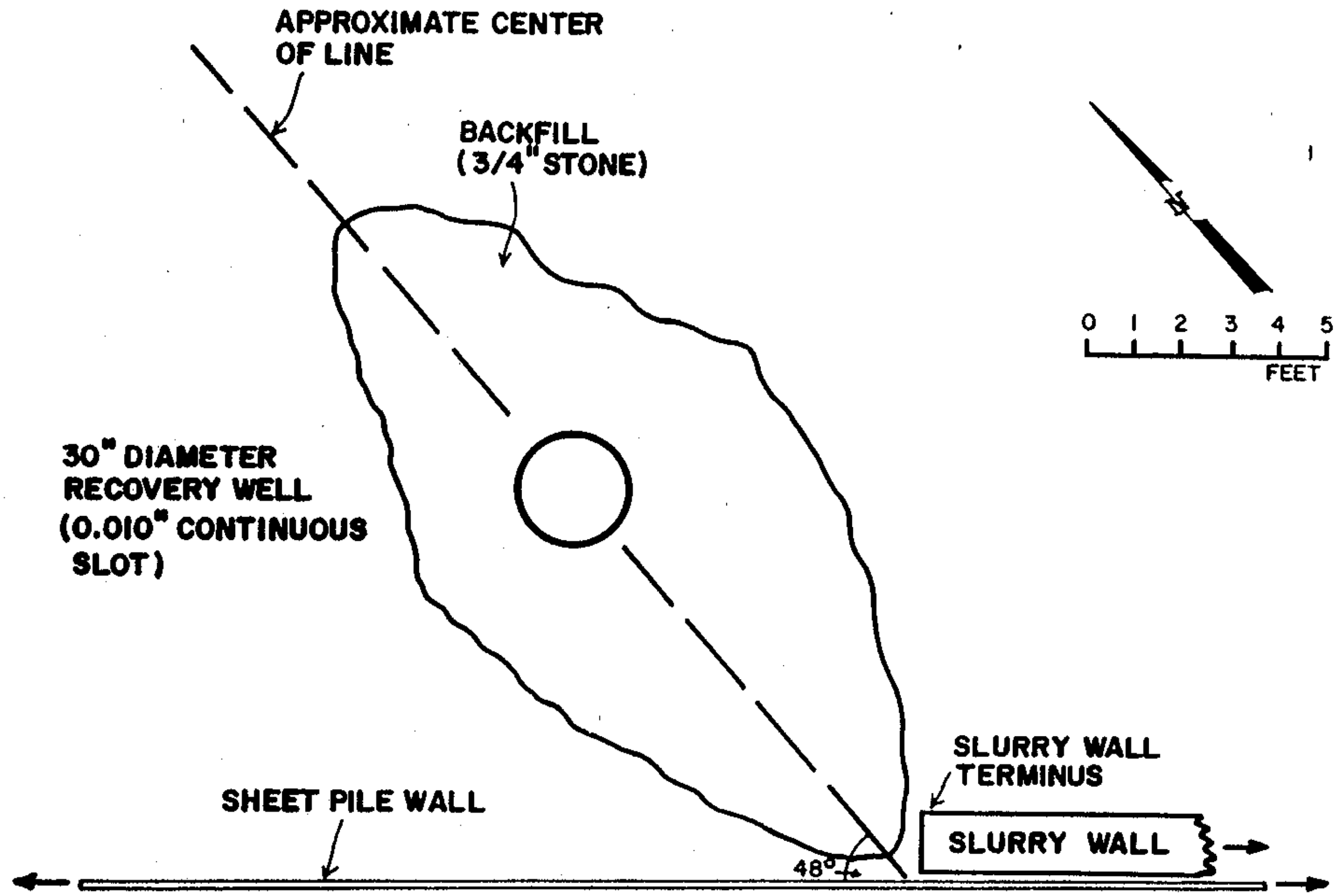


FIGURE 2
SCHEMATIC DIAGRAM - PLAN VIEW
SLURRY WALL RECOVERY WELL SWR-1
CHEVRON USA, INC.
PHILADELPHIA REFINERY
PHILADELPHIA, PA.

GROUNDWATER
TECHNOLOGY, INC.

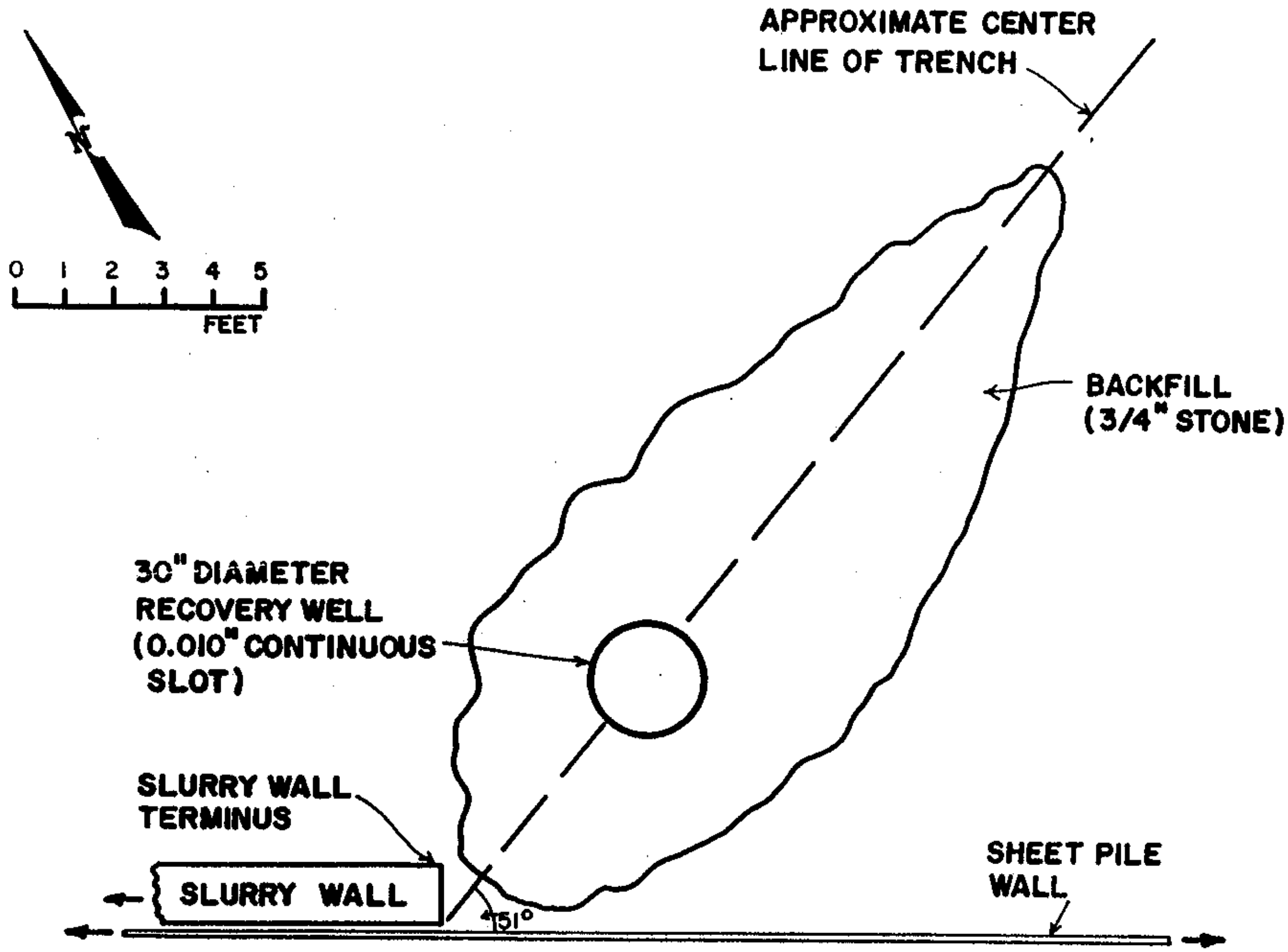


FIGURE 3
SCHEMATIC DIAGRAM - PLAN VIEW
SLURRY WALL RECOVERY WELL SWR-2
CHEVRON USA, INC.
PHILADELPHIA REFINERY
PHILADELPHIA, PA.

GROUNDWATER
TECHNOLOGY, INC.

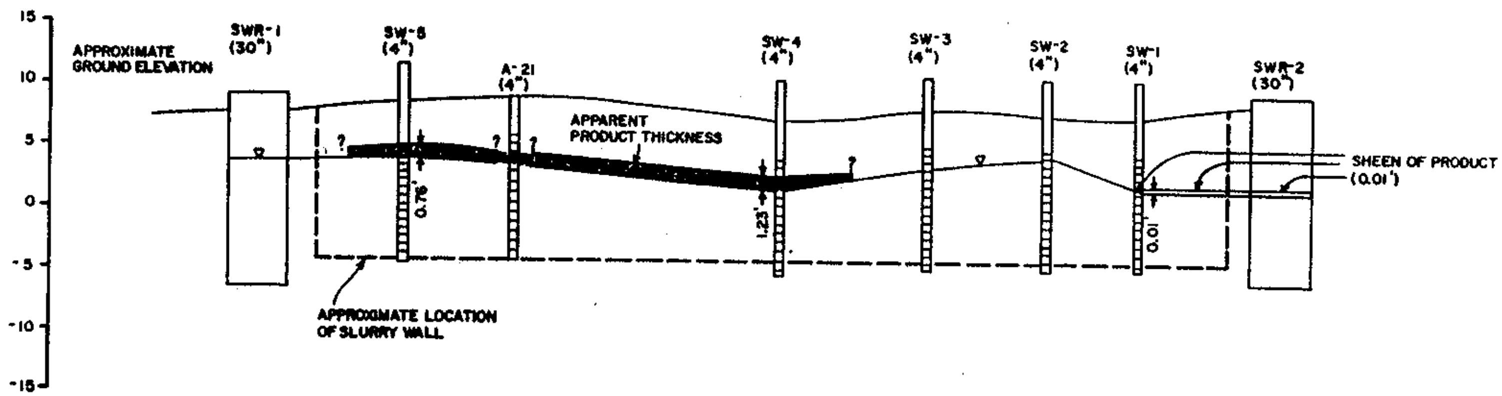


FIGURE 4
SCHEMATIC CROSS SECTION
SLURRY WALL WELLS
CHEVRON USA, INC.
PHILADELPHIA REFINERY
PHILADELPHIA, PA.

0 50 100
HORIZONTAL SCALE FT.

NOTE: GROUNDWATER ELEVATIONS GAUGED ON 8-23-89

VERTICAL EXAGGERATION= 6.5x

APPENDIX A: DRILLING LOGS

GROUNDWATER TECHNOLOGY, INC.

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron U.S.A., Inc.
PROJECT NAME: Chevron - Slurry
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.

DATE 4-17-89 WELL NUMBER SW-1
DRILLER: GT Drilling

CASED FROM 0' TO 5' WITH PVC Casing
DRILL RIG B-56 Mobile Drill
SCREENED FROM 5' TO 15' WITH .010"Slot
DRILL METHOD Hollow Stem Auger
WELL DEPTH 15' WELL DIAMETER 4"
DATE(S) DRILLED 17 April 1989
ELEVATION 10.51' (AMSL)
LOGGED BY C. Carlson
ANNULUS COMPLETION #2 Morie Sand, bentonite sealed, protective steel casing
OTHER 3' Stick-up

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2				
	3				
	4		Fill, silts, debris		
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron U.S.A., Inc.
PROJECT NAME: Chevron - Slurry
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.
DRILLER: GT Drilling

DATE 4-17-89 WELL NUMBER SW-2

CASED FROM 0' TO 5' WITH PVC Casing
SCREENED FROM 5' TO 15' WITH .010"Slot
WELL DEPTH 15' WELL DIAMETER 4"
ELEVATION 10.65' (AMSL)
DRILL RIG B-56 Mobile Drill
DRILL METHOD Hollow Stem Auger
DATE(S) DRILLED 17 April 1989
LOGGED BY C. Carlson
ANNULUS COMPLETION #2 Morie Sand, bentonite sealed, protective steel casing
OTHER 3' Stick-up

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2				
	3				
	4		Fill, silts, debris		
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron U.S.A., Inc.
PROJECT NAME: Chevron - Slurry
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.
DRILLER: GT Drilling

DATE 4-17-89 WELL NUMBER SW-3

CASED FROM 0' TO 5' WITH PVC Casing
SCREENED FROM 5' TO 15' WITH .010"Slot
WELL DEPTH 15' WELL DIAMETER 4"
ELEVATION 10.78' (AMSL)
DRILL RIG B-56 Mobile Drill
DRILL METHOD Hollow Stem Auger
DATE(S) DRILLED 17 April 1989
LOGGED BY C. Carlson
ANNULUS COMPLETION #2 Morie Sand, bentonite sealed, protective steel casing
OTHER 3' Stick-up

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2				
	3				
	4		Fill, silts, debris		
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron U.S.A., Inc.
PROJECT NAME: Chevron - Slurry
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.
DRILLER: GT Drilling

DATE 4-17-89 WELL NUMBER SW-4

CASED FROM 0' TO 5' WITH PVC Casing
SCREENED FROM 5' TO 15' WITH .010"Slot
WELL DEPTH 15' WELL DIAMETER 4"
ELEVATION 10.35' (AMSL)
DRILL RIG B-56 Mobile Drill
DRILL METHOD Hollow Stem Auger
DATE(S) DRILLED 17 April 1989
LOGGED BY C. Carlson
ANNULUS COMPLETION #2 Morie Sand, bentonite sealed, protective steel casing
OTHER 3' Stick-up

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2				
	3				
	4		Fill, silts, debris		
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron U.S.A., Inc.
PROJECT NAME: Chevron - Slurry
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.
DRILLER: GT Drilling

DATE 4-17-89 WELL NUMBER SW-5

CASED FROM 0' TO 5' WITH PVC Casing
SCREENED FROM 5' TO 15' WITH .010"Slot
WELL DEPTH 15' WELL DIAMETER 4"
ELEVATION 11.83' (AMSL)
DRILL RIG B-56 Mobile Drill
DRILL METHOD Hollow Stem Auger
DATE(S) DRILLED 17 April 1989
LOGGED BY C. Carlson
ANNULUS COMPLETION #2 Morie Sand, bentonite sealed, protective steel casing
OTHER 3' Stick-up

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2				
	3				
	4		Fill, silts, debris		
	5				
	6				
	7				
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				
	21				
	22				
	23				
	24				
	25				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron USA, Inc.
PROJECT NAME: Slurry Wall Wells
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.

DATE 6-28-89 WELL NUMBER SWR-1
DRILLER: GTI Construction Management

CASED FROM ____ TO ____ WITH ____
DRILL RIG Backhoe
SCREENED FROM 0 TO 14' WITH 010"Slot
DRILL METHOD Excavation
WELL DEPTH 14' WELL DIAMETER 30"
DATE(S) DRILLED 27-28 June 1989
ELEVATION 9.05' (AMSL)
LOGGED BY C. Carlson
ANNULUS COMPLETION 17'L x8'W x14'D Trench backfilled w/3/4" Stone
OTHER Well constructed of 30", .010" continuous slot galvanized screen

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1		1.5" Stone		
	2				
	3		Fill material (silts, sands, debris).		
	4				
	5				
	6				
	7				Soils with heavy oil residue- free-phase entering excavation
	8				
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

GROUNDWATER TECHNOLOGY, INC.

CLIENT: Chevron USA, Inc.
PROJECT NAME: Slurry Wall Wells
PROJECT NUMBER: 300-175-3527
LOCATION: Philadelphia Refinery
Philadelphia, Pa.

DATE 7-14-89 WELL NUMBER SWR-2
DRILLER: GTI Construction Management

CASED FROM ____ TO ____ WITH ____
DRILL RIG Backhoe
SCREENED FROM 0 TO 14' WITH .010"Slot
DRILL METHOD Excavation
WELL DEPTH 14' WELL DIAMETER 30"
DATE(S) DRILLED 14 July 1989
ELEVATION 10.65' (AMSL)
LOGGED BY C. Carlson
ANNULUS COMPLETION 18'L x7'W x14'D Trench backfilled with 3/4" Stone
OTHER Well construction of 30", .010" Continuous slot, galvanized screen

WELL DETAIL	DEPTH	GRAPHIC COLUMN	LITHOLOGICAL DESCRIPTION	SAMPLE	COMMENTS
	1				
	2		Fill (silts,sands,debris)		
	3				
	4				
	5				Soils with heavy
	6				oil residue-
	7				free-phase entering
	8				excavation
	9				
	10				
	11				
	12				
	13				
	14				
	15				
	16				
	17				
	18				
	19				
	20				

APPENDIX B: LIQUID LEVELS

CHEVRON REFINERY
MONITORING WELL DATA
SLURRY WALL WELLS

23 AUGUST 1989

WELL	ELEVATION (FT)	DEPTH TO WATER (FT)	DEPTH TO PRODUCT (FT)	PRODUCT THICKNESS (FT)	WATER ELEVATION (FT)	PRODUCT ELEVATION (FT)	CORRECTED WATER ELEVATION (FT)
SW-1	10.51	8.15	8.14	0.01	2.36	2.37	2.37
SW-2	10.65	6.51			4.14		4.14
SW-3	10.78	7.47			3.31		3.31
SW-4	10.35	8.83	7.6	1.23	1.52	2.75	2.63
SW-5	11.83	7.46	6.7	0.76	4.37	5.13	5.05
SWR-1	9.05	5.1			3.95		3.95
SWR-2	10.65	8.96	8.95	1.69	1.69	1.70	1.70

CHEVRON REFINERY
MONITORING WELL DATA
SLURRY WALL WELLS

13 JULY 1989

WELL	ELEVATION (FT)	DEPTH TO WATER (FT)	DEPTH TO PRODUCT (FT)	PRODUCT THICKNESS (FT)	WATER ELEVATION (FT)	PRODUCT ELEVATION (FT)	CORRECTED WATER ELEVATION (FT)
SW-1	10.51	8.18	8.17	0.01	2.33	2.34	2.34
SW-2	10.65	6.62			4.03		4.03
SW-3	10.78	7.83			2.95		2.95
SW-4	10.35	11.05	7.52	3.53	-0.70	2.83	2.48
SW-5	11.83	7.03	6.7	0.33	4.80	5.13	5.10
SWR-1	9.05	6.98			2.07		2.07
SWR-2	10.65						

APPENDIX C

OIL RECOVERY TRENCH PROPOSAL

GROUNDWATER TECHNOLOGY, INC.

Rt. 1, Chadds Ford West, Chadds Ford, PA 19317 (215) 388-1466

Fax (215) 388-6298

November 13, 1989

Ms. Joyce T. Shirazi, P.E.
Environmental Engineer
Chevron USA, Inc.
810 Gleneagles Court
Towson, MD 21204

RE: Separate-Phase Hydrocarbon Recovery Trench Cost Estimate for Philadelphia Refinery.

Dear Joyce:

The following is a cost estimate for the installation of a separate-phase hydrocarbon recovery trench at the Chevron USA, Inc. refinery in Philadelphia, Pennsylvania.

I. SCOPE OF WORK

A. Trench Construction

The specifications for the separate-phase hydrocarbon recovery trench construction are briefly outlined below:

1. The perimeter of the recovery trench will be saw-cut along its length to facilitate removal of the 8-10 inches of concrete and asphalt roadway. This will also allow the disposal of the excised concrete/asphalt as construction debris, rather than having to be potentially treated as contaminated "soils."

2. The dimensions of the recovery trench will be approximately 270 feet long by 12 feet deep by 3 feet wide.

3. Excavated soils will be transported to a location in the refinery as directed by Chevron USA, Inc. personnel.

4. The longitudinal axis of the trench will be in an east-west direction, between Pipe Conduits 42 and 41 (about 70 feet long, denoted as T-1), and between Pipe Conduits 40 and 39 (about 200 feet long, denoted as T-2), along the north side of Warehouse No. 1.

5. A total of six (6) corrugated, perforated sumps will be installed. Two (2) sumps will be installed within trench T-1, and four (4) sumps will be installed within trench T-2. Additionally, 2-inch wells may be installed to enhance the monitoring of separate-phase hydrocarbon thickness within the trench.

6. The trench will be backfilled to within four (4) feet of grade with a clean stone (size to be determined at a later date).

7. After completion, the trench will be re-asphalted with 4 inches of BC/BC.

8. A vacuum truck will be provided to de-water the trench during excavation.

The following assumptions are made with respect to the trench construction:

1. No underground or overhead utilities hinder work.
2. No soil disposal.
3. All de-watering fluids can be properly disposed of on site.
4. No shoring or bracing is required.

B. Pump Test

Subsequent to the trench installation, a 72-hour, total fluids pump test will be performed to determine pump specifications. Pumped fluids will be routed either to a vacuum truck or directly to Chevron USA, Inc.'s oily water sewer, depending upon Chevron USA, Inc.'s preference. In any case, it is assumed that withdrawn fluids can be properly disposed of on site.

C. Recovery Equipment

The recovery equipment will consist of at least two (2) Oil Recovery Systems Filter Scavengers (1/4 hp, 115V) for separate-phase hydrocarbon recovery, and at least two (2) Water Table Depression Pumps (WTDP) to provide hydraulic control within and proximal to the recovery trench perimeter. All equipment comes complete with the necessary probes, probe panels, and cables, is rated for operation in hazardous locations (i.e., explosion-proof).

D. Reporting

Following the installation of the recovery trench, the performance of a pump test, and the installation of the recovery equipment, a report will be generated to Chevron USA, Inc. outlining work steps, pump test analyses, and recommendations to enhance remediation efforts, if applicable. Also included in the report will be as-built plans and specifications.

E. Maintenance & Monitoring

After the installation and start-up of the recovery equipment within the recovery trench sumps, Groundwater Technology, Inc. geotechnicians will visit the site thrice per week for two (2) weeks, followed by visits once per week for fifty (50) weeks. During these visits, liquid levels will be obtained from all wells within the recovery area, in addition to the calibration, maintenance, and adjustment of the recovery equipment.

Quarterly reports will be generated documenting site operations, product recovery information, and general remediation program status.

II. COST ESTIMATE

The following is a breakdown of costs associated with the construction of the recovery trench:

A. Trench Construction . . . .$ 64,965.00

Includes professional fees for the coordination of field work and supervision of trench construction, technical fees for the actual excavation, materials (six (6) 30" I.D. x 12' corrugated, perforated sumps, and backfill stone), and heavy equipment rental. Also includes transportation, expenses, and explosimeter and Photoionization Device (PID) rental for safety monitoring.

B. Pump Test . . . .$ 15,590.00

Includes manpower, equipment, transportation, and expenses to perform a 72-hour pump test to determine pump specifications. Includes rental fees on all pumps, hoses, meters, probe panels, and miscellaneous tools.

C. **Recovery Equipment . . . . $ 35,000.00**

Includes the purchase of two (2) Oil Recovery Systems (ORS) Filter Scavenger with product totalizers, and two (2) Water Table Depression Pumps (WTDP) with flow meters. Includes freight charges and PA sales tax.

NOTE: There are six (6) sumps to be installed along the length of the recovery trench. The above recovery equipment costs are based upon one (1) Filter Scavenger/WTDP in each trench (T-1 and T-2). Should additional recovery equipment be required, the per unit (consisting of one (1) Filter Scavenger, one (1) WTDP, and installation costs) cost would be approximately $19,500.00.

D. **Reporting . . . .$ 7,300.00**

Includes reporting of work performed, construction of as-built plans, senior engineer review (concurrent with trench construction), analyses of pump testing, and additional recommendations, if any.

E. **Maintenance & Monitoring (one year) . . . .$ 29,970.00**

Includes weekly monitoring of liquid levels, maintenance and adjustment of recovery equipment, and the generation of quarterly status reports for one year from system start-up.

Subtotal	=	**$ 152,825.00**
Contingency	=	**$ 10,000.00**
Total	=	**$ 162,825.00**

NOTE: The above estimated costs are presented for budgetary purposes only. Actual costs will be billed on a time and materials, as per Chevron USA, Inc.'s Regional Contract with Groundwater Technology, Inc. (Contract #M26CMA02938X). The billings will be generated monthly and will not exceed the above amount without prior authorization.

NOTE: It is assumed that Chevron USA, Inc. will provide electrical power as specified by Groundwater Technology, Inc. to the sump location(s) where equipment will be located.

NOTE: It is assumed that Chevron USA, Inc. will provide a hook-up at the sump head for the discharge water.

NOTE: It is assumed that Chevron USA, Inc. will provide a product storage tank or a product hook-up line (compatible with the specifications of the recovery equipment) to the location of the equipment. It is also assumed that Chevron USA, Inc. will be responsible for all pumped product.

NOTE: It is assumed that Chevron USA, Inc. has facilities to handle the excavated soil that is not used as backfill during trench construction. Because this soil may contain elevated concentrations of petroleum hydrocarbons, it may require disposition. Groundwater Technology, Inc. could provide a separate proposal to address on-site remediation of this soil if so desired by Chevron USA, Inc.

Joyce, I feel I need to mention that the above costs compare quite well with our original proposal dated September 30, 1988 and our revised proposal dated February 14, 1989. These earlier proposals, however, assumed that Chevron USA, Inc. would provide the heavy equipment and operator(s) with which to install the trench. This current proposal, of course, includes these costs as part of Groundwater Technology, Inc.'s responsibility.

One other dissimilitude between earlier proposals and this proposal is the proposed length of the recovery trench. Earlier proposals were based upon assumptions Groundwater Technology, Inc. was forced to make, due to the lack of knowledge of the subsurface conditions with respect to ease of excavation. Because Groundwater Technology, Inc. has recently performed similar recovery trench installations at the Philadelphia Refinery, we are able to more accurately assess what subsurface conditions and/or complications could reasonably be expected to be encountered.

As you probably are aware from your discussions with Mr. Vince Damiano, P.E., Groundwater Technology, Inc. is prepared to implement this scope of work upon receipt of a Release Number from your office.

If you have any questions, please feel free to contact me at this office (215-388-1466).

Sincerely,
GROUNDWATER TECHNOLOGY, INC.

Christopher D. Carlson
Project Manager
Project Geologist

cc: Eric Schneider
Vince Damiano
Paul Miller
Mark Wrigley
Project File (300-175-3549)

APPENDIX D

LEAD ANALYTICAL RESULTS (SOIL)

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/10/87
PAGE: 1

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Sample Points, Sampling Dates, and ETC Sample No.'s

arameters	Units	S TB221A 861211 P8323	S TB221B 861211 P8322	S TB224B 861211 P8326	S TB238 861211 P8324	S TB242 861211 P8325	S TB245B 861211 P8673	S TB309A 861212 P8672	S TB309B 861212 P8331
oundwater Metals									
ead	ug/kg	589000	52300	558000	1610000	2970000	230000	935000	725000

lnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/10/87
PAGE: 2

Chain of Custody Data Required for ETC Data Management Summary Report

See Below	DAMES AND MOORE	CHEVPPASLP	See Below	
ETC Sample No.	*Company*	*Facility*	*Sample Point*	*Date*

Sample Points, Sampling Dates, and ETC Sample No.'s

Parameters	*Units*	S TB311 861212 P8328	S TB313A 861212 P8329	S TB313B 861212 P8330	S TB328 861212 P8327				
Groundwater Metals									
Lead	ug/kg	310000	370000	130000	735000				

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/87
PAGE: 1

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Sample Points, Sampling Dates, and ETC Sample No.'s

Parameters	Units	S TB202A 861211 N9596	S TB202B 861211 N9603	S TB206A 861211 N9600	S TB206B 861211 N9597	S TB209A 861211 N9604	S TB209B 861211 N9599	S TB226A 861215 N9585	S TB226B 861215 N9584
Groundwater Metals									
Lead	ug/kg	88600	310000	340000	420000	330000	671000	370000	130000

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/87
PAGE: 2

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Parameters	Units	S TB243A 861211 N9593	S TB243B 861211 N9589	S TB244A 861210 N9573	S TB224A 861211 N9601	S TB244B 861210 N9575	S TB245A 861211 N9595	S TB246A 861211 N9588	TB246B 861210 N9571
Groundwater Metals									
Lead	ug/kg	1370000	1490000	390000	17000000	360000	190000	1440000	1390000

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/8

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Parameters	Units	S TB251A 861211 N9587	S TB251B 861211 N9594	S TB276A 861210 N9574	S TB276B 861210 N9572	S TB277A 861210 N9576	S TB277B 861210 N9570	S TB286A 861210 N9577	S TB286B 861210 N9578
Groundwater Metals									
Lead	ug/kg	370000	594000	4950000	3220000	1120000	340000	1630000	480000

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

— ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/87
PAGE: 4

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Sample Points, Sampling Dates, and ETC Sample No.'s

Parameters	Units	S TB289A 861208 N9590	S TB290A 861208 N9591	S TB290B 861208 N9592	S TB426A 861208 N9566	S TB426B 861208 N9567	S TB430A 861208 N9568	S TB430B 861208 N9569	S TB438A 861208 N9563
roundwater Metals									
Lead	ug/kg	1970000	857000	370000	631000	340000	1760000	170000	610000

ootnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/8
PAGE: 5

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Sample Points, Sampling Dates, and ETC Sample No.'s

Parameters	Units	S TB438B 861208 N9564	S TB440A 861208 N9562	S TB440A 861211 N9602	S TB440B 861208 N9565	S TB440B 861211 N9598	S TP202A 861204 N9555	S TP202B 861204 N9560	S TP203A 861204 N9554
Groundwater Metals									
Lead	ug/kg	50200	140000	370000	99800	51900	2000000	160000	410000

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

DATE: 01/11/87
PAGE: 6

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Sample Points, Sampling Dates, and ETC Sample No.'s

Parameters	Units	S TP203B 861204 N9558	S TP205A 861204 N9556	S TP205B 861204 N9559	S TP207A 861204 N9557	S TP207B 861204 N9561	S TP208A 861204 N9609	S TP208B 861204 N9611	S TP215A 861204 N9605
Groundwater Metals									
Lead	ug/kg	29000	55000	41000	590000	280000	925000	119000	501000

Footnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

ETC ENVIRONMENTAL TESTING and CERTIFICATION

DATA MANAGEMENT SUMMARY REPORT
(DM-OL) - All Parameters Tested, Samples Linked by Order

Chain of Custody Data Required for ETC Data Management Summary Report

ETC Sample No.	Company	Facility	Sample Point	Date
See Below	DAMES AND MOORE	CHEVPPASLP	See Below	

Parameters	Units	S TP215B 861204 N9606	S TP223A 861204 N9608	S TP223B 861204 N9612					
roundwater Metals									
Lead	ug/kg	15000	180000	120000					

ootnotes: BMDL=Below Method Detection Limit ND=Parameter not detected '-'=Parameter not tested

APPENDIX E

SAMPLING PLAN

TABLE OF CONTENTS

1.0 SURFACE SOIL SAMPLING

The purpose of the surface soil sampling is to characterize surface soil quality from 0 to 6 inches. The following sections detail the appropriate sampling, decontamination, custody, and sample blank procedures for surface soil sampling.

1.1 SOIL SAMPLING PROCEDURES

Soil sampling procedures will be as follows:

1. The laboratory "shuttle" will be opened and the sample bottles will be inspected to ensure that all of the required bottles are present and properly labeled.

2. Soil sampling locations will be designated in accordance with the Work Plan. (Samples will not be collected during periods of significant rainfall).

3. The sampling area will be cleaned of gravel and/or twiggs. Collection of soil samples will be performed using a clean stainless steel trowel. Each trowel will be cleaned using the procedures outlined in Section 1.2. At each sample location the soil will be placed into the sample vials or jars using the trowel. When collecting a composite sample, equal proportions from each sample location will be combined.

4. For each sampling event, samples will be handled with a new pair of disposable plastic surgical gloves.

5. Upon the completion of sampling at each location, the sampler will be decontaminated in accordance with the procedures described in Section 1.2.

6. Each bottle will be labeled with the following information:

   a. Job number
   b. Owner/client
   c. Location
   d. Sample number or designation
   e. Date
   f. Time
   g. Type of laboratory analysis (i.e., metals, pH, etc.)
   h. Name of person collecting the sample

7. The sample bottles will be placed in the shuttle and packed with ice or chemical ice packs to maintain the temperature at $4^{O}C$.

8. The Chain-of-Custody and Field Parameter Forms from the analytical laboratory will be completed and signed. The Sampling Record will also be completed.

9. The shuttle will be sealed and stored.

10. If applicable, a field blank will be collected in accordance with procedures described above.

11. The shuttles will be transported by Federal Express or car to the laboratory within 24 hours of collection. The laboratory will be notified by the project manager in a timely manner of the impending arrival of the samples. The laboratory will be prepared to receive the samples and to perform preliminary extractions or analyses within the recommended holding times.

1.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

All sampling equipment will be constructed of inert materials and will be decontaminated in the field prior to use. The sampling device and equipment decontamination method will involve a non-phosphate detergent, tap water, deionized water, methanol, and air drying.

Samplers and sample containers will be cleaned and prepared for field use according to the following procedures:

1. Non-phosphate detergent and tap water wash

2. Tap water rinse

3. Distilled/deionized water rinse

4. 10% nitric acid rinse

5. Distilled/deionized water rinse

6. Methanol (reagent grade) rinse*

7. Total air dry or nitrogen blow out*

8. Distilled/deionized water rinse

Note: * Methanol is an acceptable cleaning solvent provided that it is allowed to <u>totally</u> evaporate via air drying or a nitrogen blowout and if is followed by a distilled/deionized rinse.

1.3 SAMPLE CUSTODY PROCEDURES

Sample chain of custody is initiated by the laboratory with the selection and preparation of the sample containers. To reduce the chance for error, the number of personnel that assume custody of the sample will be held to a minimum.

In-situ or on-site monitoring and sampling data will be controlled and entered onto appropriate records. Personnel involved in the chain-of-custody and transfer of samples will be trained regarding the purpose and procedures prior to implementation.

1.3.1 Field Sample Custody

Dames & Moore personnel receiving the sample containers will check each cooler for the integrity of the seals. Coolers with broken seals will be returned to the laboratory with the containers unused. The receiving Dames & Moore personnel will break the seal, inspect the contents for breakage, sign the Chain-of-Custody Form as their receipt of the sample containers. A temporary seal will be affixed to each cooler until the sample containers are filled.

A Chain-of-Custody Form will accompany the samples from initial sample container selection and preparation at the laboratory to the field for sample containment and preservation, through its return to the laboratory. Under no circumstances will sample coolers and bottles be left unattended in the field unless stored in a secured area.

The project manager will notify the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped and the samples' anticipated date of arrival. Insulated sample shipping containers (coolers) will be provided by the laboratory. All sample bottles within each shipping container will be individually labeled.

When the sample containers have been filled, they will immediately be placed in the cooler with sealed bags of ice or chemical ice to maintain the samples at 4^oC. The field sampler will indicate the sample designation/location number in the space provided on the appropriate Chain-of-Custody Form for each sample of water or sediment. The Chain-of-Custody Forms will be signed and placed in the cooler. The completed shipping container will be closed and a seal will be affixed to the latch or lid. This seal must be broken to open the cooler, and will indicate tampering if the seal is broken before receipt at the laboratory. The samples will be delivered via car or Federal Express to the laboratory not later than one day after sample collection.

If samples are split and sent to different laboratories, a separate Chain-of-custody Form will be sent with the replicate sample. The original Chain-of-Custody Form will accompany the sample to the primary laboratory. The "remarks" column of the Chain-of-Custody Form will be used to record specific considerations associated with the samples, such as sample type, container type, sample preservation methods, and analyses to be performed. The laboratory will maintain the completed original forms on file. Copies will be submitted as part of the final analytical report.

1.3.2 Laboratory Sample Custody

Receipt, storage, and tracking of samples submitted to the laboratory is conducted according to strict protocol in order to prevent sample contamination or loss, and to avoid the production of invalid laboratory data as a result of sample deterioration or tampering.

1.4 SAMPLE BLANKS

For quality assurance, blanks will be prepared or collected and analyzed in order to:

1. Provide a check on sample bottle preparation

2. Evaluate the effectiveness of the field cleaning procedures

Field blanks will be collected at the discretion of the sampling team during the course of the project. The blank will be analyzed as another sample for the same test parameters as the soil samples where the blank was collected. The blanks will consist of water.

A field blank consists of two sets of laboratory-cleaned sample containers. One set of containers is empty and serves as the sample containers that will be analyzed. The second set of containers are filled at the laboratory with laboratory-demonstrated analyte-free water. At the field location, this analyte-free water is passed through the sampling device, after the device has been cleaned with solvent and water, and is placed in the empty set of sample containers for analysis. This sample will be labeled as a unique individual sample and packaged with the other samples for analysis. The field blank will evaluate the effectiveness of the field cleaning procedures for sampling equipment.

Trip blanks will be submitted periodically for laboratory analysis of VOCs in accordance with the Data Collection Quality Assurance Plan (Appendix F).

2.0 SOIL BORING PROCEDURES

A soil boring program will be conducted in order to provide data to:

- Evaluate the degree and extent of soil contamination.
- Evaluate contamination source areas.

Specification for materials and procedures for soil borings are described in this Appendix. Section 2.1 describes preparatory activities; Section 2.2 lists field equipment; Section 2.3 presents the site management responsibilities; and Section 2.4 gives the field activities.

2.1 PREPARATORY ACTIVITIES

The field geologist shall locate and stake all soil boring locations, at the area of the facility under investigation, prior to the commencement of boring activity. The boring locations shall be in accordance with locations presented in the VI or RFI Workplan. If site conditions preclude boring placement, alternative locations will be proposed. Furthermore, borings will not be drilled during periods of significant rainfall.

2.2 FIELD EQUIPMENT

Geological field equipment to be used for this task includes:

- Organic vapor analyzer (flame ionization detector)
- Stainless steel trowel, spatula or spoon
- Boring logs and sampling records
- Decontamination detergents and methanol
- Tap water
- Distilled water
- Sample bottles
- Cleaning brushes
- Stakes, marking flags, and paint
- Depth-sounding tape
- Required health and safety clothing and equipment

2.3 PROCEDURES AND SITE MANAGEMENT

The field geologist will supervise the soil borings, as discussed in Section 2.4. The field geologist will also be responsible for logging field notes, for obtaining soil samples, and for ensuring that both decontamination and health and safety procedures are observed in the field.

2.4 SOIL BORING PROCEDURES

Soil borings must be performed in accordance with the specifications given below.

2.4.1 Cleaning

The drilling contractor shall certify, and the project manager/geologist shall confirm, that the tools, and any downhole components or materials have been steam-cleaned immediately before work begins. An on-site controlled decontamination area will be selected for equipment cleaning. Rinse water from cleaning will be released to the ground surface at the decontamination area. Decontamination of the drill rig and drilling equipment will consist of:

- o Decontaminating all equipment that will be introduced into the borehole by steam cleaning or other appropriate decontamination procedures followed by a spray rinse with deionized water.

- o Decontaminating split-spoon samplers and related sampling equipment by rinsing them with the tap water, followed by a rinse with deionized water, 10% nitric acid rinse, deionized water rinse, methanol, and a final rinse of deionized water. The samplers will be allowed to totally air-dry after the methanol rinse.

- o Washing and decontaminating the split-spoon samplers in accordance with the procedures stated in step 3 after collection of each soil sample.

- o Storing all augers, split-spoon samplers, and equipment used in drilling on clean plastic until they are required for use.

- o Decontaminating and handling the boring and sampling equipment, as described in steps 2 through 5, prior to augering at each successive borehole.

- o Using dedicated latex gloves when handling augers, split-spoon samplers, etc. Gloves will be collected in garbage bags and disposed of at the conclusion of daily operations.

These cleaning and decontamination procedures will be employed for all drilling activities in potentially contaminated environments. Their purpose is to minimize the potential for transferring possible contaminants from one borehole to another.

2.4.2 Boring Operations

The use of hollow-stem augers for borehole development is expected. Hand augers and tripod-driven split spoons may also be used. Stainless steel split-spoons will be used to collect soil samples.

Split-spoon samples will be collected and described every two (2) feet if possible, to the final depth of the boring. The samples will be described and logged by a qualified geologist. Additionally, OVA readings will be made of the sample immediately after collection. Further, OVA readings will also be collected in the completed borehole.

Once the sample has been collected, blow counts recorded, sample described, OVA reading measured and recorded, a grab/discrete sample will be obtained for sampling from a designated section of recovery. The designated sample intervals are proposed in the Work Plan. The sample(s) will be immediately placed in jar(s) pre-supplied by a qualified laboratory using a dedicated or decontaminated stainless steel trowel, spatula or spoon.

After each use, split-spoon samplers and sampling spoons/trowels etc., will be cleaned as per subsection 2.4.1.

At the conclusion of each boring, the borehole will be tremie grouted from the bottom to the ground surface.

3.0 <u>SUBSURFACE SOIL SAMPLING</u>

The purpose of the subsurface soil sampling plan is to characterize the soil quality with depth. The following sections detail the appropriate sampling, decontamination, custody, and sample blank procedures.

3.1 SUBSURFACE SOIL SAMPLING PROCEDURES

The subsurface soils will be retrieved from below ground in accordance with the procedures outlined in this Appendix, Chapter 2. The soil samples will be collected and containerized for laboratory analysis as per the procedures of subchapter 1.1 in this appendix, except for step 2. The subsurface soils will be collected from a split-spoon using trowels.

3.2 SAMPLING EQUIPMENT DECONTAMINATION PROCEDURES

Subsurface equipment will be decontaminated in accordance with this appendix, subchapter 2.4.1.

3.3 CUSTODY PROCEDURES

Applicable custody procedures are included as subchapter 1.3 of this appendix.

3.4 SAMPLE BLANKS

The procedures included as Section 1.4 of this appendix are also appropriate for subsurface soil sampling.

4.0 MONITORING WELL INSTALLATION PROCEDURES

The purpose of installing monitoring wells is to:

- o Provide more complete information of the hydrogeologic regime under the Chevron Refinery facility.
- o Allow for the evaluation of the ground water quality at the Chevron Refinery facility.

Specifications for materials and procedures in monitoring well installation and development are described in this chapter. Section 4.0 describes preparatory activities, discusses field equipment, and presents site management responsibilities. Section 4.0 also presents the field procedures for monitoring well construction, including decontamination procedures, and materials specifications. Section 5.0 describes monitoring well development techniques, and Section 6.0 addresses monitoring well surveying.

4.1 PREPARATORY ACTIVITIES

The drilling contractor shall be contacted prior to initiation of site work to review the scope of work. The scope is based on existing knowledge of site hydrogeology. All required permits, licenses, approvals, certificates, and authorizations must be obtained prior to initiation of field activities. The field geologist shall locate and stake all well locations prior to the commencement of drilling activities. These locations shall be consistent with locations presented in the VI or RFI Workplan. If site conditions preclude well placement, alternative locations will be proposed.

Field equipment to be used for this task includes:

- o Organic vapor analyzer
- o Boring logs and sampling records
- o Decontamination detergents, nitric acid, and methanol
- o Distilled water
- o Sample bottles
- o Stakes and marking flags
- o Depth-sounding tape
- o Required health and safety clothing and equipment

The field geologist will supervise the installation of monitoring wells, as discussed in Section 3.0. The field geologist will also be responsible for maintaining field notes, for logging the boreholes, and for ensuring that decontamination and health and safety procedures are observed in the field.

Monitoring wells must be installed in accordance with the specifications expressed below.

4.2 CLEANING

Prior to arriving on-site, the drilling contractor shall certify, and the project manager/geologist shall confirm, that the tools, and any downhole components or materials have been steam-cleaned immediately before work begins. An on-site controlled decontamination area will be selected for additional equipment cleaning. Rinse water from cleaning will be released to the ground surface at the decontamination area. Decontamination of the drill rig and drilling equipment will consist of:

- o Steam-cleaning all equipment that will be introduced into the boreholes.
- o Storing equipment used in drilling on clean plastic until it is required for use.
- o Using dedicated, disposable Latex plastic gloves when handling drilling equipment and downhole tools. Gloves will be collected in garbage bags and disposed of upon completion of each borehole. Dedicated gloves and other handling materials will be used at each subsequent borehole location.

These cleaning and decontamination procedures will be employed for all drilling activities in potentially contaminated environments. Their purpose is to minimize the potential for transferring possible contaminants from one borehole to another.

4.3 DRILLING OPERATIONS

The use of an air-rotary drill rig is proposed. For the overburden wells, the augers will be used.

All boreholes for monitoring wells will be sampled in 5 to 10 foot intervals to the final depth of the borehole. These samples will be described and logged by a qualified and degreed geologist. Additionally, lithological changes and significant water entry zones will be noted for all well types.

During drilling, in-situ "return" air will be monitored with an OVA by field personnel.

4.4 MONITORING WELL CONSTRUCTION MATERIALS

Each well type (shallow and deep) will require the same well construction materials.

Four-inch diameter schedule 40 flush-threaded PVC riser pipe and screen will be placed in the eight-inch diameter borehole. The borehole will be drilled from the ground surface to an approximate depth of 10 to 15 feet. The appropriate sandpack, No. 1 grade quartz sand, will be poured into the annular space between the borehole wall and the outside of the PVC casing to one foot above the screen. On top of the sand will be a two-foot thick bentonite pellet seal. Grout, which is cement with 3 to 5 percent bentonite, will be added on top of the seal to approximately three feet from ground surface. The PVC casing will be capped with a water-tight lid. To secure the PVC casing, a lockable six-inch diameter protective steel casing with a steel lid will be cemented in place to a depth of three feet. The protective steel casing will stand approximately two feet above the ground surface. Figure 16 depicts a general shallow well diagram.

For deep monitoring wells, an 8-inch-diameter steel casing will be set into the clay. Figure 17 depicts a generalized deep well construction diagram.

5.0 MONITORING WELL DEVELOPMENT

After the installation of the monitoring wells, they will be developed to ensure a representative ground water sample of the aquifer can be obtained.

Development of the wells will consist of pumping and backwashing with a submersible or centrifugal pump. The pump will be positioned opposite the water-bearing fracture zone or 5 feet below the top of the screen. The pump will be started at a reduced capacity, and gradually increased to full capacity. The pump will be stopped after 15 minutes to allow a column of water to flow into the well. The procedure will be repeated at the discretion of the supervising geologist until turbidity readings in samples of the discharge water have stabilized.

The discharge rate during development should be estimated by timing the pump discharge fill rate of a 5-gallon bucket or other suitable container. The development water will be discharged to the ground surface.

Equipment used to develop the wells will be thoroughly cleaned as specified in Section 8.3 before each well development program is begun.

6.0 WELL POINT INSTALLATION PROCEDURES

The purpose of installing ground water well points is to provide more complete information of the hydrogeologic regime under the Chevron Refinery facility, to aid in the selection of monitoring well locations and/or the scoping of corrective measures, if necessary.

Specifications for materials and procedures in well point installation are described in this chapter. Section 6.1 describes preparatory activities, field equipment, and site management responsibilities. The field procedures are presented for well point construction, including decontamination procedures (Section 6.2), drilling operations (Section 6.3), and materials specifications (Section 6.4).

6.1 PREPARATORY ACTIVITIES

The drilling team will review the scope of work presented in the work plan prior to initiation of site work. The scope is based on existing knowledge of site hydrogeology. All required permits, licenses, approvals, certificates, and authorizations must be obtained prior to initiation of field activities. The field geologist shall locate and stake all well point locations prior to the commencement of drilling activities. If site conditions preclude well placement, alternative locations will be proposed.

Field equipment to be used for this task includes:

- Power auger equipment
- Organic vapor analyzer
- Boring logs and sampling records
- Decontamination detergents, nitric acid, and methanol
- Decontamination brushes, buckets, and plastic
- Distilled water
- Sample bottles
- Stakes and marking flags
- Depth-sounding tape
- Required health and safety clothing and equipment

The field geologist will supervise the installation of well points, as discussed in Chapter 4.0. The field geologist will also be responsible for maintaining field notes, for logging the boreholes, and for ensuring that decontamination and health and safety procedures are observed in the field.

Well points must be installed in accordance with the specifications expressed below.

6.2 CLEANING

Prior to arriving on-site, the project manager/geologist shall verify that the tools and any downhole components or materials have been decontaminated immediately before work begins. An on-site controlled decontamination area will be selected for additional equipment cleaning. Rinse water from cleaning will be released to the ground surface at the decontamination area. Decontamination of the drilling equipment will consist of:

- o Decontaminating (as specified in Section 1.2) all equipment that will be introduced into the boreholes.
- o Storing equipment used in drilling on clean plastic until it is required for use.
- o Using dedicated, disposable Latex plastic gloves when handling drilling equipment and downhole tools. Gloves will be collected in garbage bags and disposed of upon completion of each borehole. Dedicated gloves and other handling materials will be used at each subsequent borehole location.

These cleaning and decontamination procedures will be employed for all drilling activities in potentially contaminated environments. Their purpose is to minimize the potential for transferring possible contaminants from one borehole to another.

6.3 DRILLING OPERATIONS

The use of a power auger is proposed. The auger is capable of drilling to the required depth of six to eight feet.

All borehole cuttings will be continuously logged to the final depth of the borehole. These cuttings will be described and logged by a qualified and degreed geologist. Additionally, lithological changes and significant water entry zones will be noted for all well types.

During drilling, in-situ "return" air will be monitored with an OVA by field personnel.

6.4 WELL POINT CONSTRUCTION MATERIALS

One-inch diameter schedule 40 flush-threaded PVC riser screen will be placed in the borehole. The borehole will be drilled from the ground surface to six to eight feet. Once the well point has been installed, the annular space will be backfilled with No. 1 grade sand. A plastic cap will be placed on the top of the piping.

7.0 MONITORING WELL AND WELL POINT SURVEYING

All newly installed monitoring wells and well points will be surveyed to determine their geographic locations. With accurate locations, the configurations of contaminant plumes potentially present may be estimated by correlation of the water quality data and the well locations. Survey data are also essential for construction of maps showing lines of equipotential, from which ground water gradients can be determined.

The elevation of the inner well casing on all monitoring wells and well points will be surveyed to the nearest 0.01 foot. In addition, the ground elevation at the base of the protective outer well casing will be surveyed to an accuracy of 0.01 foot. The geographic location or horizontal survey measurement accuracy will be within one foot.

A shallow notch will be incised in the top of each inner well casing at the time of construction. The elevation of the inner well casing will be surveyed to the bottom of the notch, and all future water level recordings will be made with respect to that notch.

8.0 WELL SAMPLING PROCEDURES

8.1 INTRODUCTION

This section contains procedures for the collection, preservation, field analysis, shipment, and chain of custody of ground water samples. The goal of these procedures is to collect representative ground water samples in a credible, uniform, and well-documented manner.

Ground water sampling will be conducted by personnel knowledgeable and trained in procedures necessary for the proper collection of ground water samples and the proper operation of field analytical and sampling equipment. Also, personnel will have completed the OSHA 40-hour 29 CFR 1910.20 Health and Safety Training course.

Materials used for ground water sampling will include pumps and associated supplies, ground water sample collection devices and associated supplies, sample bottles and preservatives, and sample shuttles. The materials associated with the various elements of ground water sampling are listed in their respective sections below.

Ground water collection procedures include depth to ground water measurements, well evacuation, sample withdrawal, and sample placement into jars. Ground water collection will proceed from the upgradient wells to the downgradient wells or from the well of least suspected contamination to the well of greatest suspected contamination. The elements of ground water sampling are discussed in Sections 8.2, 8.3, and 8.4, respectively. Figure E-1 is a sampling form which will be completed for each monitoring well sampled.

Please note that if floating petroleum hydrocarbon is encountered, a water sample will not be collected for analysis. However, a sample of the hydrocarbon will be collected for GC analysis.

8.2 DEPTH TO GROUND WATER MEASUREMENTS

Objective

The objective of this task is to provide data on water level elevations at the Chevron Refinery facility so that ground water gradients can be evaluated.

Materials

1. Electric ground water measuring device, or steel tape

2. Cleaning materials, including tap water, paper towels, and detergent

3. Spray bottle of deionized water

Activity

1. Before static water levels are measured, the steel tape or electric water level depth recorder, including any part of the device that will enter the well or be positioned over it, shall be cleaned using a detergent wash. Cleaning will be followed by a spray wash of deionized water.

2. Water levels will be measured and recorded to the nearest 0.01 foot relative to a datum marked on the casing or inner PVC well casing.

3. The total depth of the well will be measured and recorded from the datum.

4. If floating petroleum hydrocarbon is encountered, an interface probe (Oil Recovery Systems, Model 100 en/m, will be used to measure product thickness and depth.

Elevations of the static water levels will then be calculated with respect to a datum, such as mean sea level.

8.3 WELL EVACUATION

Objective

Following ground water level measurement, the wells will be evacuated. Evacuation is performed to remove standing water in the well and in the filter pack (if present) in order to enhance the likelihood that the ground water sampled is representative of the formation water.

Materials

1. Submersible pump and generator or centrifugal pump
2. PVC pipe to fit pump
3. Decontamination materials, including non-phosphate detergent, tap water, deionized water, methanol, paper towels, and scrub brushes
4. 5-gallon buckets
5. Polypropylene or nylon rope, knife, and stopwatch
6. Latex gloves
7. pH meter, turbidimeter, specific conductance meter, and temperature meter

Activity

1. Prior to evacuation, a dedicated length of polypipe shall be sprayed with deionized water and wiped dry with clean paper towels. Submersible pumps will be decontaminated by washing with a detergent rinse, followed by a tap water rinse.

   If a submersible pump is used, the pump will be placed in a clean PVC vessel for further decontamination. Liquids (such as methanol) will be added and evacuated from the vessel and pump. Approximately two gallons of the following liquids will be sequentially pumped through the pump:

   o Distilled/deionized water
   o Methanol (10 to 20 percent)
   o Distilled/deionized water

   After the methanol rinse, equipment will be air-dried.

2. For a 6-inch diameter borehole, the minimum volume of water to be evacuated will be calculated by the formula:

   3 volumes = 4.41 x length of water column (well depth from top of casing in feet - depth to ground water from top of casing in feet) = volume in gallons.

   For 4-inch inner diameter pipe, the minimum volume of water to be evacuated will be calculated by the formula:

   3 volumes = 1.96 x (well depth from top of PVC casing in feet - depth to ground water from top of PVC casing in feet) = volume in gallons

3. The submersible pump, or the check valve associated with the centrifugal pump, will be lowered into the well by the dedicated polypipe until it is several feet below the water surface. If the water level should fall below the pump, the pump will be lowered.

4. The pump will be run to remove a minimum of three volumes of well water.

5. The discharge rate of well water into a 5-gallon container will be recorded using a stopwatch. Discharged water will be containerized.

6. After a minimum of three volumes of water have been removed, the temperature, pH, specific conductance, and turbidity of the water will be measured.

Dedicated latex gloves will be worn at all times when personnel handle the sampling equipment. Before evacuation equipment is reused, it must be decontaminated in accordance with the specifications of Step 1 above.

8.4 SAMPLE RECOVERY

Objective

Immediately following well evacuation, ground water samples will be collected for laboratory analysis. The goal of the procedures described below is to minimize the potential for altering the sample during the sample recovery process.

Materials

1. Decontaminated teflon or stainless steel bailers
2. Polypropylene or nylon rope
3. Clean plastic sheeting
4. Sample bottles and preservatives
5. Latex gloves
6. Paper towels
7. Decontaminating materials
8. First aid kit
9. Sample labels

Activity

1. Prior to sampling, the bailers will be decontaminated in laboratory space designated for ground water sampling equipment decontamination or in the field. Decontamination includes:

   - Wash with a detergent rinse

   - Rinse with deionized water

- Rinse with 10% nitric acid
- Rinse with deionized water
- Rinse with methanol
- Rinse with deionized water

The bailers will be allowed to air dry after the methanol rinse. Following decontamination, the bailers will be wrapped in aluminum foil (shiny side out).

2. The field sample form and sample labels will be completed. A copy of the field sample form is included at the end of this appendix.

3. The bailers will be unwrapped at the sampling location and tied to dedicated plastic or nylon rope. The bailers will be slowly lowered into the wells; care will be taken to minimize agitation of the ground water.

4. Samples will be collected in the bailer. Prior to being filled, sample containers will be rinsed one time with water bailed from the well where appropriate. Where appropriate, containers will be filled to overfilling, so that no head space remains. Containers with preservatives will not be filled to overflow. Care will be taken to fill the sample bottles in a manner that does not aerate or agitate the sample.

Since the samples will be analyzed for volatile organic compounds, care will be taken so that sampling does not degas the samples. The sample containers must be filled by allowing the sample to flow gently down the inside surface of the container, so that no bubbles are formed and the sample is not degassed by agitation. Each container must be filled so that a meniscus is formed over the container mouth. The container cap must be inverted and filled with sample. Then the container cap must be turned over onto the bottle mouth and tightened in a manner to ensure that no air is trapped inside the container. The sealed container must be sealed and shaken vigorously to verify that no air is trapped in the container. If visual inspection indicates that air is present, the container will be unsealed and emptied, and the collection process will be repeated.

Note that dedicated sampling materials, including bailers and rope, will be stored on dedicated clean plastic sheeting, as required to ensure that contaminants are not introduced into the well or the sample. All sampling equipment will be handled with dedicated, disposable Latex gloves. New plastic sheeting and gloves shall be used for each well sampled.

Samples must be maintained at 4°C from the time they are collected.

8.4.1 Trip Blanks and Equipment Blanks

Trip and equipment blanks will be prepared for each day of ground water sample collection.

Trip Blanks

Objective

Trip blanks will serve as quality control to identify sample contamination resulting from interaction between the sample and the container, impure decontamination materials, or laboratory handling procedures that alter the chemical nature of the samples.

Activity

The laboratory will provide trip blanks in sealed 40-milliliter vials, and in sealed bottles identical to those used for collection of the ground water samples to be analyzed for volatile organic compounds.

Equipment Blanks

Objective

Equipment, or field blanks, are used to verify the effectiveness of sample handling procedures, and to establish the effectiveness of equipment decontamination procedures. Equipment blanks will be prepared for each set of parameters to be analyzed.

Activity

1. The laboratory will provide triple distilled or ultrapurified water for the preparation of equipment blanks.

2. The equipment blank will be prepared when half of the monitoring wells designated for sampling in one day have been successfully evacuated and sampled.

3. Triple distilled or ultrapurified water provided by the laboratory will be poured into a decontaminated bailer, and then into the designated sample bottles.

8.4.2 Field Logbook

Field personnel involved in ground water sampling will maintain field notes. The field notes may contain, but will not be limited to:

1. Well identification

2. Weather conditions

3. Static water level and depth of the well

4. Rate of well evacuation and volume of water purged

5. Notes on the physical appearance of the ground water, including unique or unexpected colors or odors

6. Ground water sampling equipment

7. Date and time of sample collection

8. Name of sample collector

9. Specific conductance, pH, temperature, and turbidity of the ground water after evacuation

10. Notes on unexpected or unique conditions or events related to evacuation of ground water or sample collection

9.0 SAMPLE SHIPMENT PROCEDURES

Sample shipment procedures include chain-of-custody protocols and procedures for storing and shipping collected samples. These procedures are discussed in Sections 5.1 and 5.2, respectively.

9.1 SAMPLE CHAIN-OF-CUSTODY PROCEDURES

Objective

Sample chain-of-custody will be initiated by the analytical laboratory, with the selection and preparation of the sample containers. The goal of chain-of-custody procedures is to document possession and handling of the sample jars from the time of laboratory preparation through sample collection and laboratory analysis.

Materials

1. Sample labels
2. Chain-of-custody records
3. Coolers/ice

Activities

1. Using indelible ink, labels on the sample bottles will be marked with information that will include:

   a. Site name
   b. A unique identification number
   c. Name of the collector
   d. Date and time of collection
   e. Place of collection

f. Parameters for laboratory analysis
g. Type of sample
h. Volume of sample
i. Preservative (when applicable)

2. A chain-of-custody record will be completed, which will include, but not be limited to:

   a. A unique identification number
   b. Signature and name of the collector
   c. Date and time of collection
   d. Place of collection
   e. Parameters for laboratory analysis
   f. Sample type
   g. Identification of the well
   h. Dates of possession

A chain-of-custody form (to be supplied by the selected laboratory) will accompany the sample from initial sample container selection and preparation at the laboratory, to the field for sample containment and preservation, through its return to the laboratory. The chain-of-custody form will trace the path of each individual sample container by means of a unique identification number.

The Project Manager will notify the laboratory of upcoming field sampling activities and the subsequent transfer of samples to the laboratory. This notification will include information concerning the number and type of samples to be shipped and the anticipated date of arrival.

An example chain-of-custody form is attached at the end of this appendix.

9.2 STORAGE AND SHIPMENT OF COLLECTED SAMPLES

Objective

The goal of procedures described in this section is to ensure that ground water samples are not altered by handling or storage procedures after collection, and to provide documentation to trace potential sample alteration.

Materials

1. Chain-of-custody record
2. Sample seals
3. Refrigerated or insulated shipping containers
4. Frozen "blue ice" packs or ice
5. Packing materials

Activities

1. The full labeled sample bottles will be packed in the shipping containers with frozen "blue ice" packs or ice. The bottles will be arranged and packed with suitable materials to minimize the potential for breakage.

2. The shipping container will be secured with "sample seals" in cases where the sample container will leave the immediate possession of the contractors.

3. The chain-of-custody record will accompany the shipping container at all times. Transfer of possession of the shipping container(s) will be accompanied by signatures of release and receipt on the chain-of-custody form. Notes pertaining to the condition of the sample container will be made on the chain-of-custody record at the time of transfer.

10.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments used in the field to gather information or to perform analytical tests should be calibrated prior to use in accordance with the manufacturer's instructions and recommended frequency.

The following steps should be observed by personnel engaged in ground water sampling for pH and specific conductance:

- The pH meter should be calibrated with a fresh standard buffer solution (pH 7) prior to each field test.

- The operation of the instrument should be checked with fresh standard buffer solutions (pH 4 and pH 10) prior to each day's sampling.

- The specific conductance meter should be calibrated prior to each sampling event using a standard solution of known specific conductance.

More frequent calibrations may be performed as necessary to maintain analytical integrity. Calibration records for each field instrument used on the project should be maintained and a copy kept in the project files.

GROUND WATER SAMPLING RECORD

CLIENT: Chevron USA, Inc. JOB NO.: 16000-230

LOCATION: Philadelphia, Pennsylvania SAMPLED BY: ____________

SITE NO. AND NAME: ____________

DATE: ____________ TIME: ____________

WELL TYPE: ☐ Monitor ☐ Potable ☐ Supply ☐ Other ____________

WELL NO.: ____________ WELL SIZE (I.D., inches): ____________

TOP OF CASING (TOC) ELEVATION (ft. MSL): ____________

DEPTH TO STATIC WATER LEVEL (ft. below TOC): ____________

STATIC WATER LEVEL ELEVATION (ft. MSL): ____________

DEPTH TO BOTTOM OF WELL (ft. below TOC): ____________

SCREENED INTERVAL (ft. below TOC): ____________

VOLUME OF WATER TO BE EVACUATED (gallons)*: ____________

VOLUME OF WATER EVACUATED (gallons): ____________

EVACUATION METHOD: Submersible Pump ☐ Centrifugal Pump ☐
Positive Displacement Pump ☐ Bailer ☐
Other ____________

SAMPLING METHOD: Submersible Pump ☐ Positive Displacement Pump ☐
Stainless Steel Bailer (Bottom Fill) ☐
Other ____________

SAMPLE NO.: ____________ SAMPLE DEPTH (ft. below TOC): ____________

SAMPLE TREATMENT: Field Filtered ☐ Preservative Added ☐

SAMPLE APPEARANCE, ODOR, ETC.: ____________

____

FIELD TESTS: SAMPLE TEMPERATURE (°C): ____________ ph: ____________
CONDUCTIVITY (mhos/cm): ____________ PID (ppm): ____________

LABORATORY ANALYSIS: ____________

____

NO. OF CONTAINERS AND I.D.: ____________

FIELD BLANK I.D. NO.: ____________

TRIP BLANK I.D. NO.: ____________

DUPLICATE SAMPLE I.D.: ____________

COMMENTS: ____________

____

____

*4-inch casing has 0.65 gallons/ft.
2-inch casing has 0.16 gallons/ft.

7557R

FIGURE E-1

APPENDIX F

DATA COLLECTION QUALITY ASSURANCE PLAN

RCRA Facilities Investigation
Chevron USA, Inc.
Philadelphia, Pennsylvania

Project Number: 16000-230

Prepared By: John Kearns, Quality Assurance Officer

Data Collection Quality Assurance Plan
March 1990

Approvals:

Ralph T. Golia 4/16/90
Ralph T. Golia
Project Director

Bruce C. Amig 16 April 90
Bruce C. Amig
Project Manager

John F. Kearns 16 April 1990
John F. Kearns
Quality Assurance Manager

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The key personnel of the Chevron project are:

Organization	Name/Title	Address/Phone Number
Chevron	Mr. M.T. Manigly Environmental Specialist	Chevron Refinery 30th Street and Penrose Avenue Philadelphia, PA 19101 (215) 339-7466
USEPA	Linda Carlson Project Officer	Region III 841 Chestnut Building Philadelphia, PA 19107 (215) 597-1601
Dames & Moore	Mr. Bruce C. Amig Project Manager	2360 Maryland Road Willow Grove, PA 19090 (215) 657-5000
Dames & Moore	Mr. Ralph T. Golia Project Director	2360 Maryland Road Willow Grove, PA 19090 (215) 657-5000
Dames & Moore	Mr. John F. Kearns Quality Assurance Manager	2360 Maryland Road Willow Grove, PA 19090 (215) 657-5000

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DATA COLLECTION QUALITY ASSURANCE PLAN

1.0 INTRODUCTION

Chevron's RCRA Corrective Action Permit (EPA I.D. No. 049 791 098) Part II Section (A), subsection (7) presents a listing of specific solid waste management units (SWMUs) that require an investigation. The objectives of the investigations are to:

- o Characterize the nature, extent, and rate of migration of documented releases of hazardous constituents to soil and ground water at this facility;
- o Develop a detailed characterization of the geology and hydrogeology underlying the facility; and

To accomplish these objectives, a series of tasks will be performed that are specified in the referenced permit and have been outlined in the RCRA Facility Investigation (RFI) Work Plan, Chapter 4. These tasks are:

- o Soil gas survey
- o Soil boring program
- o Soil sample collection - both surface and subsurface
- o Well installation
- o Ground water sampling
- o Well point installation

Table F-1 is a list of tasks planned at each SWMU. The designated sampling points for each of these referenced tasks has been selected with a bias toward encountering hazardous waste or hazardous waste constituents at each SWMU. This bias is based upon the following sources of information:

- o Field observations recorded during the Visual Site Inspection (VSI) RCRA Facility Assessment Report, February 1990, and Dames & Moore's site reconnaissance
- o Permit Fact Sheet
- o Chevron employee interviews
- o Aerial photograph review (photos dated 1960, 1965, 1975, 1980, 1985)

Moreover, the data generated from completion of these tasks will be used for engineering purposes for the characterization of the facility and for the development of corrective measures, if necessary.

This Data Collection Quality Assurance Project Plan (DCQAP) addresses the program requirements to ensure that the data generated during the RFI at the Chevron USA, Inc. (Chevron) Refinery in Philadelphia, Pennsylvania, conform to the specifications agreed to by Chevron and the United States Environmental Protection Agency (EPA).

The DCQAP addresses field and laboratory functions that may affect the quality of data generated in the course of the RFI so that all parties will be assured that the objectives of the RFI have been met upon completion.

2.0 DATA QUALITY OBJECTIVES (DQOs)

DQOs for the project will be established in terms of precision, accuracy, comparability, representativeness, and completeness of the data sets generated. A summary of the DQOs is provided in Table F-2.

"Precision" is defined as the degree of mutual agreement among individual measurements of the same property under similar conditions, and is expressed as relative percent difference (RPD).

$$RPD = \frac{[REP1 - REP\ 2]}{[(REP\ 1 + REP\ 2) \times 0.5} \times 100\%$$

"Accuracy" is defined as the degree of agreement between a known value and a measured value.

$$Accuracy = \frac{\text{Measured Value}}{\text{Known Value}} \times 100\%$$

"Comparability" of data is ensured through the consistent use of appropriate units of measure for all measurements of the same property under similar conditions.

"Representativeness" expresses the degree to which data reflect actual environmental or process conditions. It is determined, in large measure, by the degree to which appropriate sampling procedures are followed.

"Completeness" is a measure of the amount of valid data obtained compared to the ideally expected amount of data to be obtained.

Methods of sample analysis are define in the work plan as:

A) Skinner List Analyses
   As listed below

B) Appendix IX Analyses

Volatile organics	-	Method 8240
Semivolatile organics	-	Method 8270
Inorganics	-	Method 6010
		Method 7061
		Method 7421
		Method 7470
		Method 7741
		Method 7841

All methods are taken from the third edition of SW-846. The accuracy and precision objectives are as stated in SW-846. They will be detailed in the laboratory Quality Assurance Plan to be provided at a later date, once a laboratory has been selected.

The objective for completeness is 100 percent. Each data point sampled is expected to generate acceptable data.

Approved sampling procedures will be used in order to ensure representativeness of the data set. Field duplicate precision should be $\pm$20 percent.

In order to ensure comparability, consistent units of measure will be used throughout the sampling events for all analyses of the same parameter on similar matrixes.

3.0 SAMPLING PROCEDURES

3.1 SOIL (SURFACE)

See Appendix E.

3.2 SOIL (SUBSURFACE/BORING)

See Appendix E.

3.3 GROUND WATER

See Appendix E.

See Table F-3 for details of container, preservation, and holding time specifications. All sample containers related to analyses will be supplied by the laboratory to be selected. Samples that require chemical preservation will be placed in prefixed containers provided by the selected laboratory. All reagents will be analytical grade.

4.0 SAMPLE CUSTODY

Detailed log entries, identification, and chain of custody procedures will be used in order to ensure the evidentiary validity of the data generated.

4.1 ON-SITE

Sample identification procedures are given in Appendix G. This identification sequence will be used consistently in field notebooks and on chain of custody documentation.

When samples have been obtained for transport to the off-site laboratory for analysis, a chain of custody record will be generated by field personnel. The Project Manager will notify the laboratory in advance of a sampling event, providing the laboratory with a schedule and the approximate number of samples by type and parameter. Field personnel will release the samples to the laboratory courier by exchange of signatures on the chain of custody form, retaining one copy for field records. A sample chain of custody form is given as Figure 1. A sample identification label is given as Figure 2.

4.2 LABORATORY

Laboratory sample custody and internal chain of custody procedures will be addressed in detail in the selected laboratory's Quality Assurance Plan, to be submitted once a laboratory has been selected.

5.0 CALIBRATION

5.1 ON-SITE

A calibration program will be implemented to ensure that routine calibration is performed on all field instruments. Field team members familiar with the field calibration and operations of the equipment will maintain proficiency and perform the prescribed calibration procedures outlined in the Operation and Field Manuals accompanying the respective instruments.

The air monitoring instrument (OVA) used in the field to gather data for health and safety purposes, and for sample monitoring, will be calibrated each day prior to the initiation of field work. The instrument will be calibrated using appropriate ultra-zero and indicator gases. Following calibration, each instrument will be tagged to identify the person who calibrated the instrument and the calibration date.

The following procedures will be utilized to calibrate and operate the Century Systems OVA. These procedures will be followed when the OVA is used in the survey mode to obtain qualitative data.

The OVA will undergo routine maintenance and calibration by the manufacturer prior to shipment to the project.

Daily calibration and instrument checks will be performed by a trained team member at the start of each day. Daily calibrations will be performed as follows:

1) Turn on electronics and zero instrument on X-10 scale. Gas select dial to 300.
2) Turn on pump and hydrogen, and ignite flame.
3) Attach span gas standard (approximately 100 ppm of methane) to probe via Teflon tubing.
4) Adjust R-32 trim pot on circuit board to make meter read to standard.
5) Turn off flame and adjust meter needles to read 4 ppm.
6) Switch to X1 scale and adjust R-31 trim pot to make meter read 4 ppm.
7) Return to X10 scale and adjust to 40 ppm.
8) Switch to X100 scale and adjust R-33 trim pot to make meter read to 40 ppm.
9) Make sure with pump and OVA upright that ball level on pump is 2 or above.
10) If problems are encountered, go through system checks and perform routine maintenance.
11) If OVA fails calibration steps, notify Project Manager.

Calibrations of the gas chromotograph will be performed at the beginning and end of each day and after every 4 hours of GC operation. Calibrations are performed by injecting a sample (injection technique is identical to injection technique used for sampling) of a certified laboratory standard. The concentrations and retention times of the standards are programmed into the GC's memory until the next calibration is performed. The calibration will be recorded daily in the field log.

Calibration records for each field instrument used on the project will be maintained on-site and a copy will be kept in the contractor's project files.

5.2 LABORATORY

Laboratory calibration procedures will be addressed in detail in the laboratory Quality Assurance Plan, which will be submitted once a laboratory has been selected.

6.0 ANALYTICAL PROCEDURES

6.1 ON-SITE

On-site procedures for soil gas analysis are addressed in detail in Chapter 4.

6.2 LABORATORY

Laboratory analytical procedures will be taken from the third edition of SW-846, "Test Methods for Evaluating Solid Waste." These methods will be used for all samples related to the site, including surface water. In certain circumstances, the compound lists may be modified to meet work plan specifications. This modification will in no way alter the execution of the methods. Library search data may also be used. The laboratory will maintain and have available for the appropriate operators standard operating procedures related to sample preparation and analysis according to the stipulated methods.

7.0 DATA REDUCTION, VALIDATION, AND REPORTING

7.1 DATA REDUCTION

See Appendix G for information pertaining to data reduction. Reduction will also be discussed in the laboratory Quality Assurance Plan to be submitted at a later date, once a laboratory has been selected.

7.2 DATA VALIDATION

The Quality Assurance Manager will provide data validation upon receipt of the data from the laboratory by the consultant. This validation will include a check on completeness and an assessment of associated quality control data to evaluate the overall data quality. Data validation procedure will be based on functional guidelines published February 1988 for organics and July 1988 for inorganics.

7.3 DATA REPORTING

The reporting format will allow for data validation. At a minimum, the reporting format will include:

a. Sample identification
b. Chronology
c. Analytical results/Detection limits
d. QA summary

    1. Tuning and calibration (as required)
    2. Surrogate recoveries
    3. MS/MSD summary
    4. Blank reported
    5. Narrative information
    6. LCS reported (as required)

e. Chain of custody
f. Library search information (as required)

   1. Tentative identification
   2. Approximate concentration
   3. Degree of purity

g. Labeled chromatograms/RICs

8.0 INTERNAL QC CHECKS/SYSTEM AUDITS

8.1 ON-SITE

The QA/QC officer assigned to the project will conduct periodic audits of operations at the site to ensure that work is being performed in accordance with the work plan and standard operating practice (see the appendices). A checklist appropriate to the activities scheduled during the audit will be used. An example checklist is provided in Figure 3. The audit will cover but not necessarily be limited to such areas as:

- Conformance to SOPs
- Completeness and Accuracy of Documentation
- Chain of Custody Procedures
- Compliance with HASP
- Construction Specifications

These audits will occur a minimum of once per month or at the start or end of each significant phase of the project, whichever is greater.

8.2 LABORATORY

Internal QA checks/system audits will be performed by the selected laboratory. Procedure details will be submitted on a later date once a laboratory has been selected.

9.0 PREVENTIVE MAINTENANCE

9.1 FIELD EQUIPMENT

The OVA (organic vapor analyzer) and the GC (gas chromotograph) will require preventive maintenance. They will be maintained in accordance the manufacturers' specifications.

9.2 LABORATORY

Laboratory equipment maintenance will be discussed in a future laboratory Quality Assurance Plan once a laboratory has been selected.

10.0 ASSESSING DATA QUALITY OBJECTIVES

10.1 FIELD

The impact of field activities on data quality relates primarily to sampling technique and sample point location. Audits as described in Section 9 of this document will provide the principal means of assessing the conformance of field personnel to SOPs. These will be reported as part of the QA reports to management.

10.2 LABORATORY

The procedures for assessing laboratory DQOs will be discussed in the laboratory Quality Assurance Plan, which will be submitted at a future date once a laboratory has been selected.

11.0 CORRECTIVE ACTIONS

The following procedures have been established to ensure that conditions adverse to quality, such as malfunctions, deficiencies, deviations, and errors, are promptly investigated, documented, evaluated, and corrected.

When a significant non-conforming condition is noted at the site, or at laboratory or subcontractor locations, the cause of the condition will be determined and corrective action will be taken to preclude recurrence. Condition identification, cause, reference documents, and corrective actions planned to be taken will be documented and reported to the Project Manager, Quality Assurance Manager, and subcontractor management, at a minimum. Implementation of corrective action will be verified by documented follow up to the Quality Assurance Manager. All project personnel have the responsibility, as part of their normal work duties, to promptly identify, solicit approved correction, and report non-conforming conditions. Project management and staff, such as field investigation teams, remedial response planning personnel, quality assurance auditors, document and sample control personnel, and laboratory groups must monitor ongoing work performance in the normal course of daily responsibilities.

Work will be audited at the sites, laboratories, and subcontractor locations by the Quality Assurance Manager or designated auditors. Items, activities, or documents ascertained to be in noncompliance with quality assurance requirements will be documented and corrective actions will be mandated through audit finding sheets attached to the audit report. Audit findings will be logged, maintained, and controlled by the Quality Assurance Manager.

A Corrective Action Request (CAR), shown on Figure 4, should be used to identify the adverse condition, reference document(s), and recommended corrective action(s) to be administered. The issued CAR is directed to the responsible management in charge of the item or activity for action. The individual to whom the CAR is addressed returns the requested response promptly to the Quality Assurance Manager, affixing his signature and date to the corrective action block, after stating the cause of the conditions and the corrective action to be taken. The Quality Assurance Manager maintains the log for status control of CARs and responses, confirms the adequacy of the intended corrective action, and verifies its implementation. The Quality Assurance Manager will issue and distribute CARs to specified personnel, including the originator, responsible project management involved with the condition, the Project Manager, and the involved subcontractor, at a minimum. CARs are transmitted to the project file for the records.

12.0 QA REPORTS TO MANAGEMENT

Periodic reports during the time of field activities from the QA/QC Coordinator will address:

1. Overview of activities and significant events related to QA/QC
2. Summary of audit results
3. Review of corrective action request status
4. Laboratory QA/QC report
5. Data validation QA/QC report
6. Summary of significant changes in SOPs or QA/QC programs
7. Recommendations

Reports will be submitted to the Project Manager.

Upon project completion, a Final QA Report will be issued, assessing the overall degree of project conformance to specifications and the impact of any non-conforming conditions on data quality that may affect management decisions.

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TABLE F-1

SUMMARY OF SOIL SAMPLING ACTIVITIES
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

SWMU No.	SGS	SBS	Analyses
87, 88, 89	35	30	8 – Skinner List[1] (SBS) 22 – Targeted Representative Parameters[2] (SBS) 35 – OVA and GC Field Analyses (SGS)
90, 91	–	76	19 – Skinner List[1] 57 – Targeted Representative Parameters[2]
92	–	48	12 – Skinner List[1] 36 – Targeted Representative Parameters[2]
93,94	–	134	33 – Skinner List[1] 101 – Targeted Representative Parameters[2]
95	–	40	10 – Skinner List[1] 30 – Targeted Representative Parameters[2]
101	–	–	–

Explanation:

SGS = Soil gas survey sample
SB = Soil boring sample
OVA = Organic vapor analyzer
GC = (Portable) gas chromatograph

Notes:

1. The Skinner List of constituents is included as Table 9 of the Work Plan.
2. The Targeted Representative Parameters are provided on Table 8 of the Work Plan.
3. Two soil samples per boring were assumed during development of this table.

TABLE F-1 (Continued)

SUMMARY OF GROUND WATER SAMPLING
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

SWMU No.	W[1]	WP[1]	Well Water Sample Analyses Round 1	Round 2	Round 3	Round 4
87, 88, 89	12	-	TRP[2]	1-SL[3] 11-TRP	TRP plus SC	TRP plus SC
90, 91	8	-	TRP[2]	1-SL[3] 7-TRP	TRP plus SC	TRP plus SC
92	4	-	TRP[2]	1-SL[3] 3-TRP	TRP plus SC	TRP plus SC
93, 94	10	-	TRP[2]	1-SL[3] 9-TRP	TRP plus SC	TRP plus SC
95	4	-	TRP[2]	1-SL[3] 3-TRP	TRP plus SC	TRP plus SC
101	4	10	TRP[2]	1-SL[3] 3-TRP	TRP plus SC	TRP plus SC

Explanation:

W = Monitoring well water sample
WP = Well point (floating product collection only)
TRP = Targeted Representative Parameters
SL = Skinner List
TRP plus SC = Targeted Representative Parameters plus significant constituents (of the Skinner List)
(SC will be based on the results of Round 1)

Notes:

1. If free-phase petroleum product is detected within a well, ground water samples will not be collected. Any free-phase petroleum product detected in either a well or well point will be collected for analysis (one time only).
2. The Targeted Representative Parameters List is included as Table 10 of the Work Plan.
3. The Skinner List of constituents is included as Table 9 of the Work Plan.

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TABLE F-2

SUMMARY OF DATA QUALITY OBJECTIVES
CHEVRON REFINERY
PHILADELPHIA, PENNSYLVANIA

Task	Objective	Data Use	Selected Analytical Options	Sensitivity	Analytical Parameters	Number of Samples	Duplicates	Trip Blanks	Field Blanks
Soil Gas Survey	Evaluate volatilizing gases present in the soil	1,5	I, II	Low ppm VOA	FID/GC	35	NA	NA	NA
Soil Boring Program	Characterize extent of subsurface soil contamination	1,2,3	III	ENG	Skinner List Targeted Representative Parameters	82 246	4 12	1/day 1/day	4 12
Air Monitoring for Health and Safety	Monitor air quality in and near the breathing zone	1,4	I	Low ppm VOA	Low ppm VOA FID	Prior to and during each field task as a health and safety surveillance, field screening tool.	NA	NA	NA
Borehole Scan with OVA	Initial qualitative characterization of subsurface soil contamination	1,2	I	Low ppm VOA	Low ppm VOA FID	194	NA	NA	NA

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TABLE F-2 (Continued)

SUMMARY OF DATA QUALITY OBJECTIVES
CHEVRON REFINERY

PHILADELPHIA, PENNSYLVANIA

Task	Objective	Precision	Accuracy	Representativeness	Completeness	Comparability
Soil Gas Survey	Evaluate volatilizing gases present in the soil	NA	NA	A sampling grid has been designed to obtain a representative picture.	Since this is a field technique 95% can be achieved.	Use of standard soil sampling and recognized field analytical procedures assures comparability.
Soil Boring Program	Characterize extent of subsurface soil contamination	CLP/RAS Precision[6]	CLP/RAS Accuracy[6]	Based upon specific field conditions to detect off-site migration.	CLP/RAS is 95%	The use of standard operating procedures should ensure comparability.
Air Monitoring for Health and Safety	Monitor air quality in and near the breathing zone	NA	NA	Sampling will obtain site characterization and health and safety data.	Baseline worst case & final round require 100% completeness.	The use of standard operating procedures manuals should ensure comparability.

Notes:

DATA USE:
1. Site Characterization
2. Risk Assessment
3. Evaluation of Alternatives
4. Health and Site Safety
5. 95% completeness is anticipated because interference may be high due to highly contaminated samples.
6. As appropriate for the Skinner List and Target Representative Parameters.

NA = Not Applicable
CLP = Contract Laboratory Program
RAS = Routine Analytical Services
FID = Flame Ionization Detector
ENG = Engineering Judgement
SW 846 = Objectives as stated in the SW 846 Manual

ANALYTICAL OPTIONS:

Level 1 = Field screening analysis using portable instruments.

Level II = Field analysis using more sophisticated portable analytical instruments.

Level III = Analysis performed in an off-site laboratory which may not use CLP protocol. Level III does not require the extensive validation or documentation required for CLP Level IV.

Level IV = CLP routine analytical services. All analysis are performed in a CLP analytical laboratory following CLP protocols. Level IV is characterized by rigorous QA/QC protocols and documentation.

Level V = Analysis by non-standard methods. Method development or method modification may be required.

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TABLE F-3

SAMPLING SUMMARY
SOIL

	No. Samples Soil	No. QA Samples[1] DUP	TB°	FB	Method	Preservative	Container	Holding Time (from collection)
Targeted Representative Parameters[3]								
BTXE	246	12	1	12	SW-846 8020 (2nd edition)	4°C	100 g glass	14 days
Naphthalene	246	12		12	EPA 8270	4°C	125 g glass	7 days to extraction 40 days to analysis after extraction
TPH	246	12		12	SW-846 418.1[4]	4°C	100 g glass	NS
Chromium (total) and Lead	246	12		12	SW-846 7190 (Cr) SW-846 7420 (Pb)	4°C	100 g glass	180 days
Chromium (Cr^{6+}), Hexavalent	246	12		12	Standard Method 16th edition, 312B	4°C	100 g glass or plastic	NS
Skinner List								
VOA	82	4	1	12	SW-846 8240	4°C	100 g glass	7 days
SVA	82	4		12	EPA 8270	4°C	100 g glass	10 days to extraction
Metals	82	4		12	EPA 7000 Series[2]	4°C	100 g glass or plastic	180 days

Explanation:

dup = duplicate
TB = trip blank
FB = field blank
BTXE = benzene, toluene, xylene, and ethylbenzene
TPH = total petroleum hydrocarbons
VOA = volatile organic analysis
SVA = semi-volatile organic analysis
° = per day
NS = not specified within the regulated methodology

Notes:

1. For the trip and field blanks (water samples), refer to page 2 of this table for the methods, preservatives, containers, and holding times.
2. The Skinner List is included as Table 10 of the Work Plan.
3. The Targeted Representative Parameter List for soil is included as Table 8 of the Work Plan.
4. Solid sample preparation will include Soxhlet extraction with freon.

TABLE F-3

SAMPLING SUMMARY
GROUND WATER

	No. Samples Water	No. QA Samples DUP	TB°	FB	Method	Preservative	Container	Holding Time (from collection)
FIRST SAMPLING								
Targeted Representative Parameters[4]								
BTXE	42	2	1	2	EPA 8020	4°C, HCl pH<2	2 x 40 ml glass	14 days
Naphthalene	42	2		2	EPA 8270	4°C, $Na_2S_2O_3$	1 x 1 l. glass	7 days to extraction 40 days to analyze after extraction
TPH	42	2		2	SW-846 418.1		2 x 1 l. glass	NS
Ammonium	42	2		2	EPA 350.2	4°C, H_2SO_4 pH<2	500 ml glass or plastic	28 days
Metals[1]	42	2		2	EPA 7000 series[1]	4°C, HNO_3 pH<2	500 ml glass or plastic	180 days
Additional Parameters[2]	42	2		2	EPA 100 and 300 series[2]	4°C	500 ml glass or plastic	24 hours (Cr^{6+}) 28 days
SECOND SAMPLING								
Targeted Representative Parameters								
BTXE	36	2	1	2	EPA 8020	4°C, HCl pH<2	2 x 40 ml glass	14 days
Naphthalene	36	2		2	EPA 8270	4°C, $Na_2S_2O_3$	1 x 1 l. glass	7 days to extraction 40 days to analyze after extraction
TPH	36	2		2	SW-846 418.1		2 x 1 l. glass	NS
Ammonium	36	2		2	EPA 350.2	4°C, H_2SO_4 pH<2	500 ml glass or plastic	28 days
Metals[1]	36	2		2	EPA 7000 series[1]	4°C, HNO_3 pH<2	500 ml glass or plastic	180 days
Additional Parameters[2]	36	2		2	EPA 100 and 300 series[2]	4°C	500 ml glass or plastic	24 hours (Cr^{6+}) 28 days
Skinner List[3]								
VOA	6	1	1	1	SW-846 8240	4°C	3 x 40 ml glass	7 days
SVA	6	1		1	SW-846 8270	4°C	3 x 1 l. glass	7 days to extraction 40 days to analyze after extraction
Metals	6	1		1	EPA 7000 series[3]	4°C, HNO_3 pH<2	1 x 1 l. plastic	28 days
THIRD SAMPLING AND FOURTH SAMPLING								
Targeted Representative Parameters								
BTXE	42	2	1	2	EPA 8020	4°C, HCl pH<2	2 x 40 ml glass	14 days
Naphthalene	42	2		2	EPA 8270	4°C	1 x 1 l. glass	7 days to extraction 40 days to analyze after extraction
TPH	42	2		2	SW-846 418.1	4°C	2 x 1 l. glass	NS
Ammonium	42	2		2	EPA 350.2	4°C, H_2SO_4 pH<2	500 ml glass or plastic	28 days
Metals[1]	42	2		2	EPA 7000 series[1]	4°C, HNO_3 pH<2	500 ml glass or plastic	180 days
Additional Parameters[2]	42	2		2	EPA 100 and 300 series[2]	4°C	500 ml glass or plastic	24 hours (Cr^{6+}) 28 days
Significant Constituents	42	2		2	To be determined after the first sampling			

TABLE F-3

SAMPLING SUMMARY
GROUND WATER

Explanation:

dup = duplicate
TB = trip blank
FB = field blank
BTXE = benzene, toluene, xylene, and ethylbenzene
TPH = total petroleum hydrocarbons
VOA = volatile organic analysis
SVA = semi-volatile organic analysis
° = per day
NS = not specified within the regulated methodology

Notes:

1. The metals with their test methods are calcium (EPA 215.1), iron (EPA 236.1), magnesium (EPA 242.1), manganese (EPA 243.1), potassium (EPA 258.1), sodium (EPA 273.1), lead (EPA 239.1), and total chromium (EPA 218.1).

2. Additional parameters are chloride (EPA 300.0), nitrate (EPA 353.2), phosphate (EPA 365.1), silicate (EPA 370.1), sulfate (EPA 300.0), pH (EPA 150.1), specific conductance (EPA 120.1), and hexavalent chromium (Standard Method 312B).

3. The Skinner List is included as Table 9.

4. The Targeted Representative Parameter List is included as Table 10 in the work plan.

Lancaster Laboratories
INCORPORATED

2425 New Holland Pike, Lancaster, PA 17601 • 717/656-2301

Chain of Custody

Lancaster Laboratories Sample Number

Sample Type:	
HZ	Hazardous
SO	Soil
PW	Potable Water
GW	Ground Water
SW	Surface Water
WW	Waste Water
SL	Sludge

Client:

P.O. No.:

Work Order No.:

Project Name:

Submit Report to:

FSC:

Sampler:

Project Location:

Analyses

Field sample number / sample identification	Date	Time	COMP	GRAB	Number of Containers (Total)	Sample Type (use reference)						Remarks:

Sample Relinquished by:	Date	Time	Sample Received by:	Date	Time	Reason for Transfer

FIGURE 1

APPENDIX F

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

I-CHEM RESEARCH

CHEM (800) 443-1689 (800) 553-3696

SITE NAME | DATE

ANALYSIS | TIME

PRESERVATIVE

SPECIALTY CLEANED CONTAINER

FIGURE 2

APPENDIX F

QUALITY ASSURANCE
AUDIT CHECKLIST

Project ____________________ Project Manager ____________________

Site Location ____________________

Auditor ____________________ Date ____________________

Question	Yes	No	Comment/Documentation
FIELD:			
1. Was an on-site safety officer appointed?			
2. Did site personnel receive a copy of the site specific sampling and analytical plan in a timely manner to allow for sufficient review?			
3. Are copies available in the field during sampling?			
4. Was a briefing held off-site, before any site work was begun to acquaint personnel with sampling equipment, assign field responsibilities and review safety procedures?			
5. Do field personnel have a field notebook?			
6. Are the site survey grid stakes present?			
7. Are the number and location of samples collected following procedures as specified in the site specific sampling and analytical plan?			
8. Are samples labeled as described in the POP?			
9. Are samples being collected following the procedures specified in the POP?			
10. Was a chain of custody form filled out for all samples collected?			
11. Are samples preserved as specified in Appendix A of the POP?			

FIGURE 3

DAMES & MOORE
A PROFESSIONAL LIMITED PARTNERSHIP

FIGURE 4

APPENDIX F

CORRECTIVE ACTION REQUEST

NUMBER ________________________________ DATE ____________

TO ________________________________

YOU ARE HEREBY REQUESTED TO TAKE CORRECTIVE ACTIONS INDICATED BELOW AND AS OTHERWISE DETERMINED BY YOU (A) TO RESOLVE THE NOTED CONDITION AND (B) TO PREVENT IT FROM RECURRING. YOUR WRITTEN RESPONSE IS TO BE RETURNED TO THE PROJECT QUALITY ASSURANCE MANAGER BY ____________

CONDITION

REFERENCE DOCUMENTS

RECOMMENDED CORRECTIVE ACTION

ORIGINATOR	DATE	APPROVAL	DATE	APPROVAL	DATE

RESPONSE

CAUSE OF CONDITION

CORRECTIVE ACTION

(A) RESOLUTION

(B1) PREVENTION

(B2) AFFECTED DOCUMENTS

SIGNITURE ________________________ DATE ____________

Q.A. FOLLOW-UP

CORRECTIVE ACTION VERIFIED: BY ________________________ DATE ____________

C-A-R (1)

APPENDIX G

DATA MANAGEMENT PLAN

1.0 INTRODUCTION

This Data Management Plan presents a program for systematically managing information acquired during the RCRA Facilities Investigation (RFI) to be conducted at the Chevron Refinery. This plan describes project organization and procedures for tracking information, documents for recording measurements and observations in the field, and the data base management system to be employed. In addition, data reduction aspects of the project are discussed, and exhibits of the anticipated data presentation formats to be used for both raw data and conclusions are addressed.

The Data Management Plan has been designed to satisfy the following objectives:

1) Identify and establish data documentation materials and procedures for the RFI.

2) Develop and establish project file procedures to allow collection and tracking of all anticipated project documents and records.

3) Delineate project-related progress reporting procedures and deliverable documents.

4) Discuss the data base management system that will be employed.

5) Provide anticipated formats to be used to present raw data and conclusions of the RFI.

2.0 DATA DOCUMENTATION AND PROCEDURES

There are four major categories of data that will be generated in the course of the RCRA Facilities Investigation at the Chevron Refinery in Philadelphia, Pennsylvania. They are as follows:

- o Field samples and analytical results
  - Soil (geologic and geotechnical), air samples, ground water, chain of custodies, and unique identifiers
  - Laboratory data, including laboratory identifiers, analytical methodologies, analytical results, detection limits, and exceptions

- Field data
  - Field records and observations, including sampling identifiers, geologic, spatial, geotechnical characteristics, and field methods and procedures for samples collected
- Documents
  - Contracts, reports, field log books, etc.
- Communications
  - Records of telephone conversations, letters, facsimile transmissions, memoranda, meeting notes, etc.

2.1 PROJECT DATA FLOW

The four categories of data will be handled by four primary organizations: Chevron, EPA, and Dames & Moore and its subcontractors. Each of these organizations will act as one mode in the data flow network. Data handling will be accomplished as follows:

- Dames & Moore and its subcontractors:

  Will collect field samples and submit them to a laboratory for analysis, and will record all field data. The data will include all geologic, geotechnical, and procedural notes regarding samples collected and conditions observed in the field. Unique identifiers will be assigned to all samples collected in the field, and chain of custody documentation forms will be completed for all samples shipped from the site for analysis.

  Will analyze results from a laboratory to be selected in the future. These data will be consolidated with the field data, and the combined input will be utilized for analysis of contaminant presence.

  Will develop and maintain computer data bases to catalog all documents and correspondence that pertain to the project. This information will be stored in project-specific filing cabinets.

  Will provide output in the form of graphics, tabular summaries of the data and calculations, and finished reports to Chevron.

- Chevron:

  Will accept data input in the form of draft and final reports.

- o USEPA:

  Will be provided with access to all hard-copy data files and reports.

2.2 DATA MANAGEMENT ORGANIZATION

Dames & Moore has identified two separate position titles that will have primary responsibility for managing project data. The following provides a summary of the tasks that those individuals will be responsible for:

1. Project Manager - Has overall responsibility for all observations and information gathered as part of field investigational work and will oversee proper collection and recording of data, subcontractors' work in the RFI, and provide the first review of all data collected in the field for completeness.

2. Quality Assurance Officer - Responsible for supervising the validation of field and laboratory measurements as described in the DCQAP, and will ensure procedural compliance with all approved plans.

2.3 PROJECT DOCUMENTATION MATERIALS

Standardized project forms and formats have been developed for the collection of field data and observations, recording of laboratory information, and routine project communications. Laboratory data will be reported in the Contract Laboratory Protocol format where it is applicable. Routine project communications will be documented on standardized forms for telephone communications, project memoranda, and regular reporting to Chevron.

Each plan or procedural document generated as part of the RFI will include a document information block to indicate the revision number, the date of the most current revision, and the total number of pages in each document section. This document block will appear at the top of each document page and will appear follows:

Plan/Document Name	**Section No. ________**
Chevron Facility	**Revision No. ________**
	Date: ____________
	Page: _____ of _____

A signature page to record reviews, approvals, and distribution of numbered control copies will ensure the control of the RFI documents. Each of the plans will be reviewed and approved by the Dames & Moore Project Director, Project Manager, and Quality Assurance Officer. As appropriate for individual plans, additional individuals will be required to review and sign the document approval page.

3.0 PROJECT FILES

The project files will be used to store and maintain all documents pertaining to the project including reports, data, field -logs, communications, diagrams, and notes. The project files will be maintained at Dames & Moore's Philadelphia Regional office.

4.0 DATA RECORD

4.1 DATA RECORD REQUIREMENTS

A data record for information collected during the RFI will be developed to provide all information needed to subsequently analyze and assess the results of the field and laboratory work. Data records require consistent labeling and recording of field observations to facilitate future data reduction and analysis. This is necessary to eliminate the need for speculation concerning the quality of observations and establish the influence of environmental factors on an ultimate result. The following requirements will be met by the laboratory data record:

1. Unique sample code
2. Sampling location and sample type
3. Sampling date and time
4. Laboratory analysis ID number
5. Sampling or field measurement of raw data
6. Laboratory analysis identification number
7. Property or component measured
8. Results of analysis (concentration)
9. Detection limit
10. Reporting units

All data collected during the investigation will need to be accounted for and reported to the agency, including suspected outliers or samples contaminated by improper collection, preservation, or storage procedures. Data that are invalidated during the quality control assessment will be marked as such, and will include explanations of the reasons for data invalidation. These values will be flagged in summary tables.

In addition to the above, certain field information will be recorded on standardized field data collection forms to document procedures used, and the prevailing conditions during the time of the sampling. This information includes:

1. Name of sampler
2. Date and time of sampling
3. Sample type (soil, sediment, surface water, ground water, air)
4. Sampling location description and purpose of sampling
5. Sampling method, sample containers and preservative used

6. Number and volume of samples taken
7. Sample identification numbers
8. Amount purged for ground water monitoring well sampling (if applicable)
9. Field observations (prevailing weather conditions and other relevant factors that might influence sample integrity)
10. Field measurements conducted such as pH, EC, and temperature
11. Name and signature of person responsible for observation

In addition to the above information, unusual conditions encountered during sampling will also be described to allow interpretation of potentially erroneous data at a later date.

4.2 SAMPLE CODE

4.2.1 Sample Code Requirements

Each sample collected as part of this investigation will be assigned a unique identification number. These identification numbers will be assigned prior to the commencement of any field explorations. Sample codes will contain the following components:

1. Sample media [vapor phase or air, surface soil, subsurface soil (1 digit)]
2. Sample point location number (5 digits)
3. Identification numbers to indicate sample number or the collection of replicate samples, field blanks, and other quality control samples (2 digits)

The coding sequence must be strictly adhered to on the sample labels and chain of custody forms to ensure proper entry into all data management systems.

4.2.1.1 Sample Media

The sample media will appear as the initial sample code designation. This single-digit code will employ letter designations to define the media as follows:

S - Surface sample
B - Subsurface boring sample
V - Soil gas sample
W - Ground water sample

4.2.1.2 Sample Location

The sample location will be designated by five digits. The location number will be assigned as part of the investigations of each media prior to commencement of the work. All of the spaces must be completed in the sample sequence.

4.2.1.3 Identification Number

The two-digit sample identification number will be used to define the sample in terms of the precise location within the sample location or to define the sample as a field quality control sample. The identification number in regard to sample depth, where applicable, will be assigned by the field personnel and will be clearly defined in the field workers' field records.

Quality control samples will be assigned in the identification numbers so that they exist as blind samples to the laboratory. The identification will be assigned by the field personnel and will be clearly defined in the field workers' field records. For field duplicates, the same sample location number will be assigned with a unique identification number. Field blanks will be collected adjacent to the sample location believed to be the most contaminated based on previous investigations or field measurements. The sample location number will be the same location number as the collected sample. A unique identification number will then be assigned to designate the field blank. The trip blank may be assigned any sample location number that was sampled that day <u>and</u> that the trip blank was present. Again, a unique identification number will be assigned.

4.2.1.4 Code Sequence and Recording

The media, sample location, and unique identification number will be expressed in the following sequence:

_____ _____ _____ _____ _____ _____ _____ _____

Media Sample Location ID No.

The sample code will appear as noted above on all sample containers and any chain of custody forms that will accompany the samples for laboratory analysis. Each space will be filled in completely and no dashes will be used to separate the media, sample location, and identification numbers.

4.3 DATA REDUCTION

Data collected during the RFI will be reported according to accepted practices of quality assurance, as outlined in the Data Collection Quality Assurance Plan (DCQAP). All information collected during the study will be tracked. Data that fail one or more quality criteria will be qualified and used to the extent feasible based on the nature of qualifications, and the effect the qualifications will have on ultimate reliability. Primary considerations in data reduction include the following:

1. Treatment of replicate measurements
2. Identification of outlier values
3. Reporting of results determined to be below detection limits.

The specific field data reduction during the RFI Work Plan implementation is outlined below.

Evaluated Media:	Data Collection:	Data Recording:	Data Presentation:
air monitoring/ soil gas	direct read/ direct read	log in field notebook/ GC print out	records stored in file/Data presented in tabular form with GC printout
surface sample	observation	log in field notebook	records stored in file
subsurface soil	observation	logged in field notebook	boring logs presented in report
ground water	observation/ direct read	log in field notebook	records stored in file

4.3.1 Replicates

As part of the proposed QA/QC program for sampling operations, random replicate samples will be collected for analysis, as described in the DCQAP. Prior to the creation of summary data tabulations, including graphics presentations, all replicate analytical results will be statistically averaged and the resulting average value will be included in the summary data set as one value. This treatment of replicate values is intended to limit statistical bias in the summary data set. Acceptance criteria for replicate values are +/- 20%.

4.3.2 Outliers

Outliers, those data points that are believed to be inconsistent with actual conditions, will be identified during the QA/QC review of the data collected during the RFI. As these values are discovered, attempts will be made to determine the cause of the inconsistency within the data set. Common causes of outlier values are entry errors, errors in sampling or contamination of sampling equipment, and actual, but extreme, conditions. Entry errors will be identified by comparison of field logs, chain of custody documents, and raw laboratory reports. Errors in sampling procedure or contaminated sampling equipment will likely result in several corrupt data values, or may be identified through comparison of replicate samples, which will help to identify extreme values.

Analytical data stored in the data base will be periodically reviewed utilizing the "confidence interval" technique as a means of identifying statistical outlier values, and as an aid in validating the results obtained.

In cases where the cause of the outlier value can be identified, and the data can reasonably be adjusted to correct for the error (e.g., entry errors and calibration errors), appropriate corrections will be made in the summary tabulations to reflect the true data value, and these values will be flagged as "Adjusted Outliers" in the footnotes of the table. In cases where the cause of the outlier value cannot be determined, the values will be flagged as "Outlier Error" in the footnotes of the table, and they will be omitted from summary calculations. Outlier values will always be included in the raw data tabulations, in their originally reported form, and will be flagged simply as "Outlier" in the footnotes of the table.

4.3.3 Values Below Detectable Limits

Analytical results that are reported to be below the limits of detection of the specified analytical method will be reported numerically (e.g., "<X.XX") where X.XX will be a numerical representation of the limit of detection of the methodology employed for the analysis. This format will be used in all data tabulations, and these values will be omitted from any summary calculations.

5.0 DATA BASE MANAGEMENT

Analytical and significant field data collected during the RFI will be entered, stored, and evaluated using computerized data bases. The principal intent of the system will be to provide rapid access to the results of the field investigations, and to allow evaluations and comparisons to be made from a variety of references.

5.1 FIELD DATA

Information concerning conditions and features observed during the field investigation will be recorded in daily logs by the field personnel. Copies of these logs will be provided to data management personnel on a weekly basis, and suitable data will be extracted and entered into the data base system. These data will include sample identifiers, sampling methodologies, conditions during sampling, and sampler identification information. The data will be merged in the data base with analytical results obtained from the laboratory to create a unified data set describing the results of the investigations. Original log books will be logged into the project files as they are filled, and will be maintained for future comparison and QA/QC review.

5.2 ANALYTICAL DATA

Analytical data will be reported by the laboratory in one format, hard-copy reports. The hard-copy reports will be logged into and maintained in the project files for future comparison and QA/QC review.

Summary tables, graphs, and maps will be used to present the results of overall SWMU characterizations. These tables may provide statistical summaries (e.g., minima, mean, and maxima) of the analytical data for specific SWMUs or the entire site, and may be summarized by analyte classifications, strata, media, or sampling event. Example column headings for summary tables follow:

- Analyte Class: metals, volatiles, semivolatiles, etc.
- Specific Compound: Zn, Cu, Pb, Fe, etc., for metals
- Units: units of measure specified for the analytical results
- No. Samples: the total number of analyses performed for the indicated analyte, at the specified location
- No. Detections: the total number of results reported above the detection limit
- Minimum: the reported minimum concentration from the described analysis set
- Average: the arithmetic mean concentration from the described analysis set
- Maximum: the reported maximum concentration from the described analysis set
- Location of Maximum Concentration: the geographic or geologic location of the specified maximum concentration
- Selected ARAR, Concentration, Type: the regulatory guideline or limit used for comparison, and the issuing agency
- Number of Exceedances: the total number of analytical results in excess of the regulatory guideline or limit
- Relative Mobility: will be specified for analytes reported in excess of regulatory guidelines or limits

6.0 REPORTING

Periodic reports will be provided to Chevron and the EPA during the course of the project. These reports may include:

1. Description and estimate of the percentage of the RFI completed
2. Summaries of all findings
3. Work completed in the previous month
4. Work in progress
5. Projected work for the next period
6. Out-of-scope work performed and justification
7. Problems encountered and corrective actions
8. Personnel changes during the reporting period
9. Summary of all communications with EPA

Within 515 days after written approval of the RCRA Facilities Investigation, a report presenting the results of investigation will be submitted to EPA and PADER.

Emergency and priority situations will be reported to EPA by telephone and followed by a report within 24 hours. All communications will detail the nature of the situation, the proposed corrective measure, and the rationale for the proposed measure.

Completed draft task reports will be submitted as they are completed. Draft and final RFI reports incorporating the results of all previous reports will also be submitted as required by the Permit. The final report will be sufficiently detailed to allow decisions to be made regarding the need for additional investigation.

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APPENDIX H

HEALTH AND SAFETY PLAN

DAMES & MOORE

HEALTH AND SAFETY PLAN

Project Name:	Chevron-Gulf Refinery
Project Number:	16000-230
Project Site Location:	Philadelphia, Pennsylvania
Project Manager:	Bruce C. Amig
Site Safety Officer:	Laurie D. Hall
Plan Preparer:	Thomas Whitman
Preparation Date:	April, 1990

APPROVED:

Regional Health and Safety Manager

Kathryn A. Sova
(Date)

Office Safety Coordinator

Thomas E. Whitman 4/16/90
Thomas E. Whitman
(Date)

Project Director

Ralph T. Golia 4/16/90
Ralph T. Golia
(Date)

Project Manager

Bruce C. Amig 16 April 90
Bruce C. Amig
(Date)

H&S Approval No.

CONTENTS

CONTENTS
(continued)

1.0 PURPOSE

The purpose of this Health and Safety Plan is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide for contingencies that may arise while operations are being conducted at the Chevron Refinery in Philadelphia, Pennsylvania.

2.0 APPLICABILITY

The provisions of the Health and Safety Plan are mandatory for all on-site Dames & Moore employees and Dames & Moore subcontractors engaged in on-site operations who will be exposed or have the potential to be exposed to on-site hazardous substances.

Dames & Moore policy states that Dames & Moore subcontractors shall provide a Health and Safety Plan for their employees to cover any exposure to hazardous materials and shall complete all work in accordance with that plan. The subcontractor may choose to use Dames & Moore's Health and Safety Plan as a guide in developing his own plan, or he may choose to adopt, in full, Dames & Moore's plan. In either case, the subcontractor shall hold Dames & Moore harmless from, and indemnify Dames & Moore against, all liability in the case of any injury. Dames & Moore reserves the right to review and approve the subcontractors plan at any time. All subcontractor's will, at a minimum, follow all provisions of the Dames & Moore Health and Safety Plan.

Inadequate health and safety precautions on the part of the subcontractor or the belief that the subcontractor's personnel are or may be exposed to an immediate health hazard, can be the cause for Dames & Moore to suspend the subcontractor's site work, and ask the subcontractor's personnel to evacuate the hazard area.

Dames & Moore's subcontractor will be responsible for operating in accordance with current Occupational Safety and Health Administration (OSHA) regulations contained in 29 CFR part 1910.120 - hazardous waste operations and emergency response. These regulations include the following provisions for employees exposed to hazardous substances, health hazards, or safety hazards: training as described in 120(e); medical surveillance as described in 120(f); and personal protection equipment as described in 120(g).

3.0 SITE DESCRIPTION

3.1 GENERAL INFORMATION

Site: Chevron Refinery, Philadelphia, Pennsylvania

Job No.: 16000-230

Objectives: To perform a RCRA Facilities Investigation, performing soil gas surveys, surface soil sampling, soil borings, and monitoring well installation and ground water sampling.

Proposed Date of Activities: July 1990 through November 1991

Background Review of the Site: Preliminary:____ Complete: X

Documentation/Summary: Overall Hazards: Serious: ____
Moderate: X
Low: ____
Unknown: ____

3.2 SITE HISTORY

Historical reports of refinery operations indicate waste disposal at several locations. Ongoing assessment/ recovery operations indicate free product on the water table. In some areas, tank bottoms were dispersed in diked areas around storage tanks. Separator sludge and phosphoric acid catalysts were placed in waste disposal sites.

The site histories for each of the SWMUs to be addressed is further discussed in the following sections.

3.2.1 Northwestern Fill Area

The Northwestern Fill Area contains SWMU Nos. 87, 88, and 89, and is designated as a buried lead sludge area. Cooling tower sludges and oily tank bottoms are believed to have been occasionally placed behind the cooling towers by the bulkhead. The precise placement and types of waste are not known. Floating petroleum hydrocarbons have been observed in two wells throughout this area. No analysis has been performed.

3.2.2 Storage Tank Areas

This area includes SWMU Nos. 90, 91, 92, 93, 94, and 95. Petroleum products were stored in these tanks. Leaded sludges (K052) from tank bottoms were periodically removed from the tanks (approximately once every 10 years). The sludges were disposed of in areas near the tank cleanout ports by being placed directly on the ground or in shallow excavations approximately 2 to 4 feet in depth. The units began receiving waste in approximately 1960. This manner of tank sludge disposal was discontinued in January 1983. The disposal areas near the tank cleanout ports also may have received oily solids, API separator sludge, and spent catalysts. Lead has been detected in soil samples ranging from 15 ppm to 17,000 ppm, extending to a depth of more than 2 feet.

3.2.3 Bulkhead Seepage Area

This area includes SWMU No. 101. No waste disposal activities are known to have occurred in this area. This area contains several potential sources of leakage, including barge and train loading facilities, and underground pipeways. Minor seepage, if present, may include No. 2 oil, jet fuel, lube oil, and/or gasoline. A slurry wall with an oil recovery system and an oil recovery trench have been installed in this area, at separate locations. No soil sample data was available for this area; however, floating petroleum hydrocarbons have been observed on ground water.

3.3 DAMES & MOORE ACTIVITIES

Dames & Moore's on-site activities will include the identification and quantification of compounds present in soils and ground water within and around selected solid waste management units in the main plant area. Specific site activities are discussed in the Work Plan, Section 4. General site work is reviewed below, with relation to the three SWMU categories.

3.3.1 Northwestern Fill Area

A total of 15 soil borings will be drilled, two soil gas surveys will be conducted at SWMU Nos. 88 and 89, and five monitoring wells will be installed in this area.

3.3.2 Storage Tank Area

At the Storage Tank Area, approximately 166 borings, 18 monitoring wells, and 10 well points will be installed.

3.3.3 Bulkhead Seepage Area

To characterize this area, water samples from 4 monitoring wells will be collected and 10 well points will be installed to evaluate the presence of floating hydrocarbons.

3.4 FACILITY DESCRIPTION

Waste Types: Liquid __X__ Solid __X__ Sludge __X__ Gas _____

Characteristics: Corrosive __X__ Ignitable __X__ Radioactive _____ Volatile __X__ Toxic __X__ Reactive _____ Unknown _____

Status: (active, inactive, unknown) active

3.5 HAZARD EVALUATION

Based on Dames & Moore's initial background search, the suspected contaminants to ground water are: benzene, ethylbenzene, toluene, and xylenes in low ppm concentrations. Suspected contaminants to the soil are lead and tetraethyl lead (TEL).

The exposure limits, recognition qualities, acute and chronic effects, and first aid treatment for these contaminants are presented in Table 1 and 2.

The main routes of exposure associated with the volatile organic compounds are via skin contact or inhalation of vapors. The main routes of exposure associated with metals are inhalation and ingestion of contaminated dusts. Therefore, a minimum of Level D+ protection is recommended to perform work on site with the potential to upgrade to Level B. If the organic vapors exceed the established action levels (see Table 3), the area will be evacuated, and the site conditions and respiratory protection will be reassessed prior to continuation of field activities. If dry or dusty conditions exist, implement dust suppression methods. If dry or dusty conditions continue, upgrade to Level B protection. Tables 3 and 4 provide hazard monitoring methods, action levels, and protective equipment required for on-site activities.

Standard Safe Work Practices employed by Dames & Moore are listed in Appendix B, and must be adhered to at all times. Entry into the site area will be coordinated with the appropriate site contacts.

4.0 DAMES & MOORE MONITORING REQUIREMENTS

Table 3 presents the monitoring requirements, while Table 4 presents the required protective equipment for this Health and Safety Plan.

4.1 EMERGENCY CONTACTS AND PROCEDURES

Should any situation or unplanned occurrence require emergency services, the following personnel and agencies should be contacted:

Contact	Person or Agency	Telephone
Chevron Contact	Mike Manigly	215-339-7466
D&M Project Manager	Bruce Amig	215-657-5000
D&M MPIC	Roger D. Moose	215-657-5000
Firmwide H&S Director	Gary Kreiger	303-294-9100
D&M Regional Health & Safety Manager	Kathy Sova (office)	201-272-8300
Office Safety Coordinator	Tom Whitman	215-657-5000
Police	Philadelphia	911
Fire	Philadelphia	911
Ambulance	Philadelphia	911
Hospital	Methodist Hospital	215-952-9000
Medical Surveillance	Jefferson Medical Center	215-955-8381

4.2 LOCATION OF SITE RESOURCES (for emergency use)

Water Supply: Security Building, and at drilling location (supplied by Dames & Moore or subcontractor).

Telephone: Security Gate at Lanier and Pennypack and in lobby of Security Building

4.3 EMERGENCY ROUTE TO HOSPITAL

Directions to the nearest hospital are as follows:

- o From the Gate 24 entrance/exit of Chevron's refinery, turn right (south) onto Lanier Avenue.
- o Turn left under bridge and exit onto Penrose Avenue (Route 291).
- o Penrose Avenue will become Moyamensing Avenue.
- o At the Broad Street intersection, turn left (north) onto Broad Street.
- o The Methodist Hospital is the third city block on the right-hand (east) side.

4.4 ADDITIONAL ARTICLES TO BE TAKEN INTO FIELD

1. First Aid Kit
2. Disposable Eye Wash (1 liter or more)

5.0 SITE SAFETY WORK PLAN

5.1 MONITORING

5.1.1 Monitoring Requirements

The Site Safety Officer (SSO) will conduct air monitoring for the hazards presented in Table 1. Equipment necessary for air monitoring at this site consists of an Organic Vapor Analyzer (OVA), detector tubes (benzene), a particulate meter, and an explosimeter. The type of monitoring instruments specified by the hazard and the action levels to upgrade personal protection are shown on Table 3. All monitoring equipment shall be maintained following procedures outlined in the owner's manual for the specified monitoring equipment.

5.1.2 Monitoring Schedule

5.1.2.1 Instrument Calibration

All applicable instruments shall be calibrated daily. Readings shall be recorded on the Instrument Calibration Check-Out Sheet provided in Appendix F.

5.1.2.2 Background Readings

Before any field activities commence, background levels at the site will be monitored and noted on the Air Monitoring Forms in Appendix F. Daily background readings shall be taken away from areas of potential contamination in order to obtain accurate results.

5.1.2.3 Air Monitoring Frequency

All site readings may be noted on the Air Monitoring Form provided in Appendix F, with the date, time, weather conditions, wind direction and speed, if possible, and location where the background level was recorded.

The following schedule should be followed for air monitoring activities as specified for each monitoring method.

Air Monitoring Equipment	Monitoring Frequency
OVA	Monitor every 15 minutes
Explosimeter	Monitor every 30 minutes
Detector Tubes	As per Table 3
Particulate Meter	Continuously during drilling

5.2 LEVELS OF PROTECTION

A minimum of Level D+ protection is needed to perform work on-site.

5.3 RESPIRATORY PROTECTION

Sampling and drilling activities associated with contaminants listed in Table 1 will be initiated in Level D+, with Level B capability. However, if organic vapors exceed 50 ppm (as measured with the OVA), or exceed the action level for the benzene detector tubes (1 ppm), upgrade to Level B respiratory protection. If dry or dusty conditions exist, dust control procedures will be implemented (wetting the soil). If dry or dusty conditions persist, or airborn particulate concentrations exceed 150 mg/m^3, upgrade to Level B protection.

All ambient air measurements taken in order to evaluate personnel exposure will be taken within the individuals' breathing zone and shall be fairly frequent or constant for a duration of at least 30 seconds.

5.4 WORK LIMITATIONS

In general, field work will be conducted during daylight hours only. At least two personnel (one must be a Dames & Moore representative) will be in the field at all times. The Dames & Moore Project Manager (PM) or Regional Health and Safety Manager (RHSM) must grant special permission for any field activities to be conducted beyond daylight hours. All Dames & Moore personnel working in the field have completed the Dames & Moore Hazardous Material Sites Training Course (or its equivalent). Additionally, all Dames & Moore field personnel have been declared medically fit for duty and, where respiratory protection is necessary, have been properly trained, fit-tested and declared fit for respirator use. No drilling activities shall take place unless the absence of subsurface utility lines, or other buried metal objects, has been confirmed.

5.5 FIELD PERSONNEL

The responsibilities of the Project Manager, the On-Site Safety Officer, and project personnel are listed in Appendix D and must be adhered to at all times.

A work party consisting of the following persons will perform the tasks:

Project Manager: Bruce C. Amig

Site Safety Officer: Laurie D. Hall

The work party was briefed on the contents of this Health and Safety Plan at Dames & Moore's Philadelphia office in April, 1990.

5.6 HEAT STRESS/COLD STRESS

If on-site activities are conducted during extreme weather conditions, procedures for minimizing heat stress/cold stress will be followed.

6.0 DECONTAMINATION PROCEDURES

6.1 GENERAL

Personnel should follow the decontamination procedures outlined below for Level D+ personnel protection:

1. locate a decontamination area;
2. establish a personnel decontamination station consisting of a basin with soapy water, a rinse basin with plain water, and a can with a plastic bag;
3. wash and rinse boots;
4. remove outside gloves and discard in plastic bag;
5. remove disposable suit and discard in plastic bag;
6. upon leaving the contamination area, all personnel will proceed through the appropriate Contamination Reduction Sequence as described above;
7. All protection gear should be left on-site during lunch break following decontamination procedures.

The maximum decontamination layout for Level B is shown on Figure 6-1, and a description is given below.

6.2 MAXIMUM MEASURES FOR LEVEL B DECONTAMINATION

Station 1: Segregated Equipment Drop

Deposit equipment used on-site (tools, sampling devices and container, monitoring instruments, radios, clipboards, etc.) on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.

Station 2: Boot Cover and Glove Wash

Scrub outer boot covers and gloves with decon solution or detergent and water.

Station 3: Boot Cover and Glove Rinse

Rinse off decon solution from Station 2 using copious amounts of water.

Station 4: Tape Removal

Remove tape around boots and gloves and deposit in container with plastic liner.

Station 5: Boot Cover Removal

Remove boot covers and deposit in containers with plastic liner.

Station 6: Outer Glove Removal

Remove outer gloves and deposit in container with plastic liner.

Station 7: Suit and Boot Wash

Wash splash suit, gloves, SCBA and safety boots. Scrub with long-handle scrub brush and decon solution. Wrap SCBA regulator with plastic to keep out water. Wash backpack assembly with sponges.

Station 8: Suit and Boot, SCBA and Glove Rinse

Rinse off decon solution using water. Repeat as many times as necessary.

Station 9: SCBA Tank Change

If worker leaves exclusion zone to change SCBA Tank, this is the last step in the decontamination procedure. Worker's tank is exchanged, new outer gloves and boot covers donned, joints taped, and worker returns to duty.

Station 10: Safety Boot Removal

Remove safety boots and deposit in container with plastic liner.

Station 11: SCBA Backpack Removal

While still wearing facepiece, remove backpack and place on table. Disconnect hose from regulator valve.

Station 12: Splash Suit Removal

With assistance of helper, remove splash suit. Deposit in container with plastic liner.

Station 13: Inner Glove Wash

Wash inner gloves with water.

Station 14: Inner Glove Rinse

Rinse inner gloves with decon solution.

Station 15: SCBA Face Piece Removal

Remove SCBA face piece. Deposit in container with plastic liner. Avoid touching face with fingers.

Station 16: Inner Glove Removal

Remove inner gloves and deposit in lined container.

Station 17: Inner Clothing Removal

Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off-site since there is a possibility that small amounts of contaminants might have been transferred in removing the disposable coveralls.

Station 18: Field Wash

Shower if highly toxic, skin-corrosive, or skin-adsorbably materials are known or suspected to be present. Wash hands and face if shower is not available.

Station 19: Redress

Put on clean clothes.

Minimal Decontamination

Less extensive procedures for decontamination can be subsequently or initially established when the type and degree of contamination become known or the potential for transfer is judged to be minimal. These procedures generally involve one or two washdowns only.

Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation should be double-bagged and contained on-site or removed to an approved off-site disposal facility. Decon and rinse solution can be contained on-site or removed to an approved disposal facility. Reusable rubber clothing should be dried and prepared for future use. (If gross contamination had occurred, additional decontamination of these items may be required.) All wash tubs, pail containers, etc., should be thoroughly washed, rinsed, and dried prior to removal from the site.

7.0 FORMS

The following forms are located in Appendix F:

Plan Acceptance Form
Plan Feedback Form
Accident Report Form
Exposure History Form (to be completed by PM only)
Calibration Check Sheet
Air Monitoring Form
Contractor Statement of Compliance

The Plan Acceptance Form should be filled out by all employees working the site. The Plan Feedback Form should be filled out by the Site Safety Officer and any other on-site employee who wishes to fill one out. The Accident Report Form should be filled out by the Project Manager in the event that an accident occurs.

ALL COMPLETED FORMS SHOULD BE RETURNED TO THE PHILADELPHIA OFFICE SAFETY COORDINATOR.

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TABLE 1

EXPOSURE LIMITS AND RECOGNITION QUALITIES

Compound	Exposure(a) Limit (ppm unless otherwise indicated)	IDLH(b) Level (ppm unless otherwise indicated)	Odor	Odor Warning Concentration (ppm)	LEL(c) %	UEL(d) %	Ionization Potential (ev)
Ethyl benzene	100(1)(2)	2,000	Aromatic	0.25-200 (200)	1.0	6.7	8.76
Benzene	1(1) 5-15 min STEL(1) 10(2)	2,000	Aromatic	1.5-5	1.3	7.1	9.25
Toluene	200(1) 100(2)	2,000	Aromatic	0.17-40 Fatigue (300-400)	1.3	7.1	8.82
Xylenes (o-, m- and p-isomers)	100(1)(2)	10,000	Aromatic	1.8/1.1-3.7/ 0.47-0.53(R)	1/1.1/1.1	6/7/7	8.56/8.56/ 8.44
Lead	0.05 mg/m^3(1) 0.15 mg/m^3(2)	Variable	Variable	--	Variable	Variable	--

(a) *OSHA Permissible Exposure Limit or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value.

(b) Immediately Dangerous to Life or Health Level

(c) Lower Explosive Limit

(d) Upper Explosive Limit

(1) OSHA Time Weighted Average

(2) ACGIH Time Weighted Average

STEL = Short-Term Exposure Limit (averaged over a 15-minute period)

NOTE:

The odor warning concenrations given are generally odor thresholds with irritation thresholds given in parenthesis.

TABLE 2

ACUTE AND CHRONIC EFFECTS AND FIRST AID TREATMENT

Compound	Routes of Entry	Eye Irritant	Acute Effects	Chronic Effects
Ethylbenzene	Inhalation Ingestion Skin and/or eye contact	Yes	Irritates mucous membranes, headache, dermatitis, narcosis, coma	Eyes, upper respiratory system, skin, CNS
Benzene	Inhalation Ingestion Skin Absorption Skin and/or eye contact	Yes	Giddy, hadache, nausea, staggered gait, fatigue	Leukemia, potential human carcinogen, blood, CNS, skin, bone marrow, eyes, respiratory system
Toluene	Inhalation Ingestion Skin Absorption Skin and/or eye contact	--	Fatigue, weakness, confusion, euphoria, dilated pupils, lacrimation	Central nervous system, liver kidneys, skin
Xylenes (o-, m- and p-isomers)	Inhalation Ingestion Skin Absorption Skin and/or eye contact	Yes	Dizziness, excitement, drowziness, incoordination, staggering gait	Central nervous system, blood, liver, liver, kidneys, eyes, GI tract
Lead	Inhalation Ingestion Skin and/or eye contact	--	Lassitude, insomnia, eye grounds, pallor, abdominal pain, gingival lead line	GI tract, CNS, kidneys, blood, gingival tissue

General First-Aid Treatment (A first-aid kit will be kept in the site vehicle.)

Eye	Irrigate Immediately (A portable eye-wash unit will be kept in the site vehicle.)
Skin	Soap Wash Promptly
Inhalation	Move to Fresh Air
Ingestion	Get Medical Attention

TABLE 3

HAZARD MONITORING METHOD, ACTION LEVELS, AND PROTECTIVE MEASURES

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors	OVA/PID (10.2 EV lamp)	(1) Measurable Above Background Based on Judgement of SSO up to 50 ppm	Level D+ (see Table 4)	o Continue drilling
		and		
	Benzene Detector Tubes	< 1 ppm		o Continuous monitoring/ every sample retrieved
	OVA/PID (10.2 EV lamp)	Measurable Above Background Based on Judgement of SSO 50 ppm	LEVEL B (see Table 4)	o Continue drilling
		and		
	Benzene Detector Tubes	< 1 ppm		o Continuous monitoring/ every sample retrieved
	OVA/PID (10.2 EV lamp)	Measurable Above Background Based on Judgement of SSO >50 ppm	LEVEL B	
		or		
	Benzene Detector Tubes	>1 ppm		
Toxic Dust	Visual Observation	Dry or dusty conditions	LEVEL B (see Table 4)	
Explosive Atmosphere	Explosimeter	0-10% LEL	Continue Drilling	o Continue monitoring every 10 minutes/ every sample retrieved.
		10-25% LEL		o Continuous monitoring every sample retrieved
		> 25% LEL	**EVACUATE AREA EXPLOSION HAZARD NOTIFY PROJECT MANAGER	

NOTES:

(1) The above action levels are not solely based on the criteria for selecting levels of protection by the 1984 EPA Standard Operating Procedures, but also on the professional judgement and experience of the On-Site Safety Officer (OSSO).

* Super windy or dusty conditions exist. The area should be hosed down to try to minimize the potential for the inhalation of contaminated dust.

** If encountered in a boring hole or monitoring well, purge boring or well with nitrogen until safe levels (< 10% LEL) are obtained. If > 25% LEL persists, abandon boring and evacuate area temporarily. After at least 1/2 hour, re-approach borehole from an upwind direction while continuously monitoring well explosimeter. If levels are still unsafe, backfill hole and abandon.

TABLE 4

PROTECTIVE EQUIPMENT FOR ON-SITE ACTIVITIES

Activity	Level	Protective Equipment
Soil sampling, soil gas survey, monitoring well installation	D+	o Hearing protection (foam earplugs or earmuffs)(1)
		o Hard hat
		o Safety goggles
		o Chemical resistant coveralls
		o Steel toe/shank chemical resistant boots
		o Inner latex gloves with outer nitrile gloves
	B	o Self-contained breathing apparatus (SCBA) or supplied air system
		o Neoprene or nitrile outer gloves with latex inner gloves (3)
		o Neoprene or butyl rubber outer boots with safety shoes

(1) Optional during noise-intensive activities.

PROCESS DECON PROCEDURES

MAXIMUM DECONTAMINATION LAYOUT

LEVEL B PROTECTION

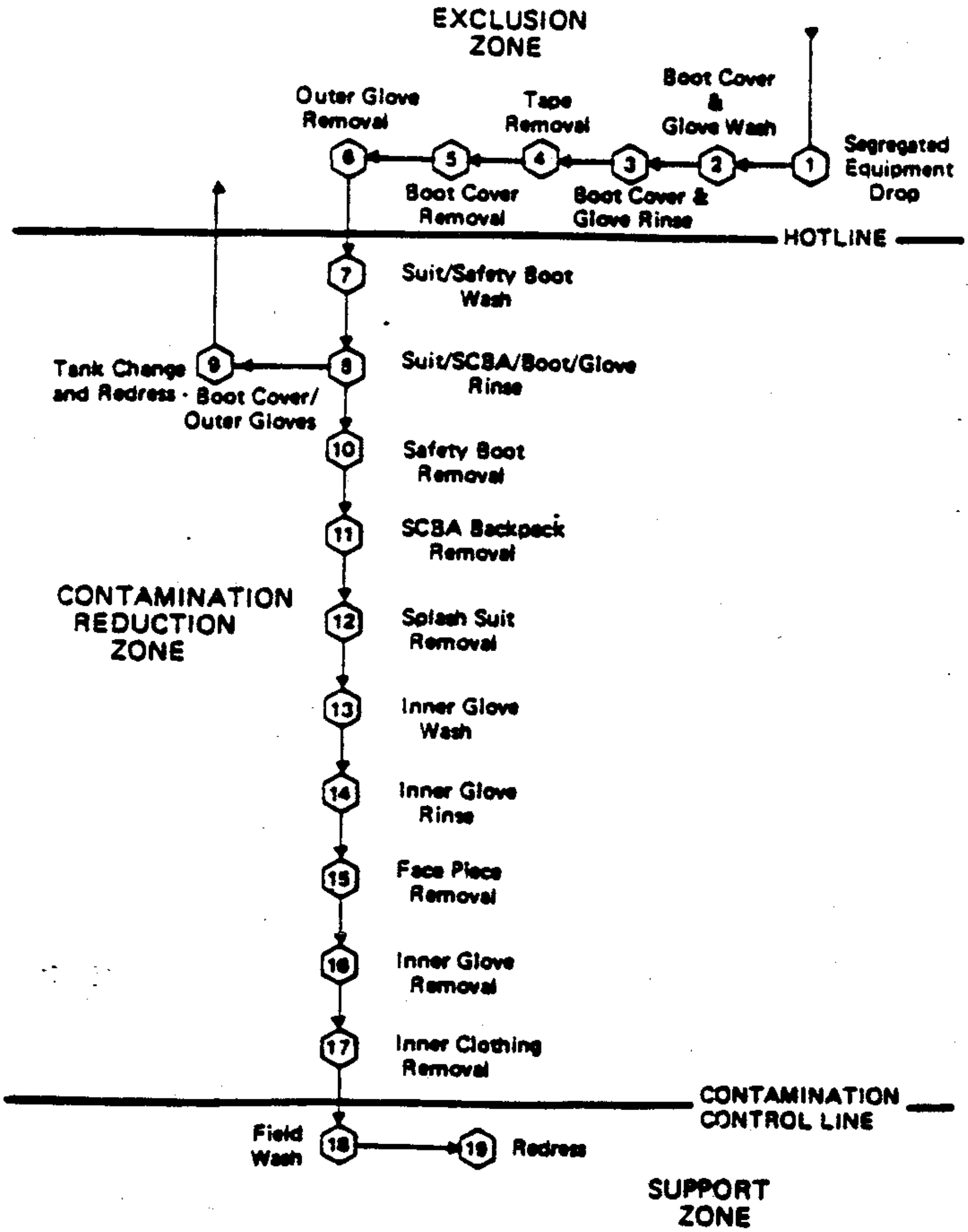

Figure 3

APPENDIX A

CHEMICAL HAZARD EVALUATION

(Material Safety Data Sheets are maintained in the Office Safety Coordinator's files.)

APPENDIX B

STANDARD SAFE WORK PRACTICES

STANDARD SAFE WORK PRACTICES

1. GENERAL

1. Eating, drinking, chewing gum or tobacco and smoking are prohibited in the contaminated or potentially contaminated area or where the possibility for the transfer of contamination exists.

2. Avoid contact with potentially contaminated substances. Do not walk through puddles, pools, mud, etc. Avoid, whenever possible, kneeling on the ground, leaning or sitting on equipment or ground. Do not place monitoring equipment on potentially contaminated surface (i.e. ground, etc.).

3. Prevent, to the extent possible, spillage. In the event that a spillage occurs, contain liquid, if possible.

4. Prevent splashing of contaminated materials.

5. All field crew members shall make use of their sense (<u>all senses</u>) to alert them to potentially dangerous situations in which they should not become involved (i.e. presence of strong, irritating or nauseating odors).

6. Field crew members shall be familiar with the physical characteristics of investigations, including:

   - Wind direction in relation to the ground zero area;
   - Accessibility to associates, equipment, vehicles;
   - Communications;
   - Hot zone (areas of known or suspected contamination);
   - Site access;
   - Nearest water sources.

7. The number of personnel and equipment in the contaminated area should be minimized, but only to the extent consistent with workforce requirements of safe site operation.

8. All wastes generated during D&M and/or subcontractor activities at the site will be disposed of as directed by the PM.

2. DRILLING AND SAMPLING PROCEDURES

For all drilling and sampling activities, the following standard safety procedures shall be employed:

1. All drilling and sampling equipment shall be cleaned before proceeding to the site.

2. At the drilling or sampling site, sampling equipment shall be cleaned after each use.

3. Work in "cleaner" areas should be conducted first where practical.

4. The minimum number of personnel necessary to achieve the objectives shall be within 25 feet of the drilling or sampling activity.

5. If emergency and back-up subcontracted personnel are at the site, they should remain 25 feet from the drilling or sampling activity, where practical.

6. Exclusion zones will be established within designated hot lines. Delineation of a hot line will reflect the interface between areas at or below a perdetemined threshold contaminant concentation, based on available data including the results of monitoring and chemical analyses, information from site personnel regarding historical site activities, and general observations. This determination will be made by the PM in conjunction with the OSSO and site personnel.

3. BOAT SAFETY PRACTICES (LAGOON SAMPLING)

1. Two persons will man the sampling boat and an on-shore supervisor will be present at all times.

2. All field personnel shall wear life preservers.

3. The on-shore supervisor should be equipped with in-plant communication in case an accident requiring emergency services occurs.

4. In-plant safety and medical personnel should have complete notification of the boat sampling schedule and locations.

5. A tow line will be attached to the boat and maintained on land at all times if practicable.

6. Boarding and unloading the sampling boat will be conducted from a dry and stable location if practible, without necessitating contact by personnel with the contaminated waste water.

7. Personnel shall position themselves accordingly in the boat to maintain a stable condition at all times (counter balancing bow and stern or port starboard).

8. Sampling equipment should be drained thoroughly before being brought into the boat.

9. If sampling equipment falls into the water, do not make any attempt to retrieve it.

4. DRILLING IN A LANDFILL

1. Specific monitoring methods and protective equipment indicated in Tables 3 and 4 should be utilized. Monitoring with detector tubes for H_2S, HCN, and vinyl chloride shall be carried out. Monitoring for exposure to CH_4 shall be conducted as well.

2. Established clean area just outside of the landfill consisting of a decontamination area and backup support health and safety and firefighting equipment (fire extinguishers). This area will be continuously monitored by the OSSO who will have visual contact with personnel in the landfill and radio contact with the plant. In addition, the OSSO will be prepared to enter the landfill in protection Level B protective gear in case of an emergency.

3. Prior to the start of drilling a probe within the landfill, a protective steel sheeting or blasting mat, about 20 feet by 10 feet will be placed over the area to be probed. The probe will be drilled through a hole cut in the center of the sheeting.

4. Appropriate emergency and backup subcontracted personnel should remain 25 feet from the drilling or sampling activity where practical.

4. Appropriate emergency and backup subcontracted personnel should remain 25 feet from the driling or sampling activity where practical.

5. CONFINED SPACE ENTRY

All personnel will treat Confined Space Entry as a special hazard, and all tanks, similar vessels and partially or entirely closed spaces shall be regarded as being potentially dangerous.

Before entering a confined space, the OSSO must see that the following is adhered to:

1. All mechanical apparatus such as agitators and pumps within the confined space, which if activated could injure the worker, is locked out.

2. The atmosphere within the confined space is tested for oxygen (O_2) deficiency and flammable gas or vapor, LEL, and the test results recorded.

The area will be continuously vented to dissipate any vapors or gases (five air changes are required). The percent O_2 and LEL will be redetermined and recorded and upon reaching safe levels, as indicated on the meter, the space may be entered. The area shall be continuously, positively (blow air in) ventilated prior to and during entry. The following equipment will be used in lieu of standard equipment.

A. Flashlights, lanterns or alternating current (AC) or direct current (DC) electric powered lighting which is approved for Class 1, Division 1, Group C or D Atmosphere (explosion-proof).

B. Hand tools constructed of non-sparking metal alloys.

3. Workers are provided and required to use protective equipment as follows:

A. For worker entering confined space:

- o gloves
- o rubber steel toed boots
- o impermeable coveralls
- o safety harness with attached lifeline
- o escape packs
- o hard hat with safety glasses.

B. For worker observing operation:

- o hard hat
- o safety glasses or goggles
- o gloves
- o boots and safety shoes
- o impermeable coveralls
- o immediate access to self-contained breathing apparatus with full face mask
- o immediate access to safety harness and lifeline
- o two-way radio for summoning assistance and emergency communication.

4. D&M employees are not permitted to enter a confined space in which levels in excess of acceptable standards (see exposure standard in Health and Safety Plan) are present.

5. Air supply lines are inspected for leaks or cracks which could result in breakage during use. Face mask respirators are checked for proper flow rate. Two-way radios are tested to assure proper working order and reception of signal transmitted. Safety harnesses and eye lines are checked for proper integrity.

6. The permit should also contain the following information:

   A. name of person entering the confined space
   B. name of observer(s)
   C. date and time of entry
   D. reason for entry.

   This permit will be prominently displayed in the area of the continued space to be entered.

6. <u>"BUDDY SYSTEM"</u>

1. All operations involving confined space entry will be performed by a team of not less than two (2) persons with specific duties as follows:

   <u>Person #1</u> — Securing of lifeline to winch or stationary object and entry into confined space to perform necessary operations(s). Maintain communication with Person #2.

   <u>Person #2</u> — Remain outside the confined space and observe and/or communicate with Person #1 until the operation is complete and Person #1 has exited the confined space.

   During the period in which the confined space operation is being performed, Person #2 will be equipped with a full-face positive pressure demand, self-contained breathing apparatus and safety harness with lifeline.

   Person #2 will tend to Person #1's lifeline during the entire operation.

2. <u>Communications</u>

Person #1 and Person #2 will communicate with each other during the entire operation, if visual contact cannot be maintained. The following code shall be used when utilizing the lifeline:

Person #2 to Person #1		Person #1 to Person #2	
1 Pull	- Are you okay?	1 Pull	- I am okay
2 Pulls	- Advance	2 Pulls	- I am going ahead
3 Pulls	- Back out	3 Pulls	- Keep slack out of line
4 Pulls	- Come out immediately	4 Pulls	- Send help

If Person #1 does not respond to the pull code, assume that there is trouble and begin effecting emergency procedures.

3. <u>Emergency Plan</u>

If it becomes necessary to effect rescue efforts to remove a worker from a confined space, the following procedures will be followed:

A. Person #2 will communicate via two-way radio to a base station and request assistance. The following information will be given:

   1. Location

   2. Bring emergency oxygen supply and first-aid kit.

   3. Bring self-contained air supply with full face mask, safety harness, and lifeline.

   4. Call for professional medical assistance.

BEFORE BEGINNING RESCUE, CONFIRM THAT COMMUNICATION WAS RECEIVED AS TRANSMITTED AND THAT ASSISTANCE IS FORECOMING.

B. If Person #1's lifeline is secured to a winch, begin hauling Person #1 out of the confined space. This procedure must be performed at speed that will not further injure Person #1.

C. If the lifeline is not secured to a winch, Person #2 will secure lifeline and enter the continued space, wearing SCBA.

ALWAYS SUMMON ASSISTANCE BEFORE BEGINNING A RESCUE ATTEMPT.

4. Reporting

Upon completion of the confined space entry operation, the permit should be completed indicating the amount of time the worker or workers were inside the confined space. This report (permit) is sent to RHSM.

APPENDIX C

CONTACTS AND PROCEDURES

CONTACTS AND PROCEDURES

1. CONTACTS

Should any situation of unplanned occurrence require outside or support services, the appropriate contacts should be made. The list of appropriate contacts is listed in Section 4 of the Health and Safety Plan.

2. PROCEDURES

In the event that an emergency develops on-site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- o Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while on-site; or
- o A condition is discovered that suggests the existence of a situation more hazardous than anticipated.

The following emergency procedures should be followed:

A. Personnel on-site should use the "buddy system" (pairs). Buddies should pre-arrange hand signals or other means of emergency signals for communication in case of lack of radios or radio breakdown (see the following item).

- o Hand gripping throat: out of air, can't breathe.
- o Grip partner's wrist or place both hands around waist: leave area immediately, no debate.
- o Hands on top of head: need assistance.
- o Thumbs up: okay, I'm alright, I understand.

- o Thumbs down: no, negative.

B. Site work area entrance and exit routes should be planned, and emergency escape routes delineated by the OSSO.

C. Visual contact should be maintained between "pairs" on-site with the team remaining in close proximity in order to assist each other in case of emergencies.

D. In the event that any member of the field crew experiences any adverse effects of symptoms of exposure while on-site, the entire field crew should immediately halt work and act according to the instructions provided by the OSSO.

E. Wind indicators visible to all on-site personnel should be provided by the PM to indicate possible routes for upwind escape.

F. The discovery of any condition that would suggest the existence of a situation more hazardous than anticipated should results in the evacuation of the field team and re-evaluation of the hazard and the level of protection required.

G. In the event that an accident occurs, the PM is to complete an Accident Report Form for submittal to the Office Safety Coordinator (OSC), who will forward a copy to the RHSM and the FWHSD. The OSC should assure that the follow-up action is taken to correct the situation that caused the accident.

H. In the event that an accident occurs, the PM is to complete an Accident Report Form for submittal to the MPIC of the office, with a copy to the health and safety program office. the MPIC should assure that follow-up action is taken to correct the situation that caused the accident.

APPENDIX D

RESPONSIBILITIES

RESPONSIBILITIES

1. PROJECT MANAGER

The Project Manager (PM) shall direct on-site investigations and operational efforts. The PM, assisted by the On-Site Safety Officer (OSSO), has primary responsibility for:

1. Making certain that appropriate personnel protective equipment and monitoring equipment is available and properly utilized by all on-site personnel;
2. Making certain that personnel receive this plan and are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are familiar with planned procedures for dealing with emergencies;
3. Making certain all field personnel have had the Dames & Moore Core Health and Safety Training Course or its equivalent;
4. Making certain that personnel are aware of the potential hazards associated with site operations;
5. Monitoring the safety performance of all personnel to ensure that the required work practices are employed;
6. Correcting any work practices or conditions that may result in injury or exposure to hazardous substances;
7. Preparing any accident/incident reports (see attached Accident Report Form) and routine job exposure records;
8. Assuring the completion of Plan Acceptance and Feedback Forms attached hereto.

2. ON-SITE SAFETY OFFICER

The On-Site Safety Officer (OSSO) shall:

1. Implement project Health & Safety Plans and report to the Site Safety Coordinator and the PM for action if any deviations from the anticipated conditions described in the plan and has the authorization to stop work at any time;

2. Calibrate all monitoring equipment (except radiation detection equipment) on a daily basis and record results on the attached sheets; (See Section 7.0 - Daily Instrument Calibration Check Sheet and Daily Radiation Instrument Operability Check Sheet.)

3. Making certain that all monitoring equipment is operating correctly according to manufacturers instructions and provide maintenance if it is not;

4. Confirm that personnel working on-site have the proper medical surveillance program and Health & Safety training which qualifies them to work at a hazardous waste site. Also be responsible for identifying all WMS site personnel with special medical problems (i.e. allergies).

3. PROJECT PERSONNEL

Project personnel involved in on-site investigations and operations are responsible for:

1. Taking all reasonable precautions to prevent injury to themselves and to their fellow employees;

2. Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the OSSO;

3. Notifying the PM and OSSO of any special medical problems (i.e. allergies) and making certain that all on-site personnel are aware of any such problems.

APPENDIX E

HEAT STRESS/COLD STRESS

HEAT STRESS/COLD STRESS

HEAT STRESS

If site work is to be conducted during the summer or in other hot environments, heat stress is a concern in the health and safety of personnel. For workers wearing permeable clothing, follow recommendations for monitoring requirements and suggested work/rest schedules in the current American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values for Heat Stress. For workers wearing semipermeable or impermeable clothing, the ACGIH standard cannot be used. For these situations, workers should be monitored when the temperature in the work area is above 70°F (21°C).

To monitor the worker, measure:

- Heart rate. Count the radial pulse during a 30-second period as early as possible in the rest period.

  If the heart rate exceeds 110 beats per minute at the beginning of the rest period, shorten the next work cycle by one-third and keep the rest period the same.

  If the heart rate still exceeds 110 beats per minute at the next rest period, shorten the following work cycle by one-third.

- Oral temperature. Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).

  If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.

If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.

Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

- Body water loss, if possible. Measure weight on a scale accurate to ±0.25 lb at the beginning and end of each work day to see if enough fluids are being taken to prevent dehydration. Weights should be taken while the employee wears similar clothing or, ideally, is nude. The body water loss should not exceed 1.5 percent total body weight loss in a work day.

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (see following Table). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

SUGGESTED FREQUENCY OF PHYSIOLOGICAL MONITORING FOR FIT AND ACCLIMATIZED WORKERS

ADJUSTED TEMPERATURE(1)	NORMAL WORK ENSEMBLE	IMPERMEABLE ENSEMBLE
90°F (32.2°C) or above	After each 45-min of work	After each 15 min of work
87.5°-90°F (30.8°-32.2°C)	After each 60 min of work	After each 30 min of work
82.5°-87.5°F (28.1°-30.8°C)	After each 90 min of work	After each 60 min of work
77.5°-82.5°F (25.3°-28.1°C)	After each 120 min of work	After each 90 min of work
72.5°-77.5°F (22.5°-25.3°C)	After each 150 min of work	After each 120 min of work

(1) Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)

If workers are not monitored for heat stress, work activities in hot environments can result in dehydration, heat exhaustion, heat stress or even heat stroke.

Signs and Symptoms of Heat Stress

- **Heat rash** may result from continuous exposure to heat or humid air.

- o **Heat cramps** are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include:
  - -- muscle spasms
  - -- pain in the hands, feet and abdomen.

- o **Heat exhaustion** occurs from increased stress on various body organs including inadequate blood circulation due to cardio-vascular insufficiently or dehydration. Signs and symptoms include:
  - -- pale, cool, moist skin
  - -- heavy sweating
  - -- dizziness
  - -- nausea
  - -- fainting

- o **Heat stroke** is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury and death occur. Competent medical help must be obtained. Signs and symptoms are:
  - -- red, hot, usually dry skin
  - -- lack of or reduced perspiration
  - -- nausea
  - -- dizziness and confusion
  - -- strong, rapid pulse
  - -- coma

COLD STRESS

Frost Bite

Frostbite is an injury resulting from exposure to cold. The extremities of the body (fingers, toes) are most often affected. The signs of Frostbite are:

- Skin turns white or grayish-yellow.

- Pain is sometimes felt early, but subsides later. Often there is no pain.

- The affected part feels intensely cold and numb.

<u>Hypothermia</u>

If site work is to be conducted during the winter, cold stress is a concern in the health and safety of the personnel. Additional insulated clothing will be provided to field personnel. Of special note for cold stress on this site is the wearing of tyvek suits. Disposable clothing does not breath; therefore, perspiration is not provided with a means of evaporation. During strenuous physical activity, an employee's clothes can become wet. Wet clothes combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40°F and an employee becomes wet, the employee must change to dry clothes. The on-site heated trailer facility or a personnel vehicle may be utilized as a change area.

Hypothermia is characterized by shivering, numbness, drowsiness, muscular weakness and a low internal body temperature when the body feels warm externally. This can lead to unconsciousness and death.

In either case (frostbite or hypothermia), seek immediate medical attention.

To present these effects from occurring, persons working in cold environments should wear adequate clothing and reduce the time spent in the cold area.

APPENDIX F

FORMS

PLAN ACCEPTANCE FORM

PROJECT HEALTH AND SAFETY PLAN

INSTRUCTIONS: This form is to be completed by each person to work on the subject project work site and returned to the Office Safety Coordinator.

Job No.: ______________________

Client/
Project: ______________________

Date: ______________________

I represent that I have read and understand the contents of the above Plan and agree to perform my work in accordance with it.

____
Signed

____
Print Name

____
Company/Office

____
Date

PLAN FEEDBACK FORM

Job Number: ______________________

Job Name: ______________________

Date: ______________________

Problems with plan requirements:

____

____

____

____

____

Unexpected situations encountered:

____

____

____

____

____

Recommendations for future revisions:

____

____

____

____

____

ACCIDENT REPORT FORM

SUPERVISOR'S REPORT OF ACCIDENT		DO NOT USE FOR MOTOR VEHICLE OR AIRCRAFT ACCIDENTS
TO	FROM TELEPHONE (include area code)	
NAME OF INJURED OR ILL EMPLOYEE		
DATE OF ACCIDENT	TIME OF ACCIDENT	EXACT LOCATION OF ACCIDENT
NARRATIVE DESCRIPTION OF ACCIDENT		
NATURE OF ILLNESS OR INJURY AND PART OF BODY INVOLVED		LOST TIME YES ☐ NO ☐
PROBABLE DISABILITY (Check One) FATAL ☐ LOST WORK DAY WITH DAYS AWAY FROM WORK ☐ LOST WORK DAY WITH DAYS OF RESTRICTED ACTIVITY ☐ NO LOST WORK DAY ☐ FIRST AID ONLY ☐		
CORRECTIVE ACTION TAKEN BY REPORTING UNIT		
CORRECTIVE ACTION WHICH REMAINS TO BE TAKEN (by whom and by when)		
NAME OF SUPERVISOR	TITLE	
SIGNATURE	DATE	

PROJECT EXPOSURE HISTORY FORM
(To Be Completed by Project Manager)

JOB NAME: ______________________________

JOB NUMBER: ______________________________

DATES FROM/TO: ______________________

D&M PERSONNEL ON SITE:

1. ______________________ 5. ______________________

2. ______________________ 6. ______________________

3. ______________________ 7. ______________________

4. ______________________ 8. ______________________

SUSPECTED CONTAMINANTS	VERIFIED CONTAMINANTS AND AIRBORNE CONCENTRATION THEREOF

DAILY INSTRUMENT CALIBRATION CHECK SHEET

INSTRUMENT: ______________________________

SERIAL # __________________________________

DATE	PURE AIR Y/N	CALIBRATION GAS (PPM)	BATTERY CHECK (GOOD/BAD)	CALIBRATED BY	REMARKS

AIR MONITORING

GENERAL INFORMATION

Name(s): ______________________ Background Level: ______________

Date: ______________________ Weather Conditions: ______________

Time: ______________________ ______________

Project: ______________________ ______________

Job No: ______________________

Estimated Wind Direction: ______________________

Estimated Wind Speed (i.e., calm, moderate, strong, etc): ______________________

Estimated Air Temperature and % Relative Humidity: ______________________

Location Where Background Level Was Obtained: ______________________

EQUIPMENT SETTINGS

HNU		EXPLOSIMETER	
Range:	______________	Alarm Trigger-%LEL :	______________
Span Pot:	______________	Alarm Trigger-%02 :	______________
Calibration GAs:	______________	Calibration GAs:	______________

FIELD ACTIVITIES

Field Activities Conducted: ______________________

____

TIME	HNU	EXPLOSIMETER %LEL	%02	DRAGER TUBE	RADIATION METER
	Equivalent			ppm-constituent	

CONTRACTOR STATEMENT OF COMPLIANCE

This is to confirm that the employees working at ______________ are qualified by virtue of training and experience to engage in field activities in connection with the Contract Agreement between Dames & Moore and _________________, dated _______________, 19___. Further, all said employees have been determined to be properly trained and medically fit to perform those field activities prescribed by said Contract and to utilize the respiratory protective equipment necessary to perform the job safely in accordance with Title 29 of the Code of Federal Regulations, Parts 1910 and 1926.

____
Authorized Contractor Representative/Date

2988A

APPENDIX I

CURRICULUM VITAE

Curriculum Vitae

BRUCE CLEMENT AMIG

Title: Project Hydrogeologist

Expertise: Site Assessments
Regulatory Interpretation

Experience with Firm:

- Prepared a work plan for an off-site hydrogeologic investigation by an industrial development in Union, New Jersey.
- Prepared a preliminary submission (siting evaluation) for a hazardous waste landfill in Pennsylvania.
- Prepared and negotiated a RCRA Facility Investigation Plan for waste disposal areas at a solvent treatment plant in Chester County, Pennsylvania.
- Sited a ground water monitoring system at seven RCRA facilities in Independence, Missouri. The facilities included surface impoundments, landfills, detonation grounds, and thermal treatment areas.
- Managed a hydrogeologic investigation, site assessment, and remedial design to address metals and solvent contamination at a manufacturing complex in Reading, Pennsylvania.
- Provided emergency response services for a fuel oil release from an underground storage tank in King of Prussia, Pennsylvania.

Past Experience: Regional Hydrogeologist, Compliance and Monitoring Section
Pennsylvania Department of Environmental Resources

- Reviewed hydrogeologic reports of accidental discharges and permitted/unpermitted municipal and industrial landfills.
- Reviewed landfill applications to determine compliance with the Municipal Waste Management Regulations.
- As Project Coordinator, assisted in writing consent order agreements, and provided oversight of all aspects of field work and environmental sampling.
- Acted as public spokesman at community meetings.
- Reviewed and assisted in development of the Municipal Waste Management Regulations, promulgated April 9, 1988.

Consulting Geologist

- Performed gas, oil, and coal property appraisals by standard reservoir engineering techniques (volumetric and decline-curve analyses with cash-flow analyses); orifice testing (open flow) of gas wells; well site geology; and gas storage field evaluations in Idaho, Wyoming, Utah, Kentucky, Tennessee, West Virginia, Illinois, and Virginia. Also performed geophysical log interpretations and prepared underground mine maps and stratigraphic correlations.

Academic Background:	M.S., Geology (1988) University of Kentucky, Lexington, Kentucky B.S., Geology (1980) Juniata College, Huntingdon, Pennsylvania
Citizenship:	United States
Language Proficiency:	English
Professional Publications:	Shepherd, R.G., Amig, B.C., et al., 1984, Genetic Identification of Disconformities: (Abstract) Annual Convention, Geological Society of America Ettensohn, F.R., Amig, B.C., et al., 1985, Paleoecology and Paleoenvironments of the Bryozoan Rich Sulphur Well, Lexington Limestone (Middle Ordovician), Central Kentucky: Southeastern Geology, Vol. 265, No. 4, pp. 199-219 Amig, B.C., 1986, Lithofacies Analysis of the Middle Carboniferous Clastics, South-Central Kentucky: Appalachian Basin Industrial Assoc., Vol. 11, pp. 33-69

0161p
7/89

Curriculum Vitae

DAVID K. COOK

TITLE: Associate

EXPERTISE: Hydrogeology
Waste Disposal Site Evaluation and Remediation
Photointerpretation

EXPERIENCE WITH FIRM: Provides hazardous and non-hazardous-waste management services to attorneys and industrial clients. Joined Dames & Moore in 1985.

- Managed more than 100 property transfer evaluations for law firm clients in New Jersey and Pennsylvania.
- Supervised ECRA and RCRA activities at the Eagle Point Refinery in Westville, New Jersey, for Coastal Corporation.
- Supervised a UST management program for Mack Trucks, Inc. in Allentown, Pennsylvania.
- Provided legal support services to major law firms in New Jersey, Pennsylvania, New York, Massachusetts, Ohio, Illinois, and Washington, D.C.
- Managed hydrogeologic investigations of the Lake View Landfill in Erie, Pennsylvania, and the Berkley Landfill in Berkley, Massachusetts, for Waste Management of North America, Inc.
- Managed the Remedial Investigation of a site in Rensselaer, New York, for Sterling Drug Co.
- Supervised a hydrogeologic investigation of the Chevron/Gulf refinery in Philadelphia, Pennsylvania, for Chevron Corporation.
- Conducted a hydrogeologic investigation of the Publicker Superfund site in Philadelphia, Pennsylvania, for Overland Corporation.
- Managed a hydrogeologic investigation at a car rental facility in Philadelphia, Pennsylvania, for Avis Rent-A-Car Systems, Inc.
- Supervised a hydrogeologic evaluation of a Superfund waste disposal lagoon in Norristown, Pennsylvania, for SmithKline Beckman.
- Provided environmental consulting services to W.R. Grace Company regarding the Woburn, Massachusetts, Superfund site ground water contamination.

PAST EXPERIENCE: Nine years' in hazardous waste management, and structural/mining geology.

Chief Geologist/Group Manager, Air Quality and Geotechnical Groups
Ecology and Environment Inc.

Technical Manager, Ecology and Environmental Drilling and Testing Co., Inc., Buffalo, New York

- o Managed evaluation of a manufacturing and degreasing facility near Hatboro, Pennsylvania, to determine the origin and nature of a perchloroethylene/trichloroethylene spill that was affecting ground water.
- o Established an asbestos sampling and analysis group that included a bulk asbestos and airborne fiber analysis laboratory. Managed numerous studies for state and local government, and conducted analyses for private clients.
- o Managed all activities at major Superfund site in Woburn, Massachusetts. Directed and participated in 15 site assessments and inspections dealing with contamination of municipal drinking water supply wells. Also designed and implemented a program to evaluate hydrogeology and ground water for a 10-square-mile area, and worked with engineers to develop remedial measures.
- o Managed activities from site inspections through completion of site clean-up at 30 gas transmission pipeline compressor stations throughout the Midwest. Included extensive evaluations of ground water, surface water, soil, and pond sediments; developing clean-up bid specifications and subsequent selection/management of subcontractors; and preparing clean-up certification documents to ensure compliance with state and federal regulations.
- o Involved in drum and tank cleaning and disposal, surface soil and sludge excavation and removal, lagoon clean-up equipment decontamination, redesign and replacement, process and fugitive dust air contamination abatement, and drainline decontamination and replacement.
- o Developed innovative procedures to predict the direction and rates of movement of hazardous substances in regions underlain by fractured bedrock.

Senior Geologist, Department of Hazardous and Toxic Wastes, Technology Division, GCA Corporation, Bedford, Massachusetts

- o Performed a comprehensive study to characterize asbestos minerals.
- o Performed engineering inspections of major mining operations (gold, silver, iron, copper, molybdenum, zinc, and other metals) across the United States.

Air Photo Interpreter, U.S. Army Engineering Topographic Laboratory
Fort Belvoir, Virginia

- o Applied remote sensing techniques to terrain analysis and geological mapping.

ACADEMIC BACKGROUND: M.A., Geological Sciences
Harvard University (1969)

B.A., Structural Geology
Rutgers University (1967)

Curriculum Vitae

RALPH T. GOLIA, P.G.

TITLE: Associate

EXPERTISE: Hydrogeology
Engineering Geology

EXPERIENCE WITH FIRM:

Mr. Golia has considerable experience in conducting and managing hydrogeologic and environmental investigations. He has evaluated hydrogeologic properties through subsurface exploration, aquifer testing, and geophysical investigations, and is experienced in the interpretation of aerial photographs.

In addition, Mr. Golia has extensive experience installing monitoring wells, sampling ground water and soil, and coordinating sampling programs for a wide variety of analytical parameters in accordance with stringent QA/QC procedures. He has designed numerous field investigations and has trained personnel in conventional field techniques. Mr. Golia has counseled clients with respect to regulatory compliance and has routinely interacted and negotiated with state and federal agencies on many projects.

Mr. Golia's participation in specific projects since he joined Dames & Moore in 1984 are presented below.

- Project Director/Manager on a hydrogeologic characterization and ground water quality assessment for a RCRA Part B Permit Modification for a landfill and land treatment area. Work included upgrading the existing monitoring well system to meet state standards, characterizing hazardous and non-hazardous waste disposed of at the site, and developing a statistical analysis, ACLs, and a corrective action plan.

- Project Director for a hydrogeologic investigation at a solvent packaging facility. Work included the installation of an extensive ground water monitoring well network to define the vertical and horizontal extent of TCE and toluene ground water contamination plumes in a karst limestone area. Interim correction measures were employed at the completion of the Phase I investigation. Subsequent phases defined the plumes for ultimate remediation.

- Project Director for a RCRA Corrective Action Permit at a petroleum refinery. Work included the identification and background information survey of several Solid Waste Management Units (SWMUs) and the preparation of work plans and implementation of; Verification of Release studies (VORs), RCRA Facility Investigations (RFIs) and Corrective Measures Studies (CMSs) in accordance with EPA guidelines.

- Project Director/Manager for an extensive environmental assessment at an oil refinery in Philadelphia, Pennsylvania. Work included the installation of 102 shallow monitoring wells, 6 deep monitoring wells, and the excavation of numerous test pits. The purpose of the investigation was to evaluate stratigraphy and hydrogeologic conditions at the site, including hydraulic gradients, ground water flow rates and direction, and product thickness and distribution. Conceptual alternative methods for free-product recovery were subsequently identified. In addition, a soil characterization study was conducted at tetraethyl lead disposal sites and other waste disposal sites.

- Project Director/Manager on an environmental assessment of a large manufacturing plant. Work included evaluation of previous environmental studies, including closure of a RCRA-regulated facility, evaluation of ground water and soil contamination, assessment of aerial and ground reconnaissance, and development of remedial alternatives. Remedial actions were implemented, and decontaminated approximately 2,000 tons of volatile organic-contaminated soil on-site.

- Project Manager and Principal Investigator for an investigation of TCE ground water contamination affecting ground water supply wells at a large manufacturing facility, and remediation of on-site dry wells. Responsibilities included program planning and coordination with NJDEP, project management, monitoring well installation and sampling, source identification, aquifer testing, design of remedial measures, and selection and supervision of subcontractors.

- Project Manager and Principal Investigator for a ground water contamination investigation and ground water recovery system design. Work included monitoring well installation, ground water sampling, source evaluation, and pumping tests. The proposed ground water recovery system was submitted and approved by state authorities. Subsequent work involved monitoring and documentation of the system's performance.

- Project Manager and Principal Investigator for a subsurface investigation at an abandoned gasoline station in Texas. Work included the installation of a ground water and vadose zone monitoring system to define the extent of floating free-phase product and to evaluate potential health and safety risk associated with future use of the site. Based upon hydrogeologic conditions at the site, a recommended method for product removal was presented to the state and subsequently implemented.

- Project Manager and Assistant Investigator for an environmental impact assessment of a proposed sanitary landfill in Rockaway, New Jersey. Work included research of existing related studies in the area, and preparing a report that reviewed potential impacts to ground water and surface water associated with potential leachate release.

- Project Manager and Principal Investigator for state-wide environmental assessments at railroad locomotive terminals in New Jersey. Work included site reconnaissance, surface soil sampling, and preparation of a report addressing areas of noncompliance with federal, state, and local regulations. Also provided recommendations to minimize the potential for future contamination and to comply with violated regulations.

- o Project Manager for review and assessment of an Environmental Cleanup Responsibility Act (ECRA) submission for a refinery in Westville, New Jersey. Work included delegation to and compilation of comments regarding various aspects of the submission and a proposed cleanup plan for ground water and soil contamination.

- o Project Manager and Principal Investigator for New Jersey Pollutant Discharge Elimination System (NJPDES) permitting to ground water for a new surface impoundment and closure for an existing surface impoundment in Cranberry, New Jersey. Work included characterization of impounded sludge, installation of a ground water monitoring system, and performance of quarterly sampling to establish background information.

- o Project Manager and Principal Investigator for an investigation of PCB and petroleum hydrocarbon contamination of soil and ground water at several D.C. substations. Work included developing a sampling plan, analyzing data, and preparing a cleanup plan and cost estimate.

- o Principal Investigator for a ground water contamination study at a site located near a TCE-contaminated municipal water supply. Work included evaluating the effect of nearby municipal water withdrawal on ground water flow conditions beneath the site. Also, a leaking underground solvent tank was investigated as a potential source of ground water contamination at the site.

PAST EXPERIENCE: Three and one-half years of experience in geology and engineering geology.

Staff Engineering Geologist, Applied Earth Consultants, Inc. San Jose, California

- o Assistant Investigator of a ground water contamination investigation in northern California. Assisted in determining stratigraphy and the relation to possible leakage between confined and water table aquifers. Also assisted in pumping tests and analysis of pumping test data to determine extent and migration direction of the plume.

- o Project Manager and field geologist for a soil stratigraphy investigation for archaeological purposes in San Jose, California. Work involved analysis of pedogenic development, age estimates, and paleo-occupation potential.

- o Project Manager and Principal Investigator for an engineering geologic review of proposed borrow site operations in northern California. Work included the development of recommendations to minimize environmental impact of the operations.

- o Project Manager and field geologist of several geologic and geotechnical soil and foundation investigations involving both residential and commercial sites.

Geologist, U.S. Geological Survey, Menlo Park, California

- o Published geologic several papers pertaining to areas in Nevada, California, and Oregon.

ACADEMIC BACKGROUND: M.S. (1983), Geology, California State University, San Jose
B.S. (1980), Geology, Southampton College of Long Island University

CITIZENSHIP: United States

COUNTRIES WORKED IN: United States

LANGUAGE PROFICIENCY: English

PROFESSIONAL AFFILIATION: Association of Ground Water Scientists and Engineers

PROFESSIONAL REGISTRATIONS: Registered Professional Geologist No. 289, State of South Carolina
Registered Environmental Assessor No. 00297, State of California

PUBLICATIONS: Author of several papers in geology. List available upon request.

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7/89

Curriculum Vitae

JOHN F. KEARNS

TITLE: Associate

EXPERTISE: Environmental Chemistry
Quality Assurance

EXPERIENCE WITH FIRM:

Mr. Kearns plans and coordinates the activities of field and office personnel in support of current requirements and programs under RCRA and CERCLA, and real estate transfer assessments and underground storage tank management. He is responsible for reviewing in-house and subcontracted work products; he validates and interprets analytical data submitted by contracted laboratories, and critiques field procedures. He also develops and implements in-house QA programs, and manages client liaison.

PREVIOUS EXPERIENCE:

During previous engagements, Mr. Kearns acquired in-depth knowledge of laboratory instrumentation and methods. He developed and taught seminars covering such topics as laboratory selection, environmental regulations, analytical protocols, data quality assessment, and laboratory data interpretation. He became familiar with method development and validation procedures for analysis of speciality chemicals and the registration/reregistration procedures of pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). He also gained experience related to the Clean Water Act and Clean Air Act. Mr. Kearns' previous experience includes service with the following:

Biospherics Inc., Laboratory Division, Beltsville, MD
Compuchem Laboratories, Inc., Research Triangle Park, NC
Capital District Regional Planning Commission, Albany, NY

- Provided consultation to support the development and/or review of field and laboratory work plans for CERCLA and RCRA remedial investigations at sites nationwide, at the federal and state levels.
- Coordinated laboratory services related to all federal laws and regulations in support of industrial and engineering clients. Gained familiarity with state regulations in EPA Regions II, III, IV and VI.
- Served as Project Director for a RCRA Facility Investigation (RFI) at a steel mill in Pennsylvania.

- Served as Quality Assurance Officer for multiple RI/FS projects and RFIs in EPA Regions II and III.
- Conducted laboratory comparison and selection studies for two major industrial concerns.
- Participated in the design and management of an analytical program for the analysis of polynuclear aromatic compounds (PACs) using both HPLC and GCMS technology. Very low levels of PACs were identified and quantified using a modified GC/MS drinking water method (S24.2).
- Participated in field analytical testing and permit research related to NPDES enforcement.
- Acted in the capacity of team leader for quality enhancement at a major computer manufacturing firm. Included implementation of a zero-defects program, and worked on the software design and development team for the firm's $8-million robotic factory.
- Conducted numerous laboratory audits to ensure analytical quality, cost-effectiveness, and appropriate levels of service. Audits included review of laboratory experience, personnel, quality assurance plans and procedures, standard operating procedures, work loads and capacity, and on-site inspection.
- Conducted a recreational land use study and plan of the city of Amsterdam, New York, using remote sensing techniques.
- Conducted a residential land use study for the Capital District Regional Planning Commission, Albany, New York.

ACADEMIC BACKGROUND:	B.S., Environmental Science State University of New York at Albany (1976)
CITIZENSHIP:	United States
COUNTRIES WORKED IN:	United States
LANGUAGE PROFICIENCY:	English
PROFESSIONAL AFFILIATIONS:	American Chemical Society (Environmental and Agricultural Chemistry Sections)

0257p
12/89

Curriculum Vitae

DONALD J. SUPKOW, Ph.D.

TITLE: Senior Hydrologist

EXPERTISE:

Geology
Ground Water Hydrology
RCRA Monitoring and Closure

PROFESSIONAL SUMMARY:

Nationwide and international project experience related to ground water hydrology, ground water contamination, potable water resources, and RCRA and CERCLA projects.

EXPERIENCE WITH FIRM:

- Consultant to the Superior Court of New Jersey regarding ground water contamination and remediation at a site in Middlesex County, New Jersey. The project involved heavy metals and solvent contamination of a major aquifer that supplied potable water to the town of Perth Amboy. The study also addressed contamination in soil and stream sediments.

- Principal ground water investigator for Getty Oil during hydrogeologic investigations for an industrial waste landfill, a land treatment facility for refinery sludges, and a fly ash disposal site.

- Principal ground water investigator for various ground water resources studies and ground water contamination prevention/remediation studies in New Jersey, New York, Delaware, Illinois, and other states. Investigations included landfill leachates, spray irrigation of treated waste water, and ground water contamination/remediation investigations.

- Senior site hydrologist during excavation and dewatering for construction of the Hope Creek Nuclear Generating Station. Supervised field activities, site monitoring, and quality control.

- Technical reviewer for the Burnt Fly Bog NPL site in Monmouth County, New Jersey.

- Principal investigator during water resource evaluations for two SANG city sites in Saudi Arabia.

- Principal ground water investigator for water supply studies in Jordan.

- Prepared RCRA monitoring plans for waste management facilities in Delaware, Texas, New Jersey, and Illinois.

PREVIOUS EXPERIENCE:

Senior Hydrologist and Director of Research Hydrogeologic Investigations, Hydrotechnics, Albuquerque, New Mexico

- o Used geothermic techniques at the Tarbela Dam site in Pakistan to locate zones of high transmissivity and the age of ground water in the reservoir area.
- o Conducted a water resources survey in Equador by applying geothermic techniques.
- o Performed hydrologic investigations to assess water resources for the government of Mexico.
- o Performed hydrologic investigations to assess water resources in Mali, Africa.
- o Conducted a monitoring program to assess the migration of leachate from a uranium tailings disposal in New Mexico.
- o Conducted an extensive study of ground water hydrology in the Tuscon Basin, Arizona. Developed geothermic techniques to analyze ground water flow systems based upon temperature and heat flow measurements made at and below the land surface in saturated and unsaturated zones.

ACADEMIC BACKGROUND:

B.A., Geology
Rutgers University, 1958

M.S., Geology
University of Maine, 1965

Ph.D., Hydrology
University of Arizona, 1971

PROFESSIONAL REGISTRATION:

Registered Professional Geologist, Arizona and Delaware

PROFESSIONAL AFFILIATIONS:

American Association for the Advancement of Science
Arizona Academy of Sciences

PROFESSIONAL PUBLICATIONS:

Several technical papers in the field of geohydrology. List available upon request.

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10/89

Curriculum Vitae

THOMAS E. WHITMAN

TITLE: Staff Environmental Scientist

EXPERTISE: Environmental Site Assessments/Audits
Environmental Compliance Programs
Asbestos Management

EXPERIENCE WITH FIRM: Two years' experience as an Environmental Scientist. Responsibilities include performance of environmental audits and assessments for property transactions. Also serves as Office Health & Safety Coordinator.

- Performed numerous site assessments in the eastern United States for Ford Motor Company. Key issues included in the assessment program included:
  - Location and identification of underground storage tanks
  - Hazardous waste handling, storage, and disposal practices
  - Waste oil handling and disposal practices
  - Identification of asbestos-containing material
  - Spill prevention and control procedures for aboveground storage tanks
  - Sludge and solid waste disposal practices
  - Location and identification of PCB-bearing electrical transformers

- Performed an environmental assessment and compliance audit for the proposed Penn's Landing development project in Philadelphia, Pennsylvania. Key compliance issues included:
  - Sanitary waste disposal practices for vessels ported at Penn's Landing
  - Electrical transformers containing PCBs
  - Underground storage tank inventory procedures
  - Wetland and floodplain delineation
  - Waste oil handling and disposal practices

- Performed several pre-purchase environmental evaluations/site assessments for real estate developers and property mortgagors, including:
  - Auto Spa/Auto Care Centers, Atlanta, GA
  - Deer Valley Airport Center, Phoenix, AZ
  - Office and apartment complexes, Baton Rouge, LA
  - Thomas & Betts manufacturing facility in Doylestown, PA
  - Thrift Drug retail warehouse, Langhorne, PA
  - Devon Apparel, Philadelphia, PA

- Performed multiple pre-purchase site assessments in western Pennsylvania for a commercial real estate developer, including the identification of a potential NPL site.

- Developed an ECRA sampling plan for an Inductotherm Industries facility in Pleasantville, New Jersey.

- Installed and sampled ground water monitoring wells at a J.C. Penney facility in Wayne, New Jersey, and at a construction site in Conshohocken, Pennsylvania.

- Conducted ground water well monitoring, sample collection, and field analysis at a petroleum refinery in Delaware.

- Performed soil sampling and field analysis for underground storage tank management at a Mobil service station in Kulpsville, Pennsylvania.

- Conducted quarterly well monitoring and sampling at a General Electric facility in Durham, North Carolina.

- Assisted in developing asbestos remediation specifications for the IBM Building in Philadelphia, Pennsylvania.

- Managed asbestos abatement monitoring activities at the former Regency Theater in Philadelphia, Pennsylvania.

- Conducted asbestos inspection surveys at residential, commercial, and industrial facilities, including:

  - Apartment complexes, Baton Rouge, LA
  - Hall's Plaza Shopping Center, Knoxville, TN
  - Industrial printing facility, Lancaster, PA

- Serves as Office Health & Safety Coordinator responsible for employee medical monitoring. Also develops site-specific Health and Safety Plans that specify air monitoring equipment necessary for the evaluation of personal and public exposure to toxic and hazardous substances.

EDUCATIONAL BACKGROUND: B.A., Geoenvironmental Studies
Shippensburg University, Pennsylvania (1987)

Asbestos Supervisors Handling Course
National Asbestos Training Institute, NJ

CITIZENSHIP: United States

COUNTRIES WORKED IN: United States

LANGUAGE PROFICIENCY: English and German

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7/89