FINAL

REMEDIAL INVESTIGATION REPORT

VOLUME 2B OF 2

CHEM-DYNE SITE

HAMILTON, OHIO

WA 21.5M10.0

W65310.C0

May 22, 1984

FINAL
Remedial Investigation Report
Volume 2B of 2
Chem-Dyne Site
Hamilton, Ohio
WA 21.5M10.0
W65310.C0

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GLT460/85

MEMORANDUM

TO: File

FROM: Brad J. Berggren/GLO

DATE: January 9, 1984

SUBJECT: Chem-Dyne Site Remedial Investigation
Phase III Hydrogeologic Investigation; Groundwater Monitoring Wells and Pumping Well Installation, Subtask 3-3.1 and Subtask 3-3.2

JOB NO: W65310.C0

INTRODUCTION

This memorandum summarizes the Phase III Hydrogeologic Investigation activities conducted to install seven offsite groundwater monitoring wells and an onsite pumping well at the Chem-Dyne site in Hamilton, Ohio. The offsite installation of seven groundwater monitoring wells was performed from September 9 through October 18, 1983, by Bowser-Morner, Inc. The onsite pumping well installation was performed from September 15 through October 8, 1983, by GMC Associates, Inc. Well installation inspection services were provided by personnel from CH2M HILL and Barr Engineering, Co. Support equipment, support personnel, drilling containment pad, and decontamination facilities were provided by O.H. Materials. All drilling, inspection, and support services were conducted under subcontract to CH2M HILL. This work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 21.5M10.0.

PURPOSE

The purpose of the Phase III well installation effort was twofold: first, to install a large diameter pumping well which would allow hydraulic testing of the aquifer system at the site, and second, to install additional groundwater monitoring wells. The additional groundwater monitoring wells supplement the previously existing network of monitoring wells and allow greater definition of the vertical and horizontal extent and movement of groundwater contamination.

The general scope and timing of this effort were determined by U.S. EPA personnel with recommendations by CH2M HILL. Joseph Keely, U.S. EPA groundwater specialist, was closely

involved in all planning related to this phase of well installation, including specification of drilling and well installation methods and selection of well locations and depths. Specific well locations and depths were reviewed with U.S. EPA and OEPA personnel prior to initiating the field work.

SCOPE

The scope for the well installation portion of the Phase III Hydrogeologic Investigation included the following:

- Procurement of well drilling contractors able to perform under levels 'B','C', and 'D' personal protection.
- Installation of seven offsite groundwater monitoring wells ranging from 40 to 100 feet in depth.
- Installation of a large diameter pumping well onsite to a depth of 80 feet.
- Design and construction of a drilling containment pan to insure containment of contaminated groundwater and soil generated during the offsite drilling activities.
- Erection of storage pools for containment of 25,000 gallons of contaminated groundwater generated during development of the onsite pumping well.

PERSONNEL

CH2M HILL

Larry A. Holm, Project Manager/GLO
Brad J. Berggren, Project Engineer/GLO

Barr Engineering Co.

Wesly Olson, Inspector
Bonnie Rohr, Inspector

O.H. Materials

Steve Brigner, Foreman
Charles Rucker

Bowser-Morner, Inc.

Joseph A. Pappert, Drilling Foreman

Mike Bish, Driller
Harvey Neal, Driller's Helper

GMC Associates, Inc.

Paul Velin, Project Supervisor
Dan Marion, Health and Safety Officer
Everett Wheeler, Driller
Bob Meyers, Driller's Helper
Doug Jones, Pump Operator

WELL INSTALLATION

OFFSITE GROUNDWATER MONITORING WELLS

Well Locations

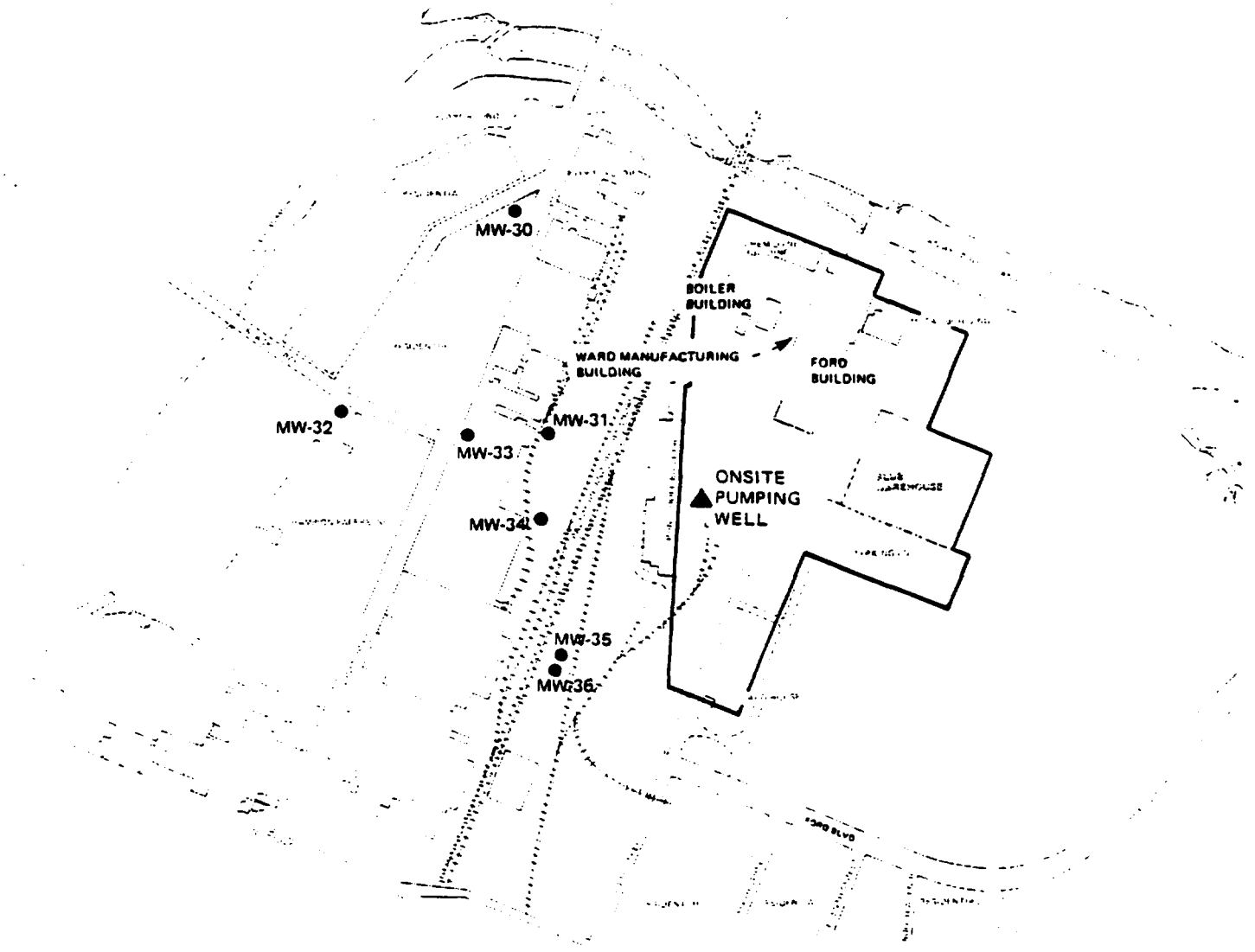
Seven groundwater monitoring wells were positioned to supplement the previously existing network of monitoring wells and allow greater definition of the vertical and horizontal extent and movement of groundwater contamination from the site.

Three primary considerations influenced the selecting of positions for the monitoring wells. First, the well installation effort concentrated on areas of apparent or potential groundwater contamination based upon laboratory analysis results obtained from groundwater samples taken in April 1983. Second, monitoring wells were positioned to correspond with the informational objectives (i.e., measurement of induced aquifer stress due to onsite pumping and evaluation of anisotropy among aquifer hydraulic properties) for the hydraulic testing of the aquifer system. Third, the practical feasibility of installation was considered in positioning the monitoring wells; industrial buildings, residential homes, and coal stock piles were major obstacles affecting the selection of well locations. Figure 1 presents the location of the seven offsite groundwater monitoring well installed during the Phase III effort. The number, general location and depth of the monitoring wells installed were determined by U.S. EPA personnel with recommendations by CH2M HILL.

Equipment and Materials

Air rotary drilling, temporary casing installation, and well casing and screen installation were performed using a Davey M-7 drill rig. Temporary steel casing was driven using a 3,000-pound pneumatic hammer.

Monitoring wells were constructed using threaded 4-inch diameter stainless steel well casing and stainless steel wire wound, No. 10 slot size well screen.



LEGEND

HAZARDOUS WASTE SITE BOUNDARIES

MONITORING WELL INSTALLATION

ONSITE WELL FOR AQUIFER TESTING

N

0 500 1000

SCALE IN FEET

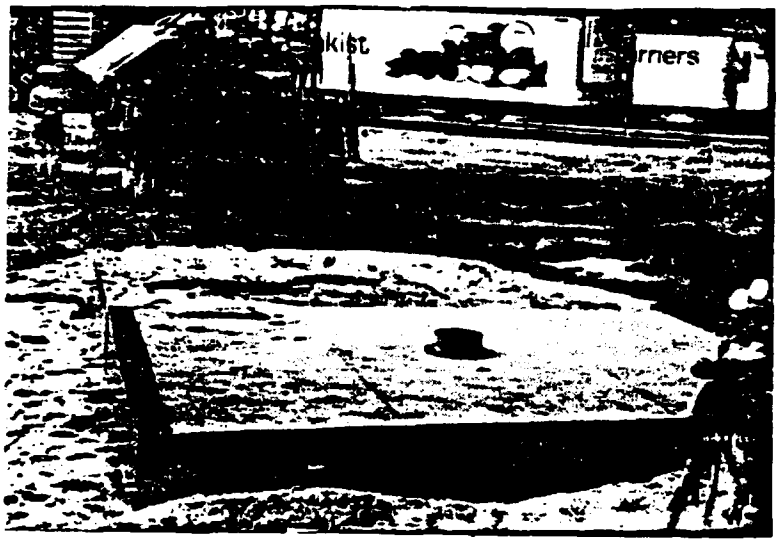
FIGURE 1
PHASE III HYDROGEOLOGICAL INVESTIGATION
INSTALLED GROUNDWATER MONITORING
WELL LOCATIONS

To avoid potential public exposure and contamination of offsite locations, contaminated groundwater and soil were contained in a specially designed and constructed drilling containment pan. The drilling containment pan, shown in Figure 2, consisted of a 15-foot square steel pan with side panels approximately 1 foot in height. Within the pan were placed a pool liner, a layer of geotextile, a PVC pipe drainage system, and gravel fill. The pool liner provided containment of groundwater generated during the drilling activities. The geotextile protected the liner against tear and punctures. The 2-inch slotted PVC pipe drainage system, set within the gravel fill, allowed removal of the fluids generated during drilling. Fluid removal was accomplished by connecting a vacuum pump to the drainage system outlet and discharging into a mobile tank. The collected fluid was then transported back to the site and treated using the available onsite treatment system by O.H. Materials. Upon completion of each well installation, soil cuttings and gravel fill were removed from the pan and stored onsite for future disposal. Disposal of contaminated soil cuttings, gravel fill, pool liners, and geotextile was handled by O.H. Materials.

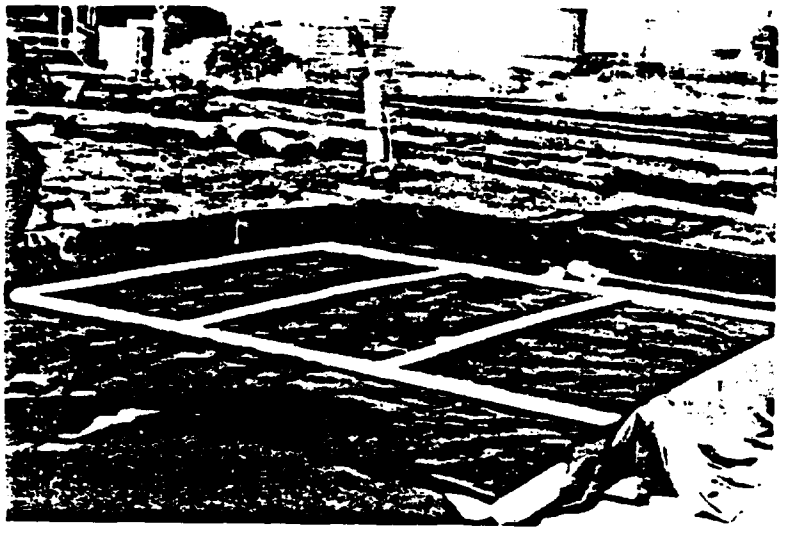
Well Installation Procedure

Prior to drilling, a small pit approximately 2 cubic feet in size was excavated over each well location using a backhoe and filled with a bentonite clay gel. The drilling containment pan was then positioned over the pit with a circular flanged section, approximately 12 inches in diameter and extending 14 inches below the bottom of the drilling pan, seated in the bentonite gel. The rear portion of the drill rig was positioned on the drilling containment pan and drilling proceeded downward through the circular flanged section in the pan. Temporary casing, 6 inches in diameter, was driven in 5- or 10-foot intervals followed by cleaning out of the casing using air rotary techniques. The 6-inch temporary casing was advanced to the well placement depth.

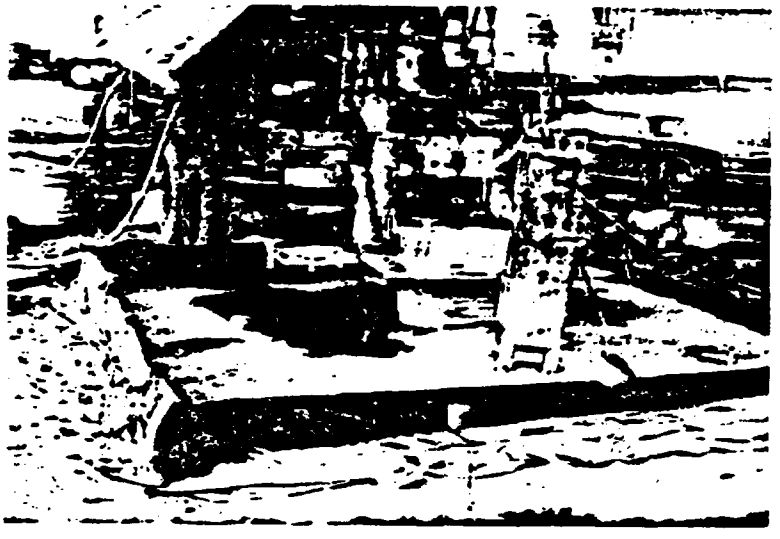
At locations where placement of the well, was anticipated below 40 feet, 8-inch diameter temporary casing was driven initially. The 8-inch temporary casing was to be sealed in a clay layer reported by previous well installation efforts at depths between 45 and 55 feet. The clay layer was encountered only in the boring for monitoring well MW-32 and the 8-inch temporary casing was sealed. In situations where 8-inch temporary casing was advanced initially, the 6-inch temporary casing was advanced to the well placement depth by telescoping through the larger temporary casing. Well screen and casing were installed within the 6-inch temporary casing. The 6-inch temporary casing was withdrawn to expose the screened well section and sand pack installed.



DRILLING CONTAINMENT PAN PRIOR TO PLACEMENT OF LINER, GEOTEXTILE, DRAINAGE SYSTEM, AND GRAVEL FILL.



DRILLING CONTAINMENT PAN PRIOR TO PLACEMENT OF GRAVEL FILL.



DRILLING CONTAINMENT PAN DURING DRILLING OPERATION.

FIGURE 2
PHASE III HYDROGEOLOGICAL INVESTIGATION - DRILLING CONTAINMENT PAN
CHEM - DYNE SITE

Following placement of a bentonite seal and addition of a cement grout seal, temporary casing was withdrawn.

To complete the well installation, the drilling containment pan was removed and a locking protective cap and concrete pad with steel guard posts placed around the well. Figures 3 and 4 present a summary of the offsite monitoring well construction. Boring logs from the installation of the seven offsite monitoring wells are presented in Appendix A.

Development of the new offsite groundwater monitoring wells was accomplished by air lift techniques. The air lift technique involved forcing air through a venturi type device attached to PVC tubing. The reduced pressure near the venturi portion of the device allowed groundwater and sediment to enter the air stream contained in the tubing. This development water was then carried along with the air stream to the ground surface. This development technique efficiently removed groundwater and sediment without direct introduction of air or water into the monitoring well and surrounding aquifer. Development water was contained in drums, transported to the site, and treated using the onsite treatment system provided by O.H. Materials.

Decontamination

Decontamination procedures included steps to avoid contaminating the monitoring zone of the aquifer system and to eliminate carry over of contamination from one monitoring well location to another. The primary steps used were as follows:

- Steam cleaning of the drilling rig and equipment prior to initiation of field work.
- Decontamination of the drill rig, drilling equipment, and temporary casing between each monitoring well installation using a high-pressure water wash provided by O.H. Materials.
- Drilling and well installation procedures (e.g., casing, sealing, and telescoping casing) to avoid contamination of lower monitoring zones by material from overlying zones.
- Removal of generated groundwater and soil and the replacement of gravel fill within the drilling containment pan between each monitoring well installation.
- Decontamination of the well casing and screen. The procedure for decontamination of the well casing and screen consisted of an acetone wash

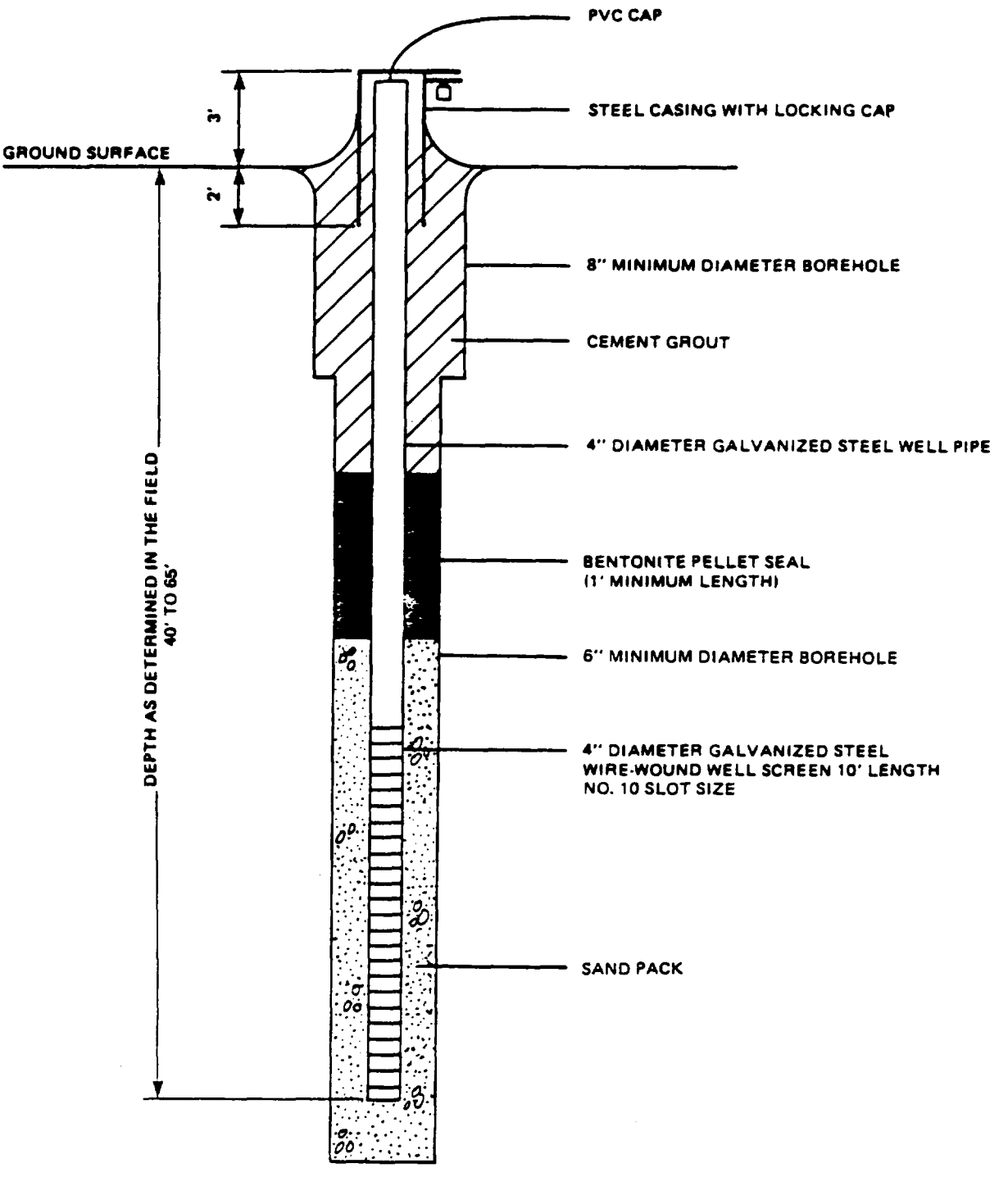


FIGURE 3
PHASE III HYDROGEOLOGICAL SHALLOW AND INTERMEDIATE MONITORING WELL CONSTRUCTION
CHEM - DYNE

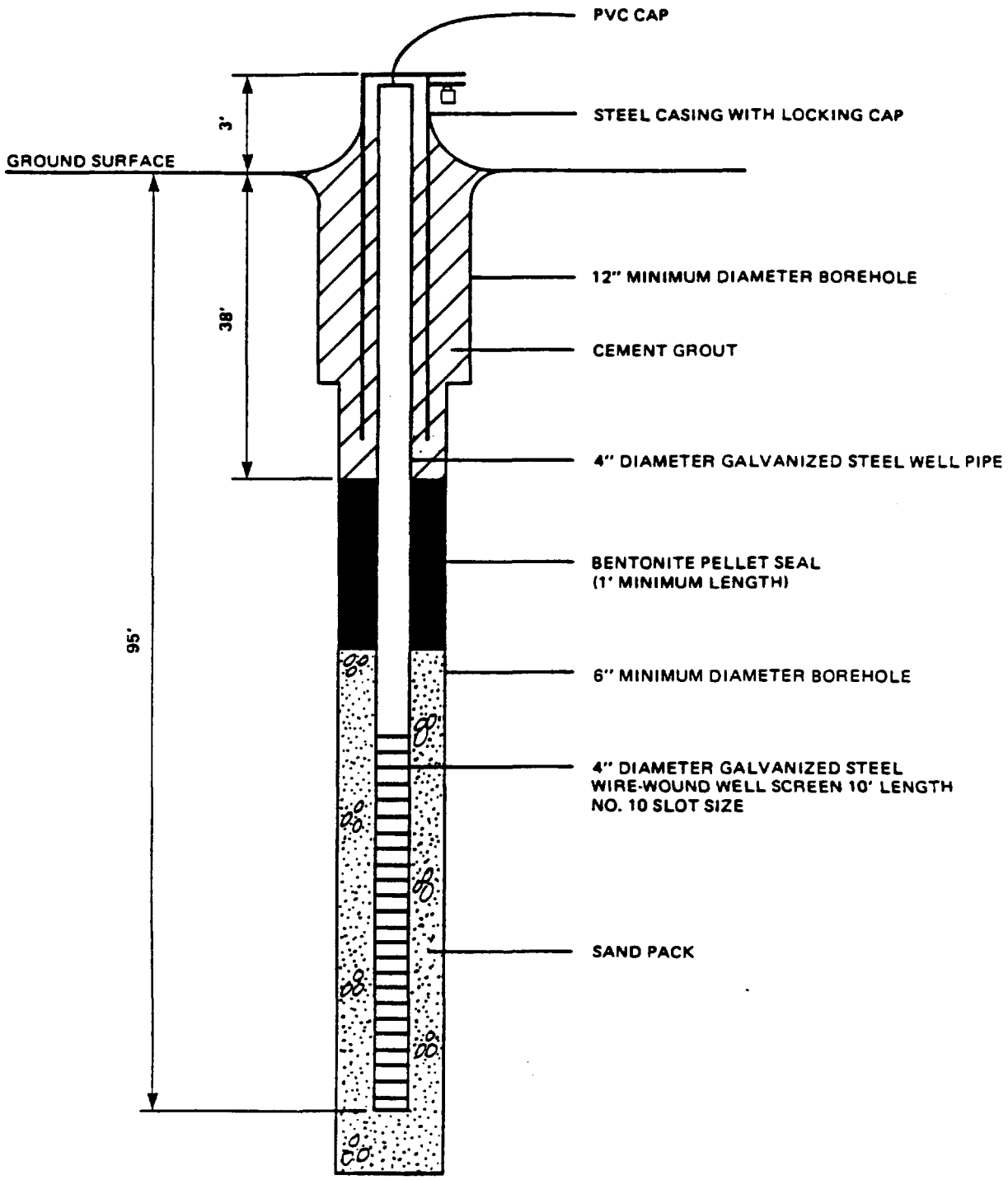


FIGURE 4
PHASE III HYDROGEOLOGICAL DEEP MONITORING WELL CONSTRUCTION
CHEM - DYNE SITE

followed by a high-pressure water rinse. Following decontamination, well casing and screen were either wrapped in or placed on plastic sheeting until installed.

Monitoring Well Installation Observations

Significant observations noted during the offsite monitoring well installation activities included the following:

- During installation and development of monitoring wells MW-31 and MW-34 groundwater was generated which possessed a strong distinctive odor. The odor was identical to the characteristic odor associated with groundwater obtained from monitoring wells shown to be contaminated by previous chemical analysis.

- During drilling and installation of monitoring well MW-33, no odor was detected from the generated groundwater. However, during development of MW-33 the same strong distinctive odor noted in groundwater derived from monitoring wells MW-31 and MW-34 was detected.

- Prior to installation of monitoring well MW-34 at the current location, an installation was attempted and abandoned approximately 20 feet to the south. Drilling at the abandoned location generated significantly less groundwater compared to the current location and the water generated was odorless.

- During well installation and development activities with strong odors associated, none of the air quality measurements obtained using the HNu Model 101 portable analyzer equipped with a 10.2 eV probe exceeded background values.

ONSITE PUMPING WELL

Well Location

Consideration of two primary factors influenced the location of the pumping well. First, to minimize the potential for public exposure to the large quantities of contaminated groundwater generated during hydraulic testing of the aquifer system, the pumping well was placed onsite. Second, the pumping well was positioned onsite to maximize the potential for obtaining useful information (i.e., influence as many monitoring wells as possible and allow construction of as many vertical cross sections of the drawdown water table as possible) from the monitoring well network

concerning the hydraulic properties of the aquifer system at the site. The position of the onsite pumping well was determined by U.S. EPA personnel with recommendations from CH2M HILL. The location of the onsite pumping well is shown in Figure 1.

Equipment and Materials

The drilling, temporary casing installation, and well piping and casing installation were performed using a 71 Speed Star cable tool drill rig.

The well was constructed using 12-inch inside diameter steel well casing and steel wire wound, No. 60 slot size well screen.

Well Installation

Drilling for installation of the onsite pumping well was performed using cable tool techniques. The potential existence of a clay confining layer within the aquifer system at the site, necessitated the installation of 20-inch diameter temporary casing to a depth of 43 feet. The clay was not encountered and 18-inch diameter temporary casing was telescoped inside the larger temporary casing to a depth of 80 feet. Inside the 18-inch temporary casing, 12-inch diameter steel well screen and casing were placed, with the aquifer screened from 80 to 40 feet. Gravel pack was added to within 25 feet of the surface and the 18-inch diameter temporary casing withdrawn. After removing the temporary casing additional gravel pack was added, a bentonite seal was placed, and the remaining annular space to the surface was filled with a cement grout seal. Following hydraulic testing of the aquifer at the site, a locking protective cover was placed on the pumping well to insure security and a concrete pad with guard posts installed. A summary of the onsite pumping well construction in presented in Figure 5.

Development of the onsite pumping well was accomplished by overpumping. The well was pumped at flow rates up to approximately 1,100 gpm and the water generated was stored in pools erected by O.H. Materials. The 25,000 gallons of development water were later discharged with water generated during hydraulic testing of the aquifer system.

Decontamination

Decontamination procedures included steps to avoid or minimize contamination of lower aquifer zones by material from overlying zones. The primary steps used to avoid or minimize contamination were as follows:

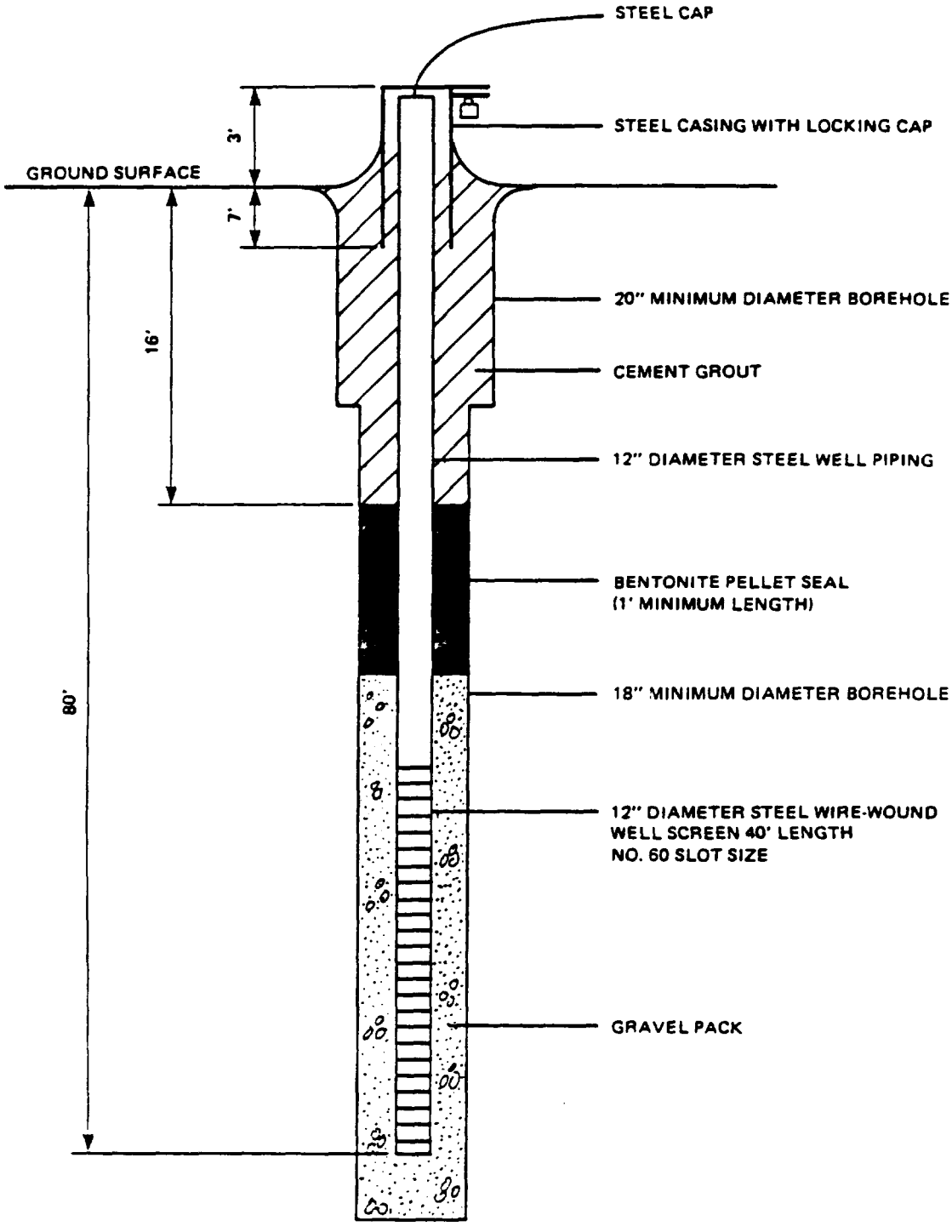


FIGURE 5
PHASE III HYDROGEOLOGICAL PUMPING WELL CONSTRUCTION
CHEM - DYNE

- The drilling rig and equipment were steam cleaned prior to going onsite.
- Temporary casing was steam cleaned prior to going onsite.
- Well pipe and screen were steam cleaned prior to going onsite and then covered with plastic sheeting until installed.
- Drilling and well installation procedures (e.g., casing, sealing, and telescoping casing) to avoid contamination of lower aquifer zones.

CHRONOLOGY

The following chronology summarizes the major activities and events of each week of the Phase III well installation effort at Chem-Dyne (both onsite and offsite) from August 29 through October 18.

August 29 - September 4

- Preconstruction meeting with representatives from Bowser-Morner
- Design and construction of drilling containment pad

September 5 - September 11

- Bowser-Morner mobilization for offsite well installation
- Groundwater monitoring well MW-34 begun
- Preconstruction meeting with GMC Associates
- Health and safety training of drillers for onsite well installation

September 12 - September 18

- Groundwater monitoring well MW-34 installed
- Groundwater monitoring well MW-31 begun
- Moody's of Dayton mobilization for onsite well installation
- Meeting of personnel from CH2M HILL, U.S. EPA, and Ohio EPA regarding details of onsite well installation

- Drilling started for installation of onsite pumping well

September 19 - September 25

- Groundwater monitoring well MW-31 installed
- Groundwater monitoring well MW-30 installed
- Groundwater monitoring well MW-36 installed
- Groundwater monitoring well MW-35 begun
- Installation of 43 feet of 20-inch diameter temporary casing and 60 feet of 18-inch diameter temporary casing installed onsite

September 26 - October 2

- Groundwater monitoring well MW-36 installed
- Groundwater monitoring well MW-33 begun
- Onsite pumping well screen and casing placed along with gravel pack. The 18-inch diameter temporary casing was removed from the onsite well.

October 3 - October 9

- Groundwater monitoring well MW-33 installed
- Groundwater monitoring well MW-32 begun
- Onsite pumping well installed and developed. Storage pools erected by O.H. Materials to contain the 25,000 gallons of contaminated development water.
- HNu readings of up to 15 ppm recorded during discharge of onsite development water into storage pools
- Sampled and analyzed development water for evaluation of disposal alternatives.
- GMC Associates demobilized drill rig and support vehicles

October 10 - October 16

- Groundwater monitoring well MW-32 installed

- Monitoring wells offsite developed and concrete pads placed

October 17 - October 23

- Bowser-Morner demobilized drill rig

GLT460/28

APPENDIX A

CHEM-DYNE SITE
SOIL BORING LOGS

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-30	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-22-83 FINISH 9-23-83 LOGGER B. ROHR

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	Q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-30' **Silty Gravel (Fill)**, light yellowish brown, dry 30-40' **Silty Gravel**, grayish brown, moist			After cleaning the hole to 40' it took several minutes for water to begin flowing. Hole yielded water well. No odor to water. 4" diameter galvanized steel casing installed to 30'. Galvanized screen installed from 30 to 40'.

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-31	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-14-83 FINISH 9-21-83 LOGGER B. ROHR

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	Q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-19' **Silty Sand**, medium sand with some fine gravel, dark brown to black, dry **19-30'** **Silty Sandy Gravel**, few cobbles, light brown to yellowish brown, dry **30-40'** **Gravel**, coarse gravel with cobbles, grayish			No HNU readings above background. Temporary casing driven easily until gravel and cobble zone at 30' or 32'. Water table at approximately 32' (measured 9-15-83). Water has Chem-Dyne contaminated odor, but no HNU readings above background. When pulled temporary casing lost 15'. The hole was abandoned and started new hole approximately 10' north. Same stratigraphy. Installed 30' of 4" galvanized steel casing and 10' of galvanized screen.
	10								
	20								
	30								
	40								
	50								

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-32	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 10-7-83 FINISH 10-13-83 LOGGER B. ROHR

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-14' **Silty Sand**, sand fine to coarse grained, some clay, sticky, moist, dark brown to black			Rig bounces some at 10' - 15'.
						14-45-1/2' **Silty Sandy Gravel**, brown			8" casing drives with difficulty from 20' - 30' casing did not drive plumb for last 10'.
	20					45-1/2-48-1/2' **Silty Clay-Clay**, some small gravel, gray, plastic, soft to stiff, moist	20		8" casing does not drive by 35'.
						48-1/2-49-1/2' **Clayey Silt**, yellowish brown			Pressure test on casing in clay.
						49-1/2-60' **Sandy Gravel**, coarse grained, well rounded, some cemetation, increasing sand content with depth			20 psi - 09:12 13 psi - 09:18
						60-70' **Gravel**, very coarse, with cobbles, some brown silt			Drove casing 7" to 8" additional (at 47-1/2')
	40					70-98' **Sandy Gravel**, yellowish brown fines	40		20 psi - 10:09 18 psi - 10:10 18 psi - 10:11 17 psi - 10:12 16 psi - 10:13 16 psi - 10:14
						98-100' **Clayey Gravel**, fine sand, reddish-yellowish brown, med. stiff			
						A lot of fine sand coming out of hole at 100'. To avoid plugging screen pulled casing back 95'. Hole caved in to 97'. Placed 2' of gravel pack.			Hear hissing noise with rig off.
	60						60		HNU readings are at background levels.
	80						80		85' of galvanized well pipe and 10' of galvanized screen installed.
	100						100		
	120						120		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-33	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-27-83 FINISH 10-7-83 LOGGER B. ROHR

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-25' **Silty Sand**, fine sand, reddish-brown, fill **25-65'** **Gravel**, medium, increasing sand content with depth, angular to sub-angular, reddish brown to light brown			12" pilot hole drilled to 25'. Drilled with added water to water table. Advanced 8" casing to 60'. Then pulled 8" casing back to 50' level and advanced 6" casing to 65'. Water generated has no odor. HNU readings are not above background. Installed 55' of galvanized steel well pipe and 10' of galvanized well screen.
	20								
	40								
	60								
	80								

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-34	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-9-83 FINISH 9-14-83 LOGGER B. ROHR

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	Q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-26' **Silty Sand**, some small gravel, dark brown to black, abundant brick fragments and occassional wood fragments, fill			Drilled open hole to 24'. Casing driven to 40'. Casing drove medium hard 25'-35'; hard 35'-45'.
						26-28' **Silty Clay**, some gravel, dark brown in upper portion and lightens to medium grayish brown in lower portion, moist			Hole yields large volumes of water, no problem of fines washing into casing.
	10						10		
						28-40' **Gravelly Sand-Sandy Gravel**, apparently greater sand content in last couple feet, medium brown			Water encountered at approximately 35'. Water has the odor of Chem-Dyne contaminated water. HNU readings are unreliable due to cold morning air. Readings are less than zero.
	20						20		Installed 30' of galvanized steel well casing and 10' of galvanized screen.
	30						30		
	40						40		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-35	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-24-83 FINISH 9-27-83 LOGGER W. OLSON

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	Q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-10' Silty Fill, dark brown to black, with brick, dry			All HNU readings are at background levels
						10-15' Silty Fill, sames as above except more gravelly and grayer			Water encountered at 35'.
						15-24' Silty Sand, some gravel and miscellaneous fill, black			Casing drove very hard from 46' to 48'.
	20					**24-26'** Gravel to Gravelly Sand, light brown to gray, dry	20		Installed 55' of galvanized steel well pipe and 10' of galvanized well screen.
						26-35' Gravelly Sand, abundant 1/2" diameter gravel, moist at			
						35-65' Gravelly Sand, coarse sand with gravel			
	40						40		
	60						60		
	80						80		

CH2M HILL

PROJECT NUMBER	BORING NUMBER	
W65310.C0	MW-36	SHEET 1 OF 1

SOIL BORING LOG

PROJECT CHEM-DYNE RI/FS LOCATION HAMILTON, OHIO

ELEVATION _____ DRILLING CONTRACTOR BOWSER-MORNER

DRILLING METHOD AND EQUIPMENT DAVEY M-7, AIR ROTARY

WATER LEVEL AND DATE _____ START 9-23-83 FINISH 9-24-83 LOGGER B. BERGGREN

ELEVATION	DEPTH BELOW SURFACE	SAMPLE: INTERVAL	SAMPLE: TYPE AND NUMBER	SAMPLE: RECOVERY	STANDARD PENETRATION TEST RESULTS 6" -6" -6" (N)	SOIL DESCRIPTION: NAME, GRADATION OR PLASTICITY, PARTICLE SIZE DISTRIBUTION, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY, USCS GROUP SYMBOL	SYMBOLIC LOG	Q_u (TSF)	COMMENTS: DEPTH OF CASING, DRILLING RATE, DRILLING FLUID LOSS, TESTS AND INSTRUMENTATION
						0-22' **Silty Gravelly Fill**, dark brown to black, abundant brick fragments, dry 22-37' **Sandy Gravel-Gravelly Sand**, light grayish brown. Drill rig indicates fairly high gravel content 37-40' **Sandy Gravel-Gravelly Sand**, same as above, except greater percentage of fine sand and silt, gravel is still rounded			At 6' drill rig behaves as though greater gravel content. Water encountered at 33' to 34'. Hole yields water very well. No odor associated with the water. All HNU readings are at background levels (0.2 ppm). No apparent problem with fines or other material coming up into casing. Installed 30' of galvanized steel well pipe and 10' of galvanized well screen.
	10								
	20								
	30								
	40								
	50								

APPENDIX B

PHASE III HYDROGEOLOGICAL INVESTIGATION
MONITORING WELL AND PUMPING WELL INSTALLATION

PHOTOGRAPHIC LOG

PHASE III HYDROGEOLOGICAL INVESTIGATION
Photographic Log
Chem-Dyne Site
W65310.C0

Photo 1: A view of onsite large diameter pumping well installation using cable tool rig.

Photo 2: Onsite well installation activities for the large diameter pumping well showing air monitoring with HNu instrument.

Photo 3: Onsite large diameter pumping well installation with cable tool methods.

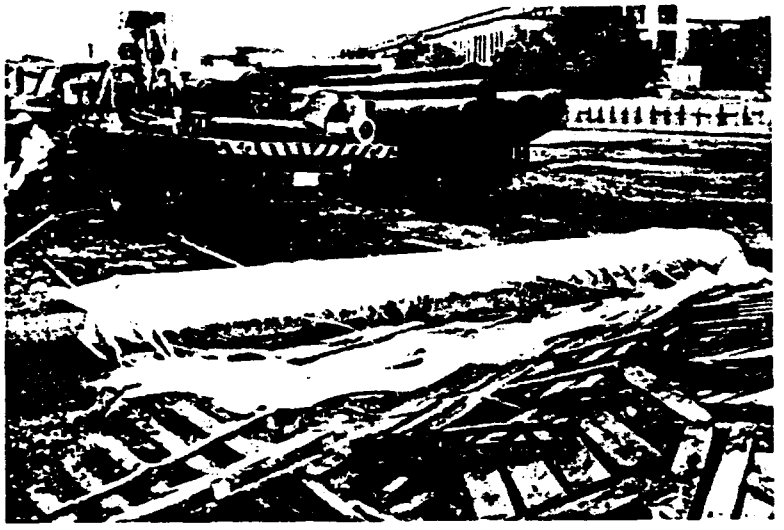


Photo 4: Sections of well screen stored adjacent to well installation onsite.

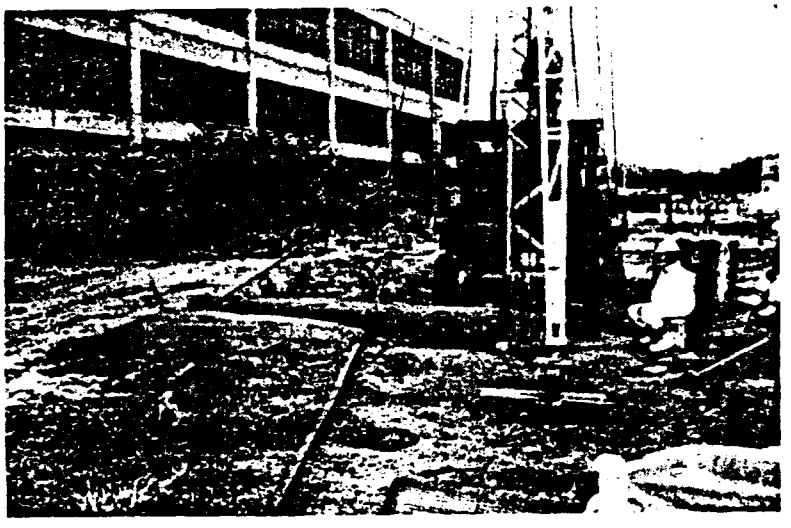


Photo 5: Cuttings associated with installation of onsite pumping well and cable tool rig.

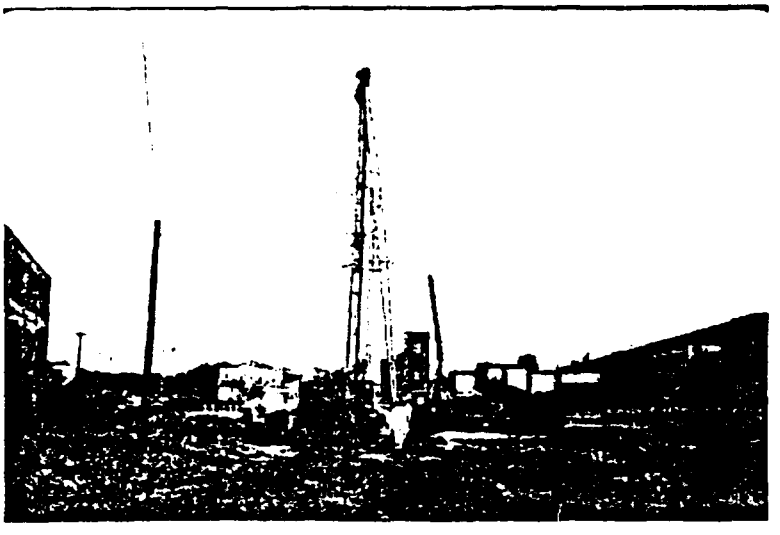


Photo 6: Setup of cable tool rig for installation of large onsite pumping well.

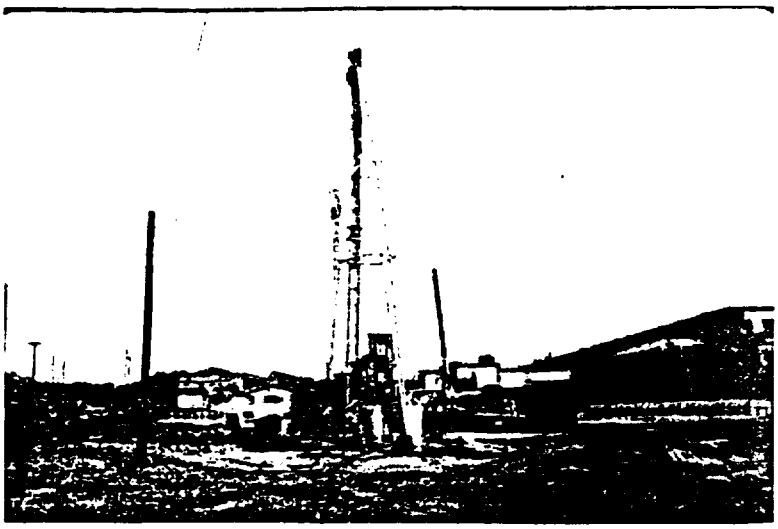


Photo 7: Same as Photo 6.

Photo 8: Air monitoring with HNu instrument around installation of large diameter onsite pumping well.

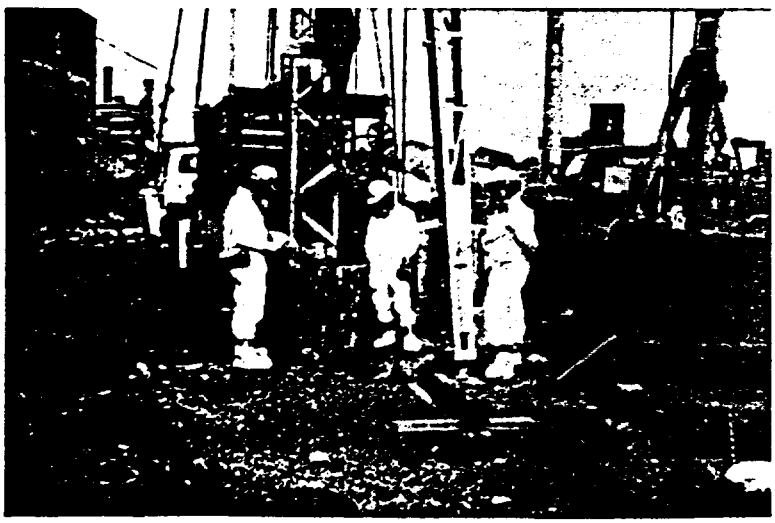


Photo 9: Same as Photo 8.

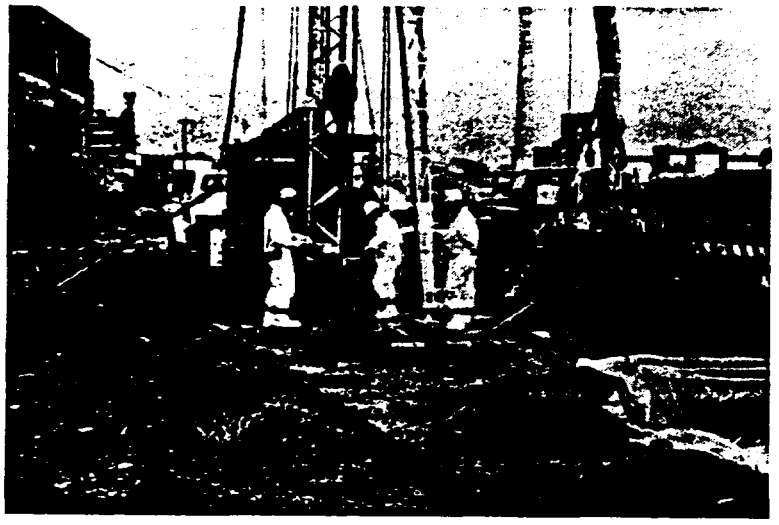


Photo 10: Same as Photo 8.

Photo 11: Same as Photo 8.

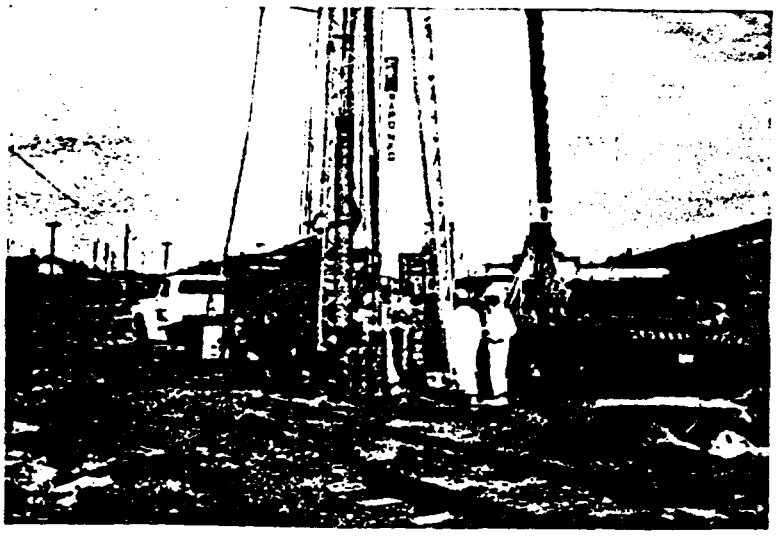


Photo 12: Large diameter pumping well installation using cable tool methods.

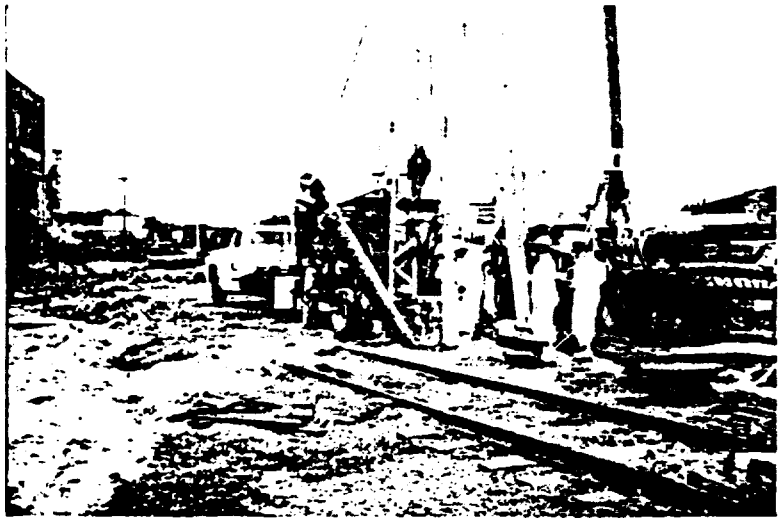


Photo 13: Same as Photo 12.

Photo 14: Air monitoring of cuttings from installation of large diameter onsite pumping well.

Photo 15: Same as Photo 14.

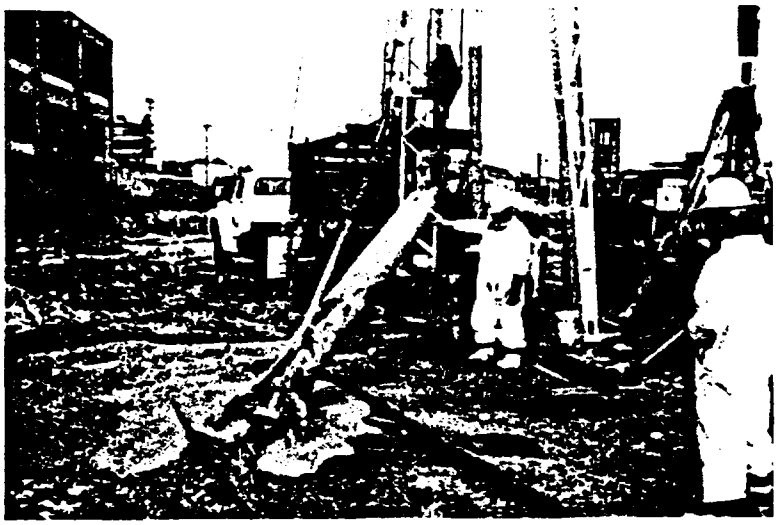


Photo 16: Removal of soil cuttings from large diameter pumping well installation onsite.

Photo 17: Air monitoring with HNu instrument of soil cuttings removed from onsite well installation.

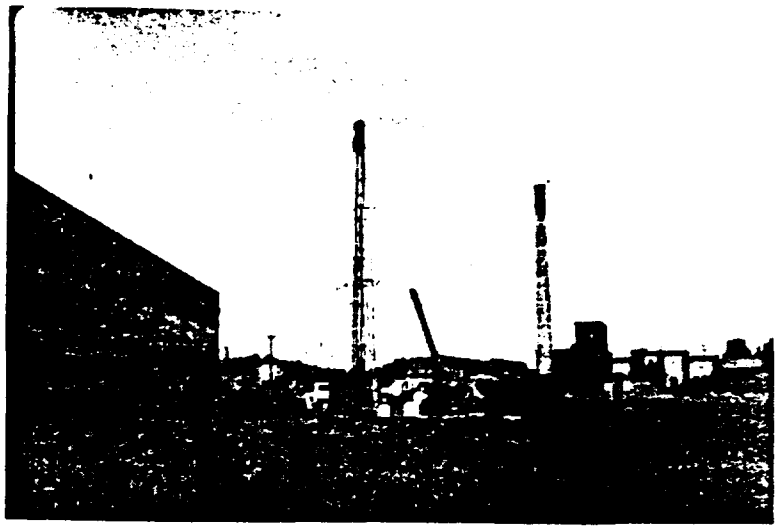


Photo 18: Setting for installation of large diameter onsite pumping well.

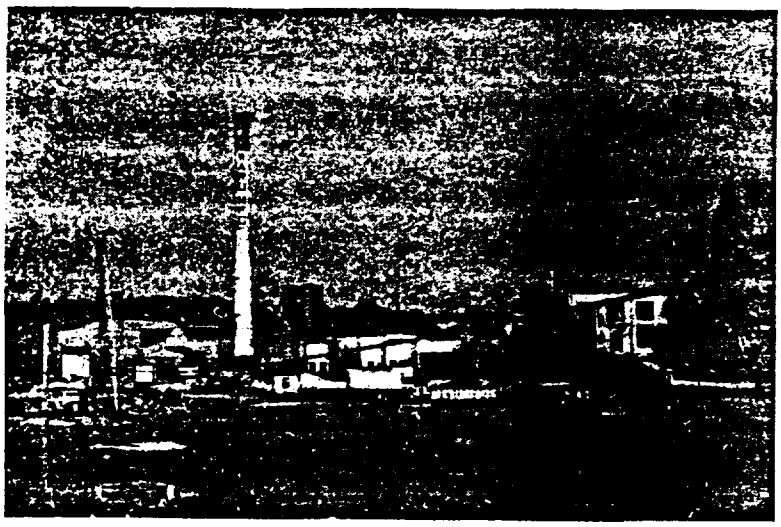


Photo 19: Same as Photo 18.

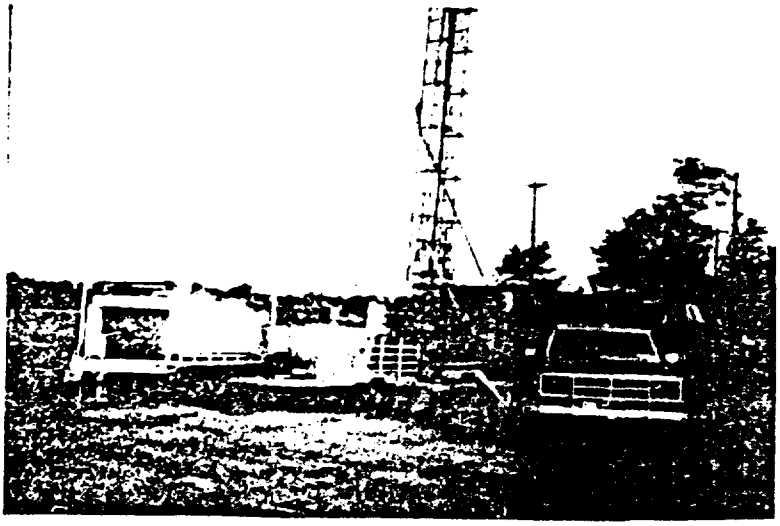


Photo 20: A view of the offsite well installation drill rig and mobile tank used for storage of contaminated fluids generated during drilling.

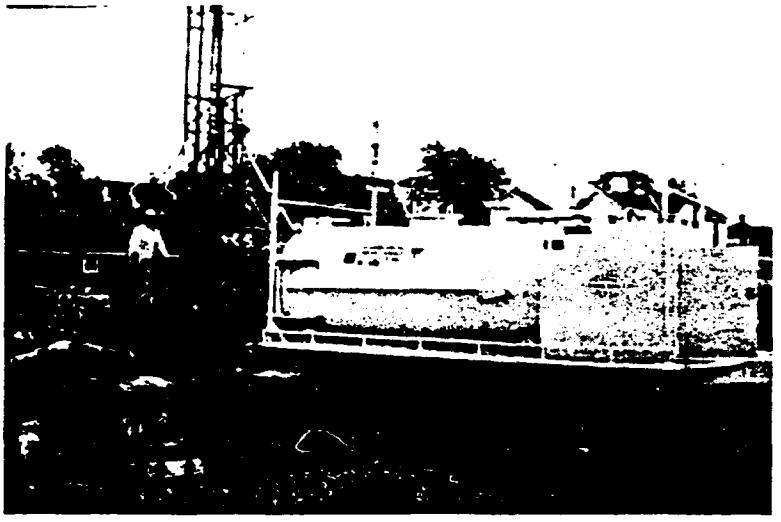


Photo 21: A closer view of the mobile tank used for containment of drilling fluids generated during the onsite well installation.

Photo 22: Same as Photo 20.

Photo 23: A view of the drill rig used for the development of the offsite monitoring well.

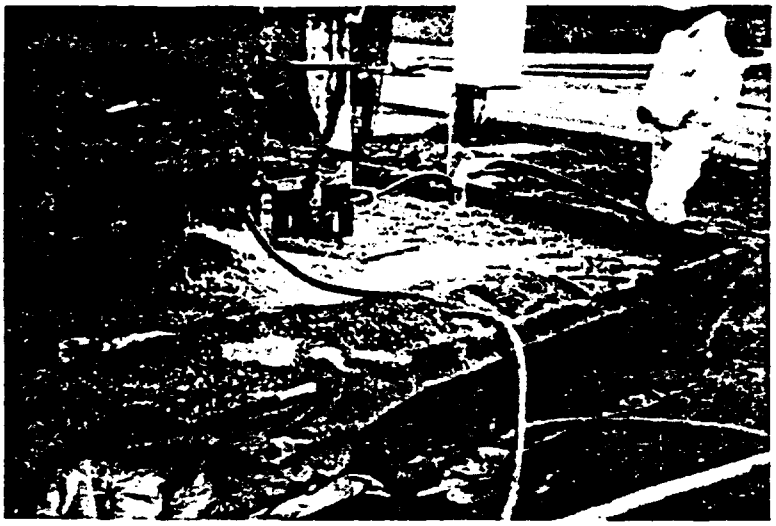


Photo 24: A view of the drilling activity offsite showing the containment of drilling fluid or water generated by the containment pan.

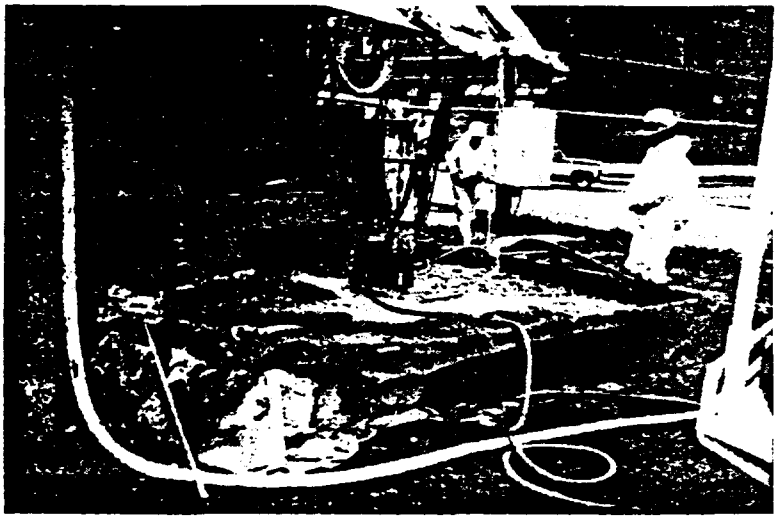


Photo 25: Same as Photo 24.

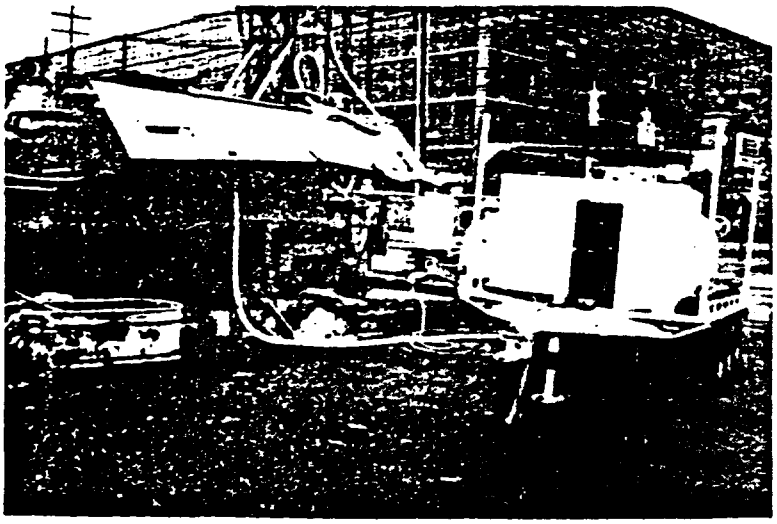


Photo 26: A view of offsite drilling and well installation showing the mobile tank used for containment of fluids generated during well installation.

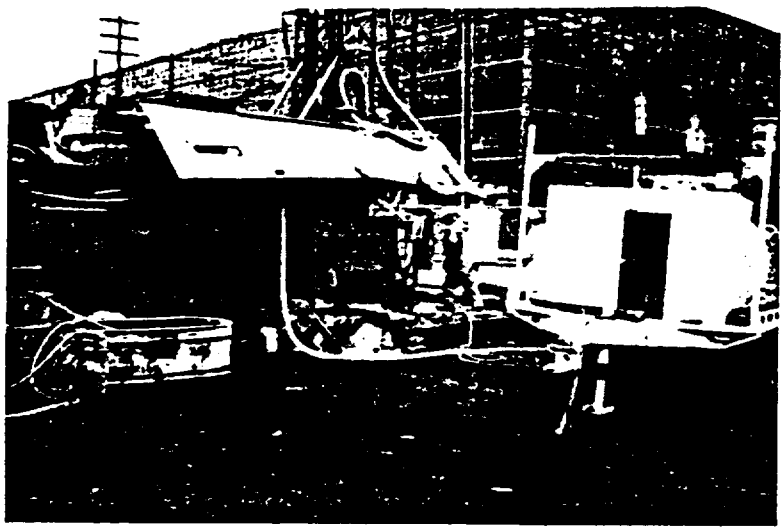


Photo 27: Same as Photo 26.

Photo 28: A view of personnel wearing SCBA's during the development of the onsite pumping well.

Photo 29: Same as Photo 28.

Photo 30: A view of the onsite pumping well development, showing the 12,000-gallon tanks erected to contain the development water.

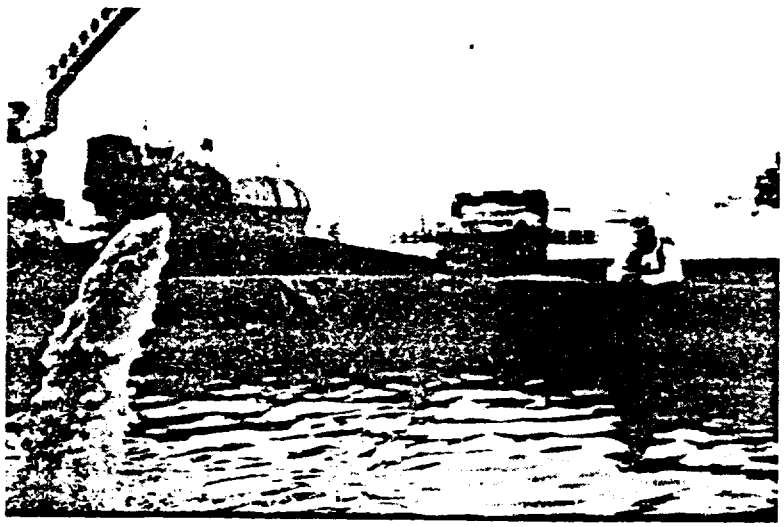


Photo 31: A view of the onsite pumping well development water discharge.

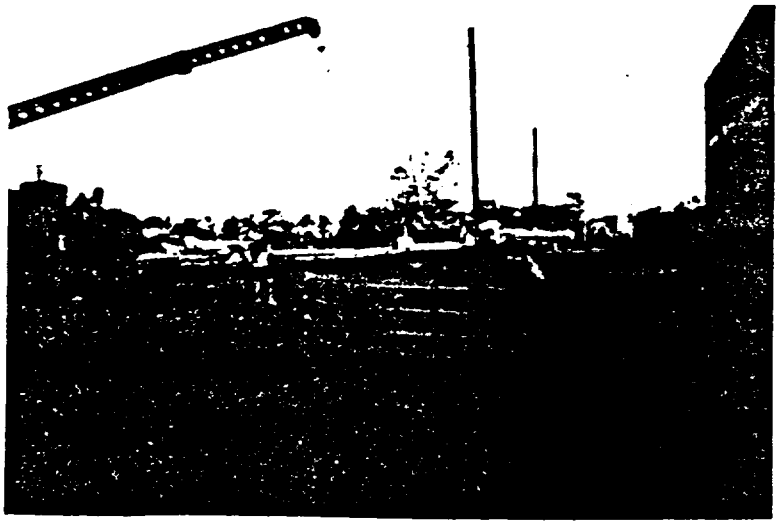


Photo 32: Same as Photo 31.

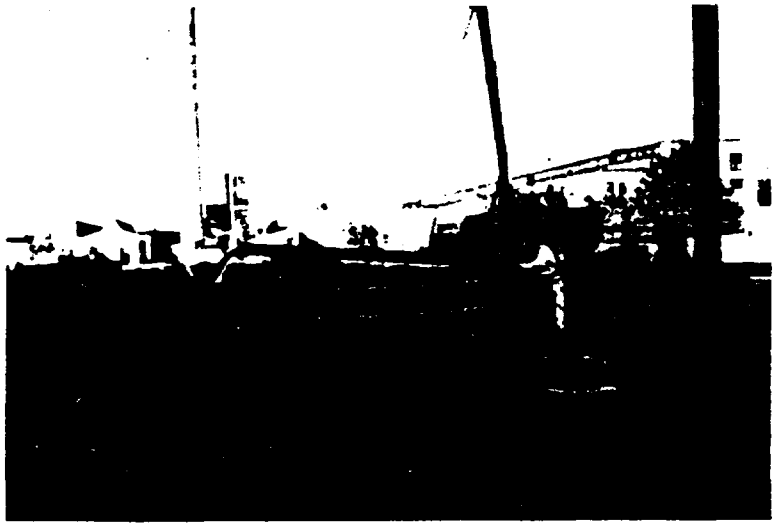


Photo 33: Same as Photo 31.

Photo 34: A view of the setting around the onsite pumping well during development, showing the two 12,000-gallon tanks erected to contain the development water.

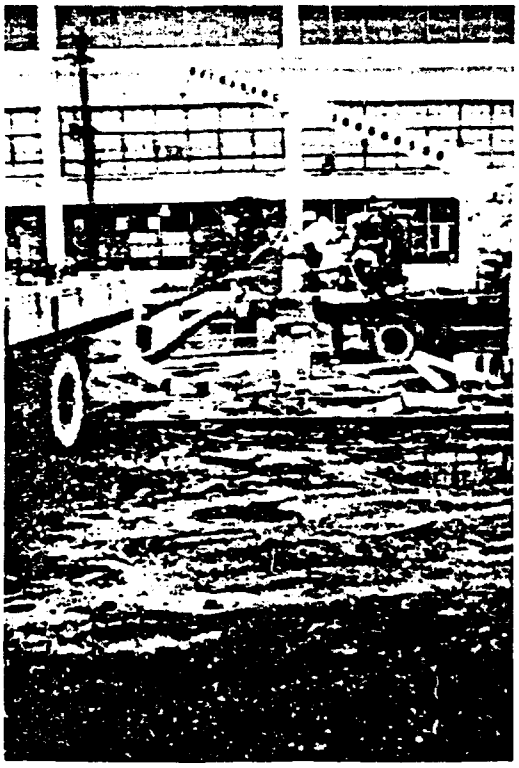


Photo 35: A view of equipment used during development of the onsite pumping well.

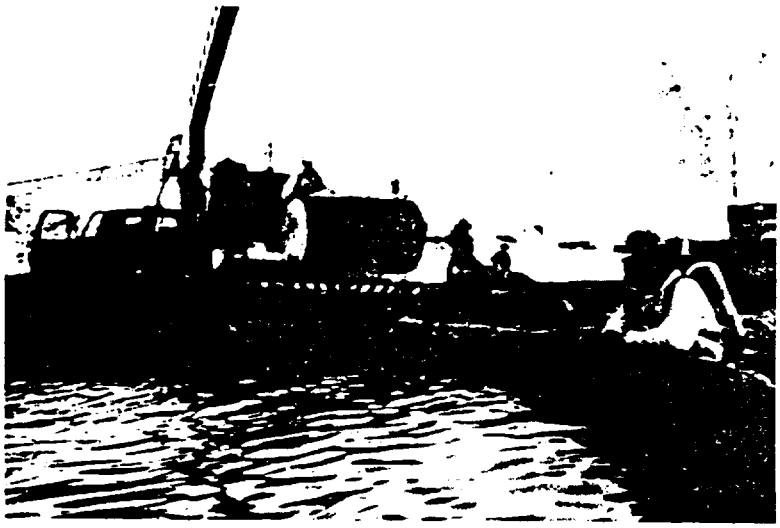


Photo 36: A view of one of the onsite pools erected to contain development water after filling.

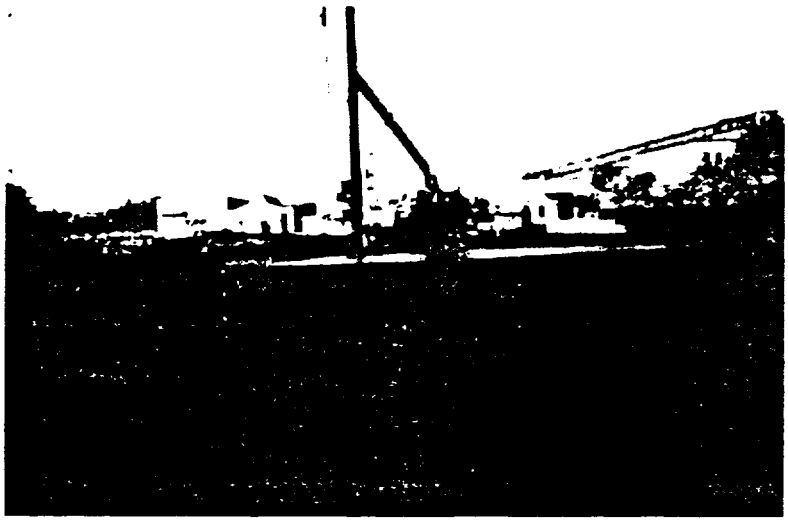


Photo 37: Same as Photo 36.

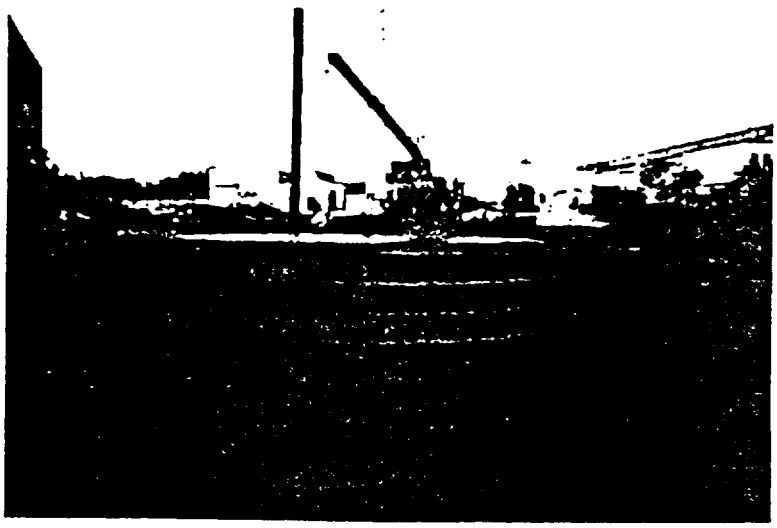


Photo 38: Same as Photo 36.

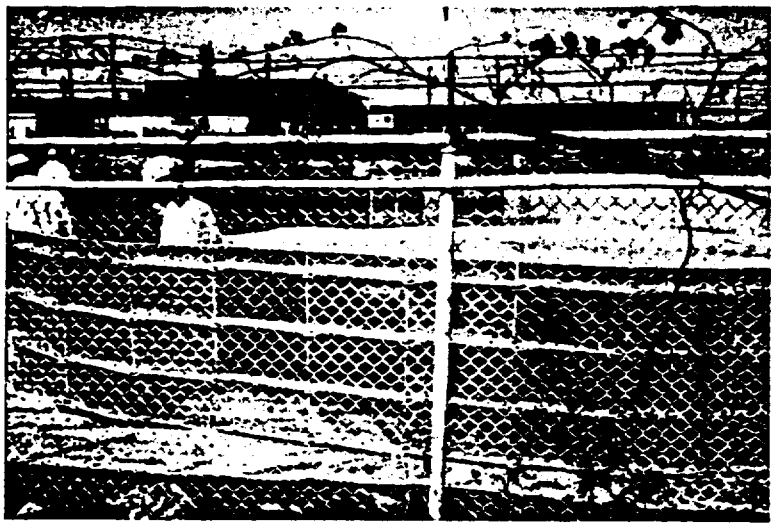


Photo 39: A view of construction activities onsite related to erection of containment pools for development water and water generated during the pump test.

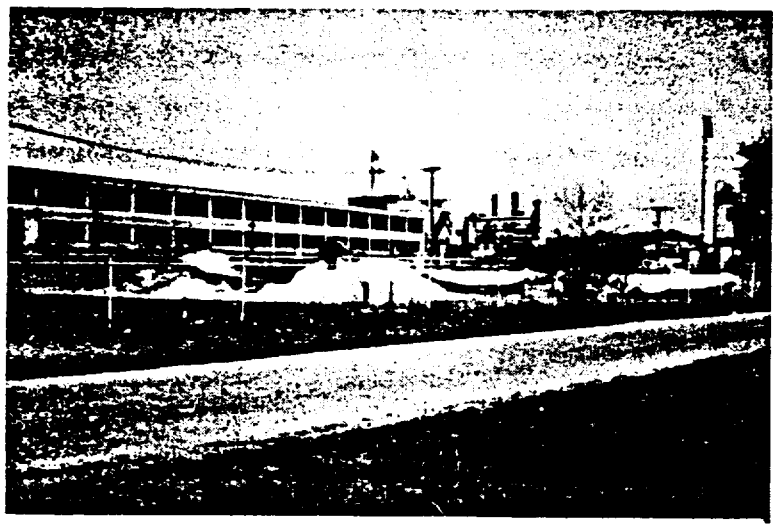


Photo 40: A view of the site during onsite containment pool construction.

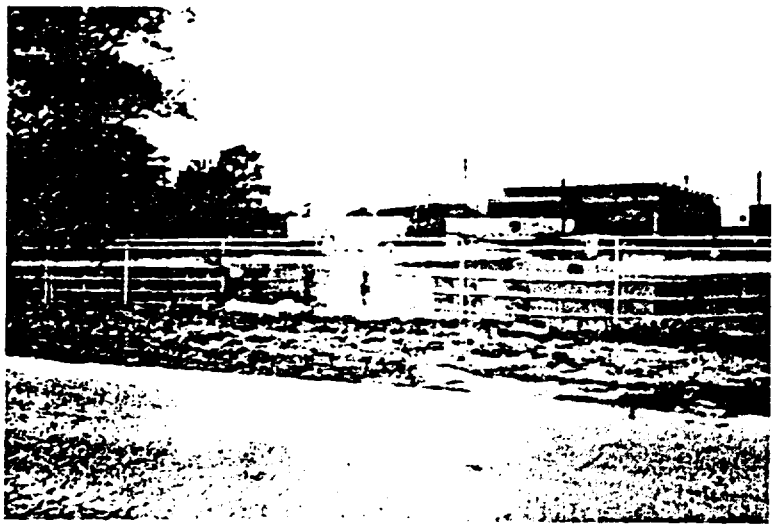


Photo 41: A view of construction of the onsite containment pools.

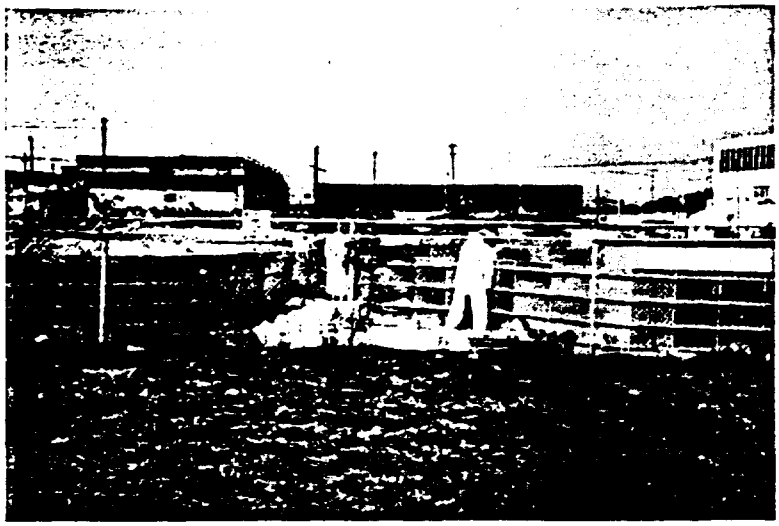


Photo 42: Same as Photo 41.

Photo 43: Same as Photo 41.

Photo 44: A view from the observation tower erected by O.H. Materials at the south end of the site, showing the pools constructed for containment of development and pump test water generated by the onsite pumping well.

Photo 45: Same as Photo 44.

Photo 46: A view of construction of onsite containment pools.

Photo 47: A view of the O.H. Materials backhoe preparing and leveling a site for placement of the drilling containment pan.

Photo 48: The placement of sand before the placement of the drilling containment pan on a site.

Photo 49: A view of the drilling containment pan in place prior to emplacement of the circular flame section through which drilling proceeds.

Photo 50: Same as Photo 49.

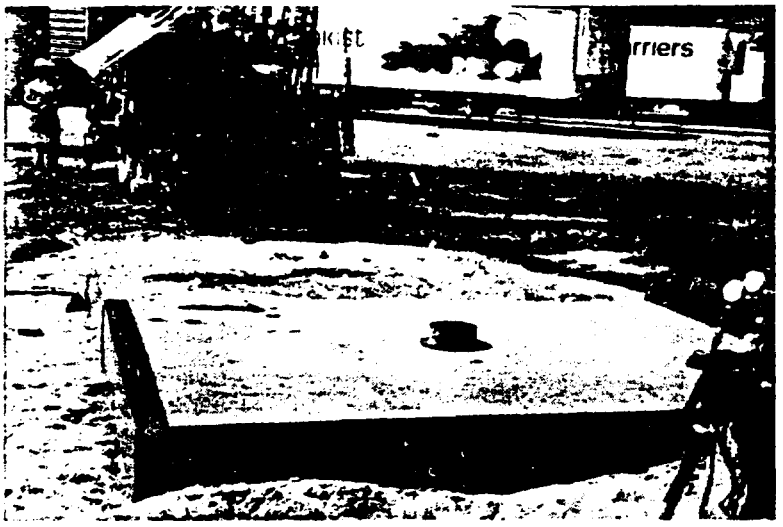


Photo 51: A view of the drilling pan in place with the circular flange section inserted.

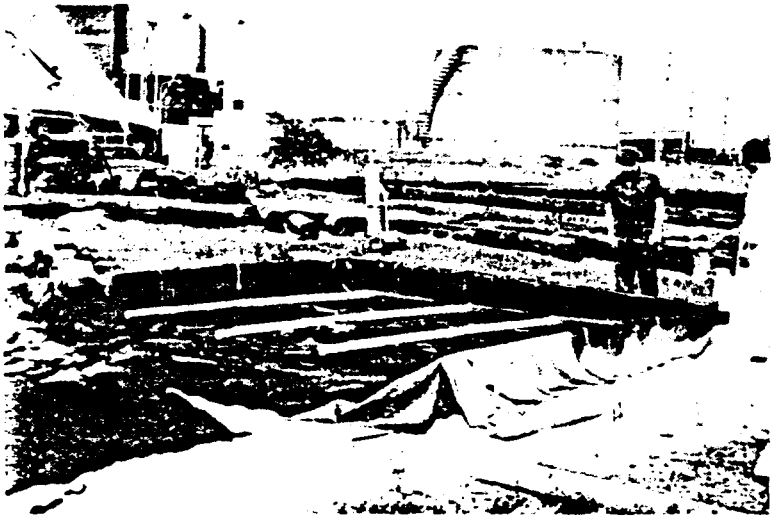


Photo 52: The drilling containment pan with liner and geotextile placed within and laying out of the drainage system.

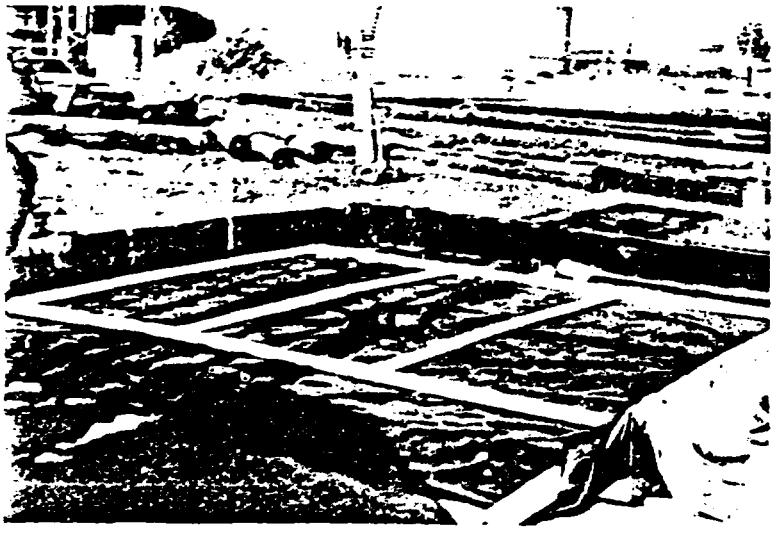


Photo 53: A view of the drilling containment pan prior to placement of the gravel fill.

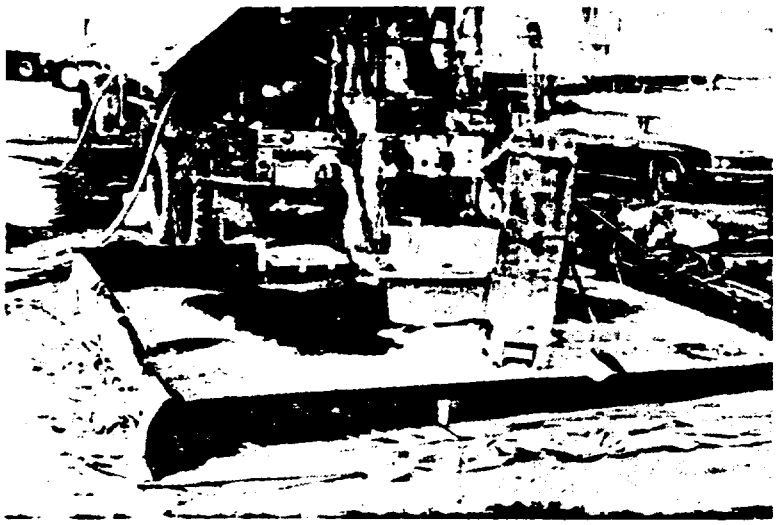


Photo 54: A view of the drilling containment pan in operation.

Photo 55: A view of the drilling containment pan movement procedure involving a backhoe, a forklift and chain.

Photo 56: The same as Photo 55.

Photo 57: The same as Photo 55.

Photo 58: The same as Photo 55.

Photo 59: A view of the driveway entrance to the Chem-Dyne site.

Photo 60: A view of the onsite large diameter pumping well installation taken from the support trailer located at the south end of the site.

Photo 61: The same as Photo 60.

APPENDIX A

PHASE III - HYDROGEOLOGICAL INVESTIGATION

Monitoring Well and Production Well Sampling

Photographic Log

GLT460/25-1

Table 5
SUMMARY OF ORGANIC PRIORITY POLLUTANT ANALYSES OF PRODUCTION WELLS NEAR CHEM-DYNE
PHASE III - HYDROGEOLOGIC STUDY CASE NO. 2064 OCTOBER 1983

Compound[a]	Beckett Paper Parking Lot Well[b]	Champion Paper Well No. 1[b]	Champion Paper Well No. 4[b]	Hamilton Municip. Electric Power Well No. 9	Vaughn Building Company Well
Acid Compounds, ug/l	NA	NA	NA		
No priority pollutant acid organic compounds were found					
Base/Neutral Compounds, ug/l	NA	NA	NA		
Bis(2-ethylhexyl)phthalate				2K	
Volatiles, ug/l					
1,1,1-Trichloroethane			2K		11
trans-1,2-Dichloroethene		2K	3K		
Methylene chloride	4K	5K	5K	14	3K
Trichloroethene		4K			
Vinyl chloride					14
Pesticides, ug/l					
No priority pollutant pesticides were found					
Nonpriority Pollutants					
Hazardous Substances, ug/l					
No prirority pollutant hazardous substances were found					
Dioxins					
2,3,7,8-Tetrachlorodibenzo -p-dioxin	NA	NA	NA		

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]Only the volatile organic fraction sampled.

GLT443/15

PHOTO LOG

Chem-Dyne Site Remedial Investigation
Monitoring Well and Production Well Sampling
Phase II - Subtask 3-3.2

The following three photographs were taken with a Nikon FE fitted with a 24mm lens and data back. The film was Kodachrome 64 slide film.

PHOTO 1: Viewing south showing sampling crew preparing to work at MW 11. At right is Javick/FMC Corporation [10-14-83]..

PHOTO 2: Similar to Photo 1 [10-14-83].

PHOTO 3: Viewing southwest showing crew lowering sampling pump to MW 11. Umbachu/Polytech at right lowering the pump [10-14-83].

APPENDIX B

TENTATIVELY IDENTIFIED COMPOUNDS

Table 3 ·

SUMMARY OF TENTATIVELY IDENTIFIED COMPOUNDS IN GROUNDATER AT THE CHEM-DYNE SITE
PHASE III - HYDROGEOLOGY STUDY (CASE NO. 2064)

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-01	none reported		
MW-02	none reported		
MW-04	Triethylester phosphoric acid	977	40
MW-05	Trichloropropene	GEN	20
MW-05	1,2,4-trithiolane	938	400
MW-05	2-chloroaniline	987	100
MW-05	1,3,5 trithiane	935	30
MW-05	1,2,4,6-tetrathiepane	974	80
MW-05	hexathiepane	938	100
MW-05	sulfur, mol.	989	200
MW-06	Tetrahydrofurfuryl alcohol	980	60
MW-06	Butanoic acid anhydzide	901	30
MW-06	Dimethoxy ethyl ether	991	100
MW-06	N,N-dimethyl methane sulponamide	939	30
MW-06	1-methyl-2-pyrroli dinone	978	50
MW-06	(2-hydroxy propoxy)-1-propanol	920	202
MW-07	Tetrahydrofuran	981	2,000
MW-07	3-hexnone	948	600

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-07	Pyridine	983	100
MW-07	3-Hexanone	988	500
MW-07	4-methyl-1-pentyn-3-ol	906	200
MW-07	Oxepane	980	200
MW-07	3-Hexyn-1-ol	925	60
MW-07	Butyl cellosolve	979	70
MW-07	Methyl cyclohexanol	995	300
MW-07	1,1'-oxybis(2-methoxy)ethane	984	300
MW-07	5-hexynoicacid	991	60
MW-08	none reported		
MW-09	none reported		
MW-10	Toluene	996	400
MW-10	1,1,2-trichloroethane	995	100
MW-10	Tetrachloroethylene	989	200
MW-10	Ethyl benzene	995	300
MW-10	Xylene isomer	994	300
MW-10	Xylene isomer	994	200
MW-10	1,1,2,2-tetrachloro ethane	997	100
MW-10	3-octanone	972	80
MW-10	2,2,4,4-tetramethyl-3-pentanone	979	60

SHELL/GLT461/45
FILE/GLT461/300

MEMORANDUM

TO: File

FROM: John T. Fleissner/GLO

DATE: November 9, 1983
(Revised December 9, 1983

RE: Chem-Dyne Site Remedial Investigation
Monitoring Well and Production Well Sampling
Phase III, Subtask 3-3.3

PROJECT: W65310.C0

INTRODUCTION

A final groundwater sampling effort was performed at the Chem-Dyne site from October 12 through October 19, 1983. Sampling was performed both offsite and onsite by personnel from CH2M HILL, Environment and Ecology, Inc., Barr Engineering, and Polytech.

This work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 21.5M10.0, Task 3-3.2.

PURPOSE

The purpose of the Phase III groundwater sampling effort was to gather additional data to investigate seasonal variation in groundwater levels and contamination at the site.

SCOPE

The scope of the sampling effort at the Chem-Dyne site included the following samples:

- Four industrial cooling and process water production wells
- One municipal power company cooling water well
- Thirty-five groundwater monitoring wells onsite and offsite
- Groundwater field blanks
- Groundwater duplicate samples

Groundwater samples were taken from both existing and newly installed groundwater monitoring wells. Eleven of the groundwater monitoring wells are onsite and 24 are offsite.

All of the groundwater samples were analyzed for the inorganic and organic constituents included in the routine analytical packages by the U.S. EPA contract laboratories. During this effort, two contract laboratories were used: IT Analytical in Cerritos, California 90701 for all organic analysis, and Chemtech Consulting Group, Ltd. in New York, New York 10014 for all inorganic analysis. This work was designated by the Sample Management Office (SMO) as Case No. 2064.

PERSONNEL

The sampling team included the following members:

CH2M HILL

John T. Fleissner, Project Engineer/GLO
Thomas A. Gilgenbach/GLO (October 11-13)
Larry A. Holm/GLO (October 17 only)

E&E, Inc.

Jerry Kelly (October 12-19)

Barr Engineering

Wes Olson (October 12-14)
Peter Sabee (October 12-19)
Bonnie Rohr (October 17-19)

Polytech

Frank Umbachu (October 12-19)

GROUNDWATER SAMPLING PROCEDURE

MONITORING WELL SELECTION

The monitoring wells sampled during this effort included those previously reviewed by Joe Keeley, U.S. EPA prior to the Phase I sampling performed April 4-14, 1983. These monitoring wells included 2-inch diameter wells installed in 1981 by E&E, Inc. during FIT activities and 4-inch diameter wells installed by Roy F. Weston in 1982.

In addition to these wells, seven new onsite and seven new offsite groundwater monitoring wells installed by CH2M HILL were also sampled. These 14 wells are described in separate technical memorandums.

MONITORING WELL SAMPLING

General Well Sampling Strategy

The general monitoring well sampling strategy was to obtain representative samples of local groundwater and minimize contamination of both monitoring wells and the samples.

The sequence of monitoring well sampling was based upon sampling the least contaminated wells first and moving progressively toward the most contaminated wells. The sequence of monitoring well sampling done during Phase III was as follows:

1.	MW-1	19.	MW-30[a]
2.	MW-2[a]	20.	MW-35[a]
3.	MW-3[a]	21.	MW-36[a]
4.	MW-18	22.	MW-34[a]
5.	MW-22	23.	MW-33[a]
6.	MW-21	24.	MW-31[a]
7.	MW-20	25.	MW-26[a]
8.	MW-19[a]	26.	MW-25[a]
9.	MW-15	27.	MW-6[a]
10.	MW-17	28.	MW-28[a]
11.	MW-8	29.	MW-5
12.	MW-16	30.	MW-27[a]
13.	MW-11	31.	MW-29[a]
14.	MW-12[a]	32.	MW-23[a]
15.	MW-13[a]	33.	MW-24[a]
16.	MW-4	34.	MW-10
17.	MW-7	35.	MW-9
18.	MW-32[a]		

[a]Note: Samples from these monitoring wells split with Mr. Richard Javick, FMC Corp. Javick collected VOA samples only at MW-2,3,12,13,18 and 19.

Well Sampling Equipment

Two types of sampling equipment were used to sample the monitoring wells. A stainless steel submersible pump (Johnson-Keck Model SP-81) was used to purge and pump out samples (except volatile organics) at most of the monitoring wells.

A 2-inch stainless steel bailer was used for monitoring wells MW-9 and MW-6 because the submersible pump did not fit all the way down these wells into the screen section. The bailer was also used at MW-5 based on experience at MW-6.

Well Depth and Water Surface Measurement

Before purging the monitoring wells, the total depth of the well and the location of the groundwater surface were mea-

sured. The total depth was sounded with a watermarker electric tape. The water surface was also measured with a watermarker electric tape. A steel tape was used for measurement of the wire. All measurements were made from the top of each well casing. Table 1 contains the well measurement data from both this Phase III work and previous work by Roy F. Weston in December, 1982.

The watermarker equipment was decontaminated after each use by rinsing the equipment through the TSP, acetone solution, and distilled water described on the next page.

Well Purging

Each groundwater monitoring well was purged prior to taking the groundwater sample. Where the pump was used for purging and sampling, the volume of the purge water at each well was based on the total depth of the well, either shallow or deep, and either one 15-minute duty cycle or three consecutive 15-minute duty cycles, respectively, of the sampling pump.

The seven new offsite wells installed by CH2M HILL were each purged by pumping five well volumes before sampling. Thus, for the shallow wells with approximately 12 feet of water column, three duty cycles were required and, for the deep wells with approximately 40 feet of water column, five duty cycles were required.

The routine for pump operation during well purging was based on the constraints of the pump itself. The submersible pump has a normal duty cycle of 15 minutes and an approximate discharge flow rate of 1.0 gpm. After 15 minutes of operation, the pump must be idle for a minimum of 5 minutes for pump and motor cooling. By operating the pump for the required number of duty cycles, depending upon the well volume, each well was adequately purged.

During well purging, the pump was periodically moved within the water column from top to bottom to distribute the source of purge suction.

Where the stainless steel bailers were used for purging and sampling, a minimum of three well volumes of water was removed for the purge.

Purge water from each well was collected in 55-gallon drums, each of which was disposed of on the Chem-Dyne site by O.H. Materials, the contractor performing concurrent drum and bulk tank removal work onsite.

Table 1 (Page 1 of 2)
PHASE III MONITORING WELL DATA SUMMARY CHEM-DYNE SITE
OCTOBER 12-19, 1983
HAMILTON, OHIO W65310.CO

WELL NUMBER		PREVIOUS DATA			NEW DATA					
MW-	As-Installed	Elevation Top of Casing (feet)	Estimated Static Water Volume (cubic/feet)	Water Elevation[a] (feet)	Elevation Top of Casing (feet)	Date of Measurement	Static Water Elevation (feet)	Elevation bottom of well (feet)	Initial HNU Reading in Casing (ppm)	Comments
MW-1	(Weston)	591.09	2.8	563.59	591.12	10/12/83	563.33	529.52	Less than 1.0	No casing cover in place
MW-2	(Weston)	591.49	0.54	563.67	591.52	10/12/83	563.20	555.02	Less than 1.0	No casing cover in place
MW-3	(Weston)	591.15	0.51	563.95	591.14	10/12/83	563.47	556.14	Less than 1.0	-
MW-4	B-9	593.20	0.04	563.44	592.89	10/14/83	562.54	560.60	Less than 1.0	-
MW-5	B-16	591.91	-	563.60	591.62	10/19/83	562.97	558.04	-	Cover in place but no padlock
MW-6	B-14	592.49	0.04	562.79	592.19	10/18/83	562.69	561.59	Less than 1.0	Padlock in place but no cover
MW-7	B-8	593.59	0.10	563.36	593.30	10/14/83	562.63	559.39	2.5	-
MW-8	(Weston)	598.20	0.35	563.20	597.91	10/13/83	562.16	557.41	Less than 1.0	-
										-
MW-9	B-15	593.11	-	563.26	592.83	10/19/83	562.54	559.89	5 - 10	-
MW-10	B-17	591.84	0.14	563.27	591.58	10/19/83	562.75	556.58	Less than 1.0	-
MW-11	B-12	598.66	0.13	563.05	598.36	10/14/83	562.36	558.86	Less than 1.0	-
MW-12	(Weston)	593.44	2.65	563.11	593.18	10/14/83	562.25	534.87	2.8 maximum	-
MW-13	B-11	593.47	0.08	563.30	593.20	10/14/83	562.53	560.87	Less than 1.0	HNU in purge water drum (MW-13 only) 8.0 ppm
MW-14	B-25	594.66	-	563.62	594.39	10/13/83	563.33[a]	563.33	Less than 1.0	Bare casing; no lock cover No sample taken
MW-15	(Weston)	595.89	0.16	563.41	595.56	10/13/83	563.56	555.85	8.4 maximum	-
MW-16	(Weston)	595.09	0.17	562.42	594.82	10/13/83	561.25	554.07	Less than 1.0	-
MW-17	(Weston)	597.55	0.45	560.68	597.32	10/13/83	559.15	553.82	-	HNU not available because of rain
MW-18	B-3	596.90[a]	0.10	562.42	594.65	10/12/83	561.82	556.48	Less than 1.0	Casing has been modified for drive-way construction by Hamilton Electric
MW-19	(Weston)	591.23	2.75	560.72	591.42	10/13/83	557.91	525.46	Less than 1.0	-
MW-20	(Weston)	591.20	0.88	561.89	592.02	10/13/83	560.72	551.90	Less than 1.0	No casing cover in place
MW-21	(Weston)	597.87	0.92	561.39	598.06	10/12/83	559.79	549.68	Less than 1.0	-
MW-22	(Weston)	597.35	3.57	560.31	597.57	10/12/83	558.86	519.65	Less than 1.0	-

[a] Water elevation before pumping December 6, 7, and 8, 1982.

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Table 1 (Page 2 of 2)
PHASE III MONITORING WELL DATA SUMMARY CHEM-DYNE SITE
OCTOBER 12-19, 1983, HAMILTON, OHIO W65310.CO

WELL NUMBER		NEW DATA					
MW-	As-Installed	Elevation Top of Casing (feet)	Date of Measurement	Static Water Elevation (feet)	Elevation bottom of well (feet)	Initial HNU Reading in Casing (ppm)	Comments
MW-23	(CH2M HILL)	590.32	10/19/83	565.44	556.19	50	-
MW-24	(CH2M HILL)	591.32	10/19/83	562.44	557.94	Less than 1.0	-
MW-25	(CH2M HILL)	591.25	10/18/83	561.68	558.25	20 - 30	-
MW-26	(CH2M HILL)	590.52	10/18/83	562.69	525.86	3 - 4	-
MW-27	(CH2M HILL)	590.71	10/19/83	562.88	555.16	8 - 10	-
MW-28	(CH2M HILL)	591.56	10/19/83	562.73	527.04	12 maximum	-
MW-29	(CH2M HILL)	590.85	10/19/83	562.85	555.77	14 maximum	-
MW-30	(CH2M HILL)	592.52	10/17/83	558.66	495.86	Less than 1.0	-
MW-31	(CH2M HILL)	594.07	10/18/83	562.22	553.52	Approx. 5 to 7	HNU "zero" drifted during operation in the rain
MW-32	(CH2M HILL)	592.52	10/17/83	558.66	495.86	Less than 1.0	-
MW-33	(CH2M HILL)	595.29	10/18/83	561.38	528.49	9.7	-
MW-34	(CH2M HILL)	596.25	10/18/83	562.14	555.75	3.0	-
MW-35	(CH2M HILL)	595.76	10/17/83	562.29	529.87	Less than 1.0	-
MW-36	(CH2M HILL)	594.73	10/17/83	562.23	554.12	Less than 1.0	-

[a] Water elevation before pumping December 6, 7, and 8, 1982.

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Well Sampling

Most of the monitoring wells were sampled with the submersible pump. At these wells, the submersible pump was used to take the samples for base/neutral, acid, and pesticide organics, metals, and cyanide. Samples for volatile organic analysis were taken with a stainless steel bailer at all monitoring wells.

Three of the monitoring wells, MW-9, MW-6, and MW-5, were purged and sampled completely with a stainless steel bailer. The bailer was used only where the submersible pump could not be used.

Samples were collected by filling the sample bottles directly from the sampling pump discharge line or the bailer. All sample fractions for metals analysis were filtered through a 0.45u filter prior to preservation. Sample fractions for metals were preserved with nitric acid and fractions for cyanide were preserved with sodium hydroxide.

Decontamination

Decontamination procedures included steps to avoid contamination of the sample and monitoring well and to minimize carry-over of contaminants from one well to another. In summary, the steps used to minimize contamination were as follows:

- Take samples from the least to most contaminated wells based on previous groundwater data.
- Decontaminate the outside of all equipment used in the wells including the water marker probe and line, sampling pump (or bailer) and discharge line after each well sampling.
- Decontaminate the inside of the submersible pump and discharge line by pumping decontamination solutions in sequence through the pump after each well sampling. Decontaminate the inside of the bailers as appropriate.
- Purge each monitoring well prior to sampling. This not only removes stagnant water in the well but also pumps out any contamination carried into the well and pumps decontamination solution out of the pump discharge line.

Three solutions were used in sequence to decontaminate well sampling equipment. These solutions were trisodium phosphate (TSP) and city tap water, acetone and distilled water

(approximately 20 percent acetone V/V), and distilled water rinse. To decontaminate the inside of the sampling pump and line, each solution was pumped for 60 seconds through the pump and discharge line. Decontamination solutions were typically used for 1 day or a maximum of six wells and then disposed of.

The decontamination procedure for gloves used to handle equipment was washing in a separate bucket of TSP solution followed by a separate tap water rinse.

The spent decontamination solutions were combined with the purge water in 55-gallon drums and disposed of by O.H. Materials at the Chem-Dyne site.

PRODUCTION WELL SAMPLING PROCEDURES

PRODUCTION WELL SAMPLING

CH2M HILL planned to sample two production wells during Phase III, at the Vaughn Building Company and the Hamilton Electric Power Plant. However, three additional wells were sampled for VOA only to correspond with the samples taken by Javick from FMC Corporation. These additional wells were the Champion Paper well Nos. 1 and 4 and the Beckett Paper parking lot well.

The production wells sampled during Phase III sampling work are summarized below:

Well Designation	Primary Water Use
Vaughn Building Company	Air conditioning
Hamilton Power Plant No. 9	Cooling water
Beckett Paper Parking Lot	Process water
Champion Paper No. 1	Process/cooling water
Champion Paper No. 4	Process/cooling water

PRODUCTION WELL SAMPLING

All production wells were sampled during normal continuous operation of the well pumps. All sampling was performed by John Fleissner, CH2M HILL, with the cooperation of industry and utility personnel.

The sampling points at each well were close to the discharge of the well pump with the exception of the Hamilton Electric Power Plant. At the power plant, the sample was taken from a new tap installed by Reeves on the discharge line approximately 50 feet from the active well. This remote point was the most practical sampling location.

The typical sample tap was a small section of pipe with a shut-off valve and a short leg of discharge pipe. These sample taps were opened and flushed for 1 minute prior to sampling.

Samples were collected by filling the sample bottles directly with water from the tap. All samples for metals analysis were filtered through a 0.45u filter prior to preservation at the command post.

SAMPLING CHRONOLOGY

The following chronology summarizes the major activities and events for each day of Phase III groundwater sampling work at Chem-Dyne from October 11-19, 1983.

October 11, 1983, Tuesday

Team: Thomas A. Gilgenbach, CH2M HILL

Samples obtained: None. Day used for site setup and preparation.

Comments: None.

October 12, 1983, Wednesday

Team: John T. Fleissner, CH2M HILL
Thomas A. Gilgenbach, CH2M HILL
Jerry Kelly, E&E, Inc.
Wes Olson, Barr Engineering Co.
Peter Sabee, Barr Engineering Co.
Frank Umbachu, Polytech

Samples obtained: MW-1
MW-2
MW-3
MW-18
MW-22
MW-21
Field blank

Comments: Dick Javick from FMC Corporation accompanied the sampling team. Javick took VOA samples at MW-2 and MW-3. Fleissner arrived on site at 1230.

October 13, 1983, Thursday

Team: Same as Wednesday, October 12

Samples obtained: MW-20
MW-19
Hamilton Power Plant No. 9
MW-15 (Duplicate)
MW-17
MW-8
MW-16

Comments: MW-14 was not sampled because no water column was present. MW-15 sampled in duplicate. Javick/FMC took VOA samples at MW-19 and the Hamilton Power Plant No. 9.

October 14, 1983, Friday

Team: John T. Fleissner, CH2M HILL
Jerry Kelly, E&E, Inc.
Wes Olson, Barr Engineering Co.
Peter Sabee, Barr Engineering Co.
Frank Umbachu, Polytech

Samples obtained: MW-11
MW-12
Beckett Paper Parking Lot Well
MW-13
MW-4
Field Blank
MW-7
Vaughn Building Company

Comments: Javick/FMC took VOA samples at MW-12, MW-13, Beckett Paper, and Vaughn Building Company. Vaughn metals sample preserved but unfiltered because sample pump was broken at MW-7.

October 17, 1983, Monday

Team: Larry A. Holm, CH2M HILL
Jerry Kelly, E&E, Inc.
Peter Sabee, Barr Engineering Co.
Bonnie Rohr, Barr Engineering Co.
Frank Umbachu, Polytech

Samples obtained: MW-32
MW-30
MW-35
MW-36

Comments: Javick/FMC collected samples at all wells.

October 18, 1983, Tuesday

Team: John T. Fleissner, CH2M HILL
Jerry Kelly, E&E, Inc.

Peter Sabee, Barr Engineering Co.
Frank Umbachu, Polytech

Samples obtained:
MW-34 (Duplicate)
MW-33
MW-31
Champion Paper No. 1
Champion Paper No. 4
MW-26
MW-25 (Duplicate)
MW-6

Comments: Collected VOA's only at the Champion Paper wells. Javick/FMC collected samples at all wells.

October 19, 1983, Wednesday

Team: Same as October 18, Tuesday

Samples obtained:
MW-28
MW-5
MW-27
MW-29
MW-23
MW-24
Field blank
MW-10 (Duplicate)
MW-9

Comments: Javick/FMC collected samples at wells MW-28, MW-27, MW-29, MW-23, and MW-24.

FIELD DATA SUMMARIES

The field data are presented on several tables which follow. These data are included without observations or evaluation. Data evaluation will be performed after all data are available under Task 5, Site Investigation Analysis in the final work plan.

The field data summaries include the following tables:

- Table 2 - Summary of Sample Locations and Traffic Report Numbers
- Table 3 - Summary of Organic Analysis of Groundwater
- Table 4 - Summary of Inorganic Analysis of Groundwater
- Table 5 - Summary of Organic Analysis of Production Wells Near Chem-Dyne

- Tentatively identified compounds detected in groundwater samples are presented in Appendix B.

GLT460/29

Table 2
SUMMARY OF SAMPLE LOCATIONS
AND TRAFFIC REPORT NUMBERS

Groundwater Sample Location	Traffic Report Numbers Inorganic	Organic
MW-1	MS-0235	S-2314
MW-2	MS-0236	S-2315
MW-3	MS-0237	S-2316
MW-18	MS-0238	S-2317
MW-21	MS-0239	S-2318
MW-22	MS-0240	S-2319
Field Blank	MS-0241	S-2320
MW-20	MS-0242	S-2321
Hamilton Power Co. No. 9	MS-0243	S-2322
MW-19	MS-0244	S-2323
MW-15	MS-0245	S-2324
MW-15 (Duplicate)	MS-0246	S-2325
MW-17	MS-0247	S-2326
MW-16	MS-0248	S-2327
MW-8	MS-0249	S-2328
MW-11	MS-0250	S-2329
MW-12	MS-0251	S-2330
Beckett Parking Lot Well[a]	--	S-2331
MW-13	MS-0252	S-2332
MW-4	MS-0253	S-2333
MW-7	MS-0254	S-2334
Field Blank	MS-0255	S-2335
Vaughn Building Co. Well	MS-0256	S-2336
MW-32	MS-0257	S-2337
MW-30	MS-0258	S-2338
MW-35	MS-0259	S-2339
MW-36	MS-0260	S-2340
MW-34 (Duplicate)	MS-0261	S-2341
MW-34	MS-0262	S-2342
MW-33	MS-0263	S-2343
MW-31	MS-0264	S-2344
Champion Paper No. 1[a]	--	S-2345
Champion Paper No. 4[a]	--	S-2346
MW-26	MS-0265	S-2347
MS-6	MS-0266	S-2348
MW-25	MS-0267	S-2349
MW-25 (Duplicate)	MS-0268	S-2350

Table 2 (continued)

Groundwater Sample Location	Traffic Report Numbers Inorganic	Organic
MW-28	MS-0269	S-3101
MW-5	MS-1004	S-3102
MW-27	MS-1005	S-3103
MW-29	MS-1006	S-3104
MW-23	MS-1007	S-3105
MW-24	MS-1008	S-3106
Field Blank	MS-1009	S-3107
MW-10	MS-1010	S-3108
MW-10 (Duplicate)	MS-1011	S-3109
MW-9	MS-1012	S-3110

[a]VOA sample only.

GLT432/79

Table 3 (Page 1 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF GROUNDWATER
AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY CASE NO. 2064 OCTOBER 1983

Compound[a,b,c]	MONITORING WELL												
	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-10	MW-11	MW-12
Acid Compounds, ug/l													
Phenol							25K			58	53		
Base/Neutral Compounds, ug/l													
Bis(2-chloroethyl)ether										4K			
Isophorone													
Naphthalene													
Bis(2-ethylhexyl)phthalate				6K	300	270	7K	3K	55	6K	7K		
Di-n-butyl phthalate							7K						
Volatiles, ug/l													
Benzene													
Carbon tetrachloride					58	160	240K						
Chlorobenzene						2,600	3,000		580		550K		
1,2-Dichloroethane							100K						
1,1,1-Trichloroethane					31	690				3,700	3,900		
1,1-Dichloroethane					54	270	850			2,800	3,100		
1,1,2-Trichloroethane				150	28								
1,1,2,2-Tetrachloroethane					65	510					2,800		
Chloroethane					50	130				1,000K	1,100K		
Chloroform				1,400									
1,1-Dichloroethene					18	22,000	6,800		380	8,200	8,800		
trans-1,2-Dichloroethene					14								
Ethylbenzene				160	250	360				38,000	40,000		
Methylene chloride	310K	240	1,200K	78K									
Tetrachloroethene					7K	440	1,000	340	55K	3,000	3,100	7K	61K
Toluene					15	61K				3,500	3,900		
Trichloroethene										7,200	7,800		
Vinyl chloride				35K	40	49K				54,000	58,000		
					47					2,000K	2,000K		
Pesticides, ug/l													
g-BHC (lindane)							0.9**						
Nonpriority Pollutants													
Hazardous Substances, ug/l													
Benzoic acid													
4-Methylphenol										380	370		
Acetone	28,000	4,000	77,000	250K	48K	16K	29,000	1,300	120K	11,000K	9,700K	280	3,200
2-Butanone					44K	8,800	1,100K						
4-Methyl-2-pentanone						79K							
O-xylene													
Dioxins													
2,3,7,8-Tetrachlorodibenzo -p-dioxin													

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]**Signifies that compound detected below GC/MS detection limits.
[c]K denotes compound detected below quantitation limit (QL) where QL = 10 x Detection Limit.

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Table 3 (Page 2 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF GROUNDWATER
AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY CASE NO. 2064 OCTOBER 1983

MONITORING WELL

Compound[a,b,c]	MW-13	MW-15	MW-15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-23	MW-24	MW-25	MW-25
Acid Compounds, ug/l														
Phenol														
Base/Neutral Compounds, ug/l														
Bis(2-chloroethyl)ether		120K	100K											
Isophorone											350			
Naphthalene													3K	5K
Bis(2-ethylhexyl)phthalate	4K			3K	6K		2K		4K	4K	5K	5K		5K
Di-n-butyl phthalate														
Volatiles, ug/l														
Benzene												23K	500	450
Carbon tetrachloride											470K	87K		
Chlorobenzene		2,000	1,700K										310	270
1,2-Dichloroethane	260	13,000	10,000											
1,1,1-Trichloroethane	300													
1,1-Dichloroethane		2,200	1,800K											
1,1,2-Trichloroethane	2,500	29,000	24,000			230K						67K		
1,1,2,2-Tetrachloroethane	870	9,400	7,400											
Chloroethane														
Chloroform	380	3,300	2,700								1,200	580		
1,1-Dichloroethene	170K	3,900	2,900			42K								
trans-1,2-Dichloroethene	4,000	12,000	10,000			530					7,700	65K		
Ethylbenzene													280	190
Methylene chloride	190K	2,700	2,500	280	390	80K	340	12	4K	89K	690	86K	49K	46K
Tetrachloroethene	140K	1,500K	1,300K									650		
Toluene		1,900K	1,600K										140	140
Trichloroethene	930	9,100	7,500			77K					120K	79K		
Vinyl chloride		6,500	5,000			550								
Pesticides, ug/l														
g-BHC (lindane)														
Nonpriority Pollutants														
Hazardous Substances, ug/l														
Benzoic acid														
4-Methylphenol		34K	30K											
Acetone	730K	69,000	6,800K	530K	9,200	540K	4,900	75K	170	20,000	6,900	330K	780K	960K
2-Butanone											7,500		1,000	1,000
4-Methyl-2-pentanone											3,100			
O-xylene													230	160
Dioxins														
2,3,7,8-Tetrachlorodibenzo-p-dioxin														

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed on this table. Compounds not identified in any sample are not listed.
[b]K denotes compound detected below quantitation limit (QL) were QL = 10 x Detection Limit.

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Table 3 (Page 3 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF GROUNDWATER
AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY CASE NO. 2064 OCTOBER 1983

Compound[a,b,c]	MONITORING WELL											
	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-32	MW-33	MW-34	MW-34	MW-35	MW-36
Acid Compounds, ug/l												
Phenol	16K	7K										
Base/Neutral Compounds, ug/l												
Bis(2-chloroethyl)ether									2K	3K		
Isophorone												
Naphthalene												
Bis(2-ethylhexyl)phthalate	3K	8K										
Di-n-butyl phthalate	2K	9K	210				2K				2K	
Volatiles, ug/l												
Benzene	150	430K	28	240								
Carbon tetrachloride												
Chlorobenzene				23K								
1,2-Dichloroethane				120	51			140				
1,1,1-Trichloroethane												
1,1-Dichloroethane					9K			59K	490K	490K		
1,1,2-Trichloroethane				140				540				
1,1,2,2-Tetrachloroethane												
Chloroethane												
Chloroform				77K								
1,1-Dichloroethene	4K			32K	9K			160	1,200	1,200		
trans-1,2-Dichloroethene	73	400K	8K	680	150			1,200	16,000	16,000		
Ethylbenzene	91	1,100	51									
Methylene chloride	6K	1,000	12	96K	7K	64K	2K	25K	420K	130K	51K	7K
Tetrachloroethene				69K								
Toluene	9K											
Trichloroethene	3K			480	15							
Vinyl chloride	15		5K		16			870	11,000	11,000		18
Pesticides, ug/l												
g-BHC (lindane)												
Nonpriority Pollutants												
Hazardous Substances, ug/l												
Benzoic acid												
4-Methylphenol												
Acetone	2,400	850	290K	3,600	2,200	850K		1,100			2,500	260
2-Butanone												
4-Methyl-2-pentanone												
O-xylene												
Dioxins												
2,3,7,8-Tetrachlorodibenzo -p-dioxin												

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed on this table. Compounds not identified in any sample are not listed.
[b]K denotes compound detected below quantitation limit (QL) were QL = 10 x Detection Limit.

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Table 3 (Page 4 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF GROUNDWATER
AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY CASE NO. 2064 OCTOBER 1983

	EPA AMBIENT WATER QUALITY CRITERIA[d,e]	
	Toxicity Protection	Carcinogenicity Protection ($R=10^{-5}$)
Acid Compounds, ug/l		
2-Nitrophenol	NCA	
2,4-Dinitrophenol	70	
Phenol	3,500	
Base/Neutral Compounds, ug/l		
Bis(2-chloroethyl)ether		0.30
Isophorone	5,200	
Bis(2-ethylhexyl)phthalate	15,000	
1,2-Dichlorobenzene	400	
1,3-Dichlorobenzene	400	
1,4-Dichlorobenzene	400	
Naphthalene	NCA	0.028
Benzyl butyl phthalate	NCA	
Di-n-butyl phthalate	34,000	
Di-n-octyl phthalate	NCA	
Volatiles, ug/l		
Benzene		
Carbon tetrachloride		
Chlorobenzene		6.6
1,2-Dichloroethane		9.4
1,1,1-Trichloroethane	18,400	
1,1-Dichloroethane	NCA	
1,1,2-Trichloroethane		6.0
1,1,2,2-Tetrachloroethane		1.7
Chloroethane	NCA	
Chloroform		1.9
1,1-Dichloroethene		0.33
1,2-trans-Dichloroethene	NCA	
1,2-Dichloropropane	NCA	
Ethylbenzene	1,400	
Methylene chloride		1.9
Bromodichloromethane		1.9
Fluorortrichloromethane		1.9
Chlorodibromomethane	NCA	
Tetrachloroethene		8.0
Toluene	14,300	
Trichloroethene		27
Vinyl chloride		20
Pesticides, ug/kg		
Dieldrin		0.00071
4,4'-DDT		0.00024
4,4'-DDE	NCA	
4,4'-DDD	NCA	
a-endosulfan	74	
b-endosulfan	74	
endrin	1.0	
a-BHC		0.092
b-BHC		0.163
d-BHC	NCA	
g-BHC (lindane)		0.186
Nonpriority Pollutants Hazardous Substances, ug/l		
Dioxins		

[a] NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b] LT denotes compound identified at less than (LT) the specified detection limit but greater than one-half the detection limit, i.e., present but below the detection limit.
[c] PN represents pesticide or PCB which cannot be confirmed by GC/MS.
[d] 1980 EPA AMBIENT WATER QUALITY CRITERIA for the protection of human health from the toxic properties of a pollutant ingested through water and contaminated aquatic organisms, assuming daily ingestion of 2 liters of water and 6.5 grams of potentially contaminated fish products. Concentrations corresponding to lifetime cancer risk level $R=10^{-5}$ have been estimated for those pollutants which exhibit carcinogenic and/or mutagenic effects in certain bioassay systems and which therefore are suspected of being potentially carcinogenic to humans.
[e] NCA denotes insufficient data available upon which to derive a criterion.

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Table 4 (Page 1 of 4)
SUMMARY OF INORGANIC ANALYSES OF GROUNDWATER AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY
CASE NO. 2064 OCTOBER 1983

Constituent[a]	Groundwater Monitoring Wells													
	MW-1	MW-2	MW-3	MW-4	MW-5	MW-6	MW-7	MW-8	MW-9	MW-10	MW-10	MW-11	MW-12	MW-13
Aluminum	<100	170	<100	<100	245	173	<100	183	268	713	460	<100	174	<100
Chromium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Barium	208	184	130	624	499	1,100	<100	246	387	156	1,180	102	1,940	281
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	3.0	<1	2.0	<1	<1	<1	<1	<1	<1	<1	<1	<1	2.3	<1
Cobalt	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Copper	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<55
Iron	141	4,540	118	2,920	4,890	12,400	2,860	10,200	58	5,130	20,300	71	8,150	111
Lead	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5
Nickel	<40	<40	<40	<40	<40	<40	<40	<40	<40	<10	<40	<40	<40	<40
Manganese	10	90	72	336	1,910	122	1,600	82	135	917	1,010	77	63	788
Zinc	499	956	1,140	125	75	113	129	338	138	565	110	92	1,470	245
Boron	<100	<100	106	172	263	264	188	248	346	180	399	448	492	736
Vanadium	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Arsenic	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Antimony	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Selenium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Thallium	<10	<10	<10	<10	<10	<10	<10	<10	<100	<10	<10	<10	<10	<10
Mercury	<0.2	<0.2	<0.2	60	<0.2	1.9	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	60
Tin	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Silver	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyanide	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[a]All concentrations are expressed as ug/l.

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Table 4 (Page 2 of 4)
SUMMARY OF INORGANIC ANALYSES OF GROUNDWATER AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY
CASE NO. 2064 OCTOBER 1983

Constituent[a]	Groundwater Monitoring Wells												
	MW-15	MW 15	MW-16	MW-17	MW-18	MW-19	MW-20	MW-21	MW-22	MW-23	MW-24	MW-25	MW-25
Aluminum	<100	<100	153	<100	125	153	112	<100	<100	321	152	553	125
Chromium	15	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Barium	211	196	<100	158	<100	120	114	<100	713	386	242	433	455
Beryllium	<5	<5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Copper	184	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Iron	15,900	14,400	199	4,500	101	<50	90	128	53	12,500	1,220	7,270	8,280
Lead	<5	<5	<5	<5	6.7	<5	<5	<5	<5	<5	<5	<5	<5
Nickel	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
Manganese	704	669	348	505	391	13	25	27	370	503	1,170	83	97
Zinc	1,010	852	801	553	61	241	2,610	1,880	722	55	48	96	80
Boron	892	836	110	158	706	143	236	126	<100	179	346	638	618
Vanadium	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Arsenic	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Antimony	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Selenium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Thallium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2	5.8	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tin	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Silver	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	14	<10
Cyanide	<10	<10	<10	<10	<10	<10	<10	13	16	<10	<10	<10	<10

[a]All concentrations are expressed as ug/l.

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Table 6 (Page 3 of 4)
SUMMARY OF INORGANIC ANALYSES OF GROUNDWATER AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY
CASE NO. 2064 OCTOBER 1983

	Groundwater Monitoring Wells												Production Wells	
Constituent[a]	MW-26	MW-27	MW-28	MW-29	MW-30	MW-31	MW-32	MW-33	MW-34	MW-34	MW-35	MW-36	Municipal Power Company Well No. 9	Vaughn Building Company Well
Aluminum	<100	157	<100	3,230	<100	302	120	418	484	186	300	324	<100	<100
Chromium	<10	<10	<10	<10	<10	<10	12	<10	<10	<10	<10	<10	<10	14
Barium	1,330	652	109	128	<100	1,090	221	<100	621	661	101	243	242	164
Beryllium	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Cobalt	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Copper	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	55	<50
Iron	22,700	10,100	1,250	8,690	66	6,100	298	265	10,500	11,200	2,700	460	818	2,350
Lead	<5	<5	<5	<5	<5	<5	<5	<5	6	<5	<5	<5	<5	<5
Nickel	<40	<40	<40	<40	<40	<40	<40	<400	<40	<40	<40	<40	<40	<40
Manganese	1,110	<10	378	1,010	389	159	631	347	216	225	99	196	465	252
Zinc	65	77	62	29	2,180	940	473	1,220	4,940	4,980	2,410	6,160	37	45
Boron	479	1,160	121	628	262	1,470	135	748	485	522	227	176	<100	122
Vanadium	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
Arsenic	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Antimony	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20	<20
Selenium	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2
Thallium	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Mercury	1.6	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Tin	<20	<20	<20	<20	98	<20	87	<20	128	<20	<20	44	<20	<20
Silver	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
Cyanide	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10

[a]All concentrations are expressed as ug/l.

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Table 4 (Page 4 of 4)
SUMMARY OF INORGANIC ANALYSES OF GROUNDWATER AT CHEM-DYNE PHASE III - HYDROGEOLOGIC STUDY
CASE NO. 2064 OCTOBER 1983

Constituent[a]	INTERIM PRIMARY DRINKING WATER STANDARDS[b] Maximum Concentration	EPA AMBIENT WATER QUALITY CRITERION (for protection of freshwater aquatic life)[c,d,e] Acute	Chronic
Aluminum			
Chromium	50		
Barium	1,000		
Beryllium		NCA	NCA
Cadmium	10	(12)	(0.10)
Cobalt			
Copper		(77)	(5.6)
Iron			
Lead	50	(872)	(87)
Nickel		(5,067)	(263)
Manganese			
Zinc		(969)	47
Boron			
Vanadium			
Arsenic	50	440	NCA
Antimony		NCA	NCA
Selenium	10	260	35
Thallium		NCA	NCA
Mercury	2	4.1	0.2
Tin			
Silver	50	(40)*	NCA
Cyanide		52	3.5

[a] All concentrations are expressed as ug/l.
[b] Safe Water Drinking Act of 1974.
[c] 1980 EPA AMBIENT WATER QUALITY CRITERIA.
[d] Values within parentheses are derived from the following equations: Calculations assume water hardness value of 378 mg/l

Cadmium: acute = e exp (1.05 [ln (hardness)] - 3.73)
chronic = e exp (1.05 [ln (hardness)] - 8.53)
Copper: acute = e exp (0.94 [ln (hardness)] - 1.23)
Lead: acute = e exp (1.22 [ln (hardness)] - 0.47)
chronic = e exp (2.35 [ln (hardness)] - 9.48)
Nickel: acute = e exp (0.76 [ln (hardness)] + 4.02)
chronic = e exp (0.76 [ln (hardness)] + 1.06)
Silver: acute = e exp (1.72 [ln (hardness)] - 6.52)
Zinc: acute = e exp (0.83 [ln (hardness)] + 1.95)

[e] NCA denotes no criterion available.

GLT443/18-4

October 24. Preliminary selection of wells to be monitored with automatic data acquisition system (ADAS) was made.

OCTOBER 25, 1983, TUESDAY

Roger Lewis, Ted Way, and Joe Keely arrived. The test setup was finalized. Stevens water level recorders were set up on wells MW-3, MW-19, MW-20, and MW-32.

OCTOBER 26, 1983, WEDNESDAY

Water level measurements in all the wells were collected and transducers were set in some of the monitoring wells close to the test well. Additional 500-foot extension cables were ordered from In-Situ, Inc., to allow transducers to be placed in wells over 500 feet from the command center.

OCTOBER 27, 1983, THURSDAY

All the transducers and probes were set in the wells by late afternoon. On this date, it was planned to run the pump at several outputs and gauge the effect of opening and closing the discharge valves to the various tanks. The test was begun at 7:31 p.m. after some difficulty in starting the pump motor. Twenty-nine minutes into the test, the motor failed and recovery began. A total of 26,425 gallons were pumped. When the pump motor was disengaged, water flowed (siphoned) from the discharge line back into the well.

An inspection of the pump motor revealed the motor had failed because a fuel line had vibrated loose. The line was replaced and the engine functioned normally. No further pumping was attempted.

OCTOBER 28, 1983, FRIDAY

Water levels in all wells were measured and the chart paper changed in the Stevens recorders. The pump test began at 1:15 p.m. Approximately 18 minutes into the test, the flow meter malfunctioned and the test was aborted at 1:38 p.m. A new flow meter, as described under TEST SETUP, was located and arrangements were made to have it delivered on Saturday, October 29.

OCTOBER 29, 1983, SATURDAY

The new flow meter was delivered and installed. Upon inspection, it was determined that it had been installed incorrectly, with a 6-inch line opening directly into the 8-inch flow meter. The meter was disassembled and reinstalled correctly. A short-term equipment check test was run between 3:44 p.m. and 4:06 p.m. All equipment functioned smoothly and preparations were made for the pump test to begin on Sunday, October 30.

OCTOBER 30, 1983, SUNDAY AND OCTOBER 31, MONDAY

Water levels in all wells were measured and chart paper was changed. Test pumping began at 11:10 a.m. and pumping continued until October 31, at 1:35 a.m. The recovery cycle began at 1:35 a.m. and continued until 3:35 p.m., October 31. Manual measurements were discontinued at 5:00 a.m, October 31.

The remote recorders were picked up in the afternoon and removal of the transducers began.

NOVEMBER 1, 1983, TUESDAY

All the probes were removed from the wells, decontaminated with TSP, isopropylalcohol and distilled water wash and returned to In-Situ, Inc. One cable was cut as it was being removed from a buried trench. All equipment was decontaminated and packed for shipping. J. Fleissner departed the site.

PUMPING TEST DATA ANALYSIS

OBJECTIVES

The primary objective of the pumping test was to determine accurate estimates of the aquifer transmissivity and storage coefficient. It was also desired to determine the directional variations of the transmissivity and hydraulic conductivity of the aquifer. These properties are to be used in subsequent analyses to aid in predicting the groundwater movement.

METHODS OF ANALYSIS

The aquifer underlying the Chem-Dyne site is composed of silt, clay, sand and gravel deposits. There are no well-defined low permeability units that can be consistently traced from well log to well log directly beneath the site. There are discontinuous layers of silt and clay and there is reported

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-10	1-methyl-2-pyrrolidinone	978	80
MW-10	2,6-bis(1,1-oimethylethyl)-2,5-cyclohexadiene-1,4-dione	996	100
MW-10	1,1,2-trichloroethane	995	300
MW-10	N,N-dimethyl formamide	974	100
MW-10	tetrachloroethylene	994	500
MW-10	ethylbenzene	995	500
MW-10	xylenes	GEN	600
MW-10	xylenes	GEN	400
MW-10	1,1,2,2-tetrachloroethane	997	200
MW-10	1,1'-oxybis(2-methoxy) ethane	992	600
MW-10	2,2,4,4,-tetramethyl-3-pentanone	973	100
MW-10	C8 ketone	GEN	100
MW-10	1-methyl-2-pyrrolidinone	977	100
MW-10	sulfur (mol.)	NONE	70
MW-11	none reported		
MW-12	N,N-dimethylformamide	970	30
MW-12	hexylene glycol	976	60
MW-12	2-ethylhexanoic acid	976	20
MW-12	2-(2-hydroxypropoxy)-1-propanol	974	200
MW-13	1,1,2-trichloroethane	997	200

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-13	tetrachloroethylene	980	40
MW-13	1,1,2,2-tetrachloroethane	997	100
MW-13	1,1'-oxybis(2-methoxy) ethane	992	200
MW-13	2,6-bis (1,1-dimethylethyl)-2,5-cyclohexadiene-1,4-dione	946	20
MW-13	3,8-dimethyl-undecane	970	40
MW-13	hydrocarbon	GEN	60
MW-13	hydrocarbon	GEN	40
MW-13	hydrocarbon	GEN	40
MW-13	hydrocarbon	GEN	20
MW-15	toluene	994	1,000
MW-15	1,1,2-trichloroethane	997	3,000
MW-15	1,3-dichloropropane	937	200
MW-15	tetrachloroethylene	976	500
MW-15	chlorobenzene	992	800
MW-15	2,3-dichloro-1-propene	990	400
MW-15	1,1,2,2-tetrachloroethane	990	1,000
MW-15	1,4-dichloro-1-butene	951	500
MW-15	2-ethyl-hexanoic acid	994	300
MW-15	2-(2-hydroxypropoxy)-1-propanol	985	2,000
MW-15	toluene	992	1,000

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-15	1,1,2-trichloroethane	996	3,000
MW-15	1,3-dichloropropane	939	200
MW-15	tetrachloroethylene	964	500
MW-15	chlorobenzene	991	800
MW-15	2-3-dichloro-1-propene	968	500
MW-15	1,1,2,2-tetrachloroethane	989	2,000
MW-15	1,4-dichloro-1-butene	951	300
MW-15	2-ethyl-hexanoic acid	992	300
MW-15	2-(2-hydroxypropoxy)-1-propanol	984	2,000
MW-16	none reported		
MW-17	none reported		
MW-18	1,1,2-trichloroethane	994	30
MW-18	2,4,6-trimethyl-1,3,5-trioxane	931	20
MW-18	diglyme	969	50
MW-19	none reported		
MW-20	none rep rted		
MW-21	hydrocarbon	GEN	20
MW-22	none reported		
MW-23	4-methyl-2-pentanol	990	60
MW-23	N,N-dimethyl formamide	977	50

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-23	butanoic acid	859	30
MW-23	1-methyl-2-pyrrolidinone	977	50
MW-23	2-ethyl-hexanoic acid	973	40
MW-24	tetrachloroethylene	976	150
MW-24	tetrahydrofuran	984	400
MW-24	chlorinated carbon	GEN	100
MW-24	1,1,2,2-tetrachloro-2-2-difluoro-ethane	950	200
MW-25	2-(2-hydroxy propoxy)-1-propanol	975	100
MW-25	2,6-bis(1,1-dimethyl ethyl)-	995	50
MW-25	tetrahydrofuran	996	900
MW-25	cyclohexane	987	300
MW-25	C6 H12 hydrocarbon	GEN	200
MW-25	methylcyclohexane	992	200
MW-25	xylene isomer	GEN	200
MW-25	toluene	NONE	60
MW-25	2,4-dimethyl-1,3-dioxane	960	70
MW-25	chlorobenzene	993	80
MW-25	ethylbenzene	995	70
MW-25	xylene isomer	GEN	200
MW-25	dimethoxyethyl ether	968	200

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-25	trimethylbenzene	995	10
MW-25	1-(2-methoxypropoxy)-2-propanol	969	50
MW-25	tetrahydrofuran	995	300
MW-25	cyclohexane	990	300
MW-25	C6 H12 hydrocarbon	GEN	200
MW-25	methylcyclohexane	987	200
MW-25	xylene	GEN	200
MW-25	toluene	979	60
MW-25	chlorobenzene	993	100
MW-25	ethyl benzene	995	200
MW-25	xylene	GEN	200
MW-25	2-methyl-2,4-pentanediol	958	60
MW-25	dimethoxyethyl ether	968	50
MW-25	1-(2-methoxypropoxy)-2-propanol	972	30
MW-25	2-(2-hydroxypropoxy)-1-propanol	976	200
MW-25	2,6-bis(1,1-dimethylethyl)-2,5-cyclohexadiene-1,4-dione	995	200
MW-26	tetrahydrofuran	956	100
MW-26	methyl cyclopentane	984	50
MW-26	methyl cyclohexane	976	30
MW-26	xylene isomer(s)	984	80

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-26	N,N-dimethyl formamide	969	30
MW-26	ethylbenzene	996	200
MW-26	xylene isomer(s)	995	200
MW-26	(1-methylethyl)-benzene	985	30
MW-26	2-methyl-2,4-pentanediol	979	30
MW-26	propylbenzene	994	30
MW-26	trimethylbenzene isomer	995	100
MW-27	2-(2-hydroxypropoxy)-1-propanol	983	200
MW-27	tetrahydrofuran	990	9,000
MW-27	C6 hydrocarbon	921	1,000
MW-27	chlorofluorocarbon	GEN	5,000
MW-27	chlorofluorocarbon	GEN	3,000
MW-27	chlorofluorocarbon	GEN	5,000
MW-27	chlorofluorocarbon	GEN	100
MW-27	chlorofluorocarbon	GEN	200
MW-27	chlorofluorocarbon	GEN	70
MW-27	ethylbenzene	996	200
MW-27	xylene isomer	995	200
MW-27	chlorofluorocarbon	GEN	100
MW-27	(1-methylethyl)-benzene	991	70

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-27	2-methyl-2,4-pentanediol	958	70
MW-27	propyl benzene	993	100
MW-27	ethyl-methyl benzene isomer	995	50
MW-27	trimethyl-benzene isomer	996	50
MW-27	ethyl-methyl benzene isomer	GEN	50
MW-27	trimethyl benzene isomer	995	100
MW-27	trimethyl benzene isomer	990	90
MW-28	cyclohexane	990	20
MW-28	C6 H12	GEN	20
MW-28	methylcyclohexane	983	10
MW-28	xylene isomer	995	40
MW-29	tetrahydrofuran	987	200
MW-30	none reported		
MW-31	tetrahydrofuran	972	200
MW-31	2,4,6-trimethyl-1,3,5-trioxane	986	200
MW-31	dimethoxyethyl ether	991	200
MW-31	2-ethyl-butanoic acid	970	20
MW-31	triethylphosphate	958	30
MW-31	2-(2-hydroxypropoxy)-1-propanol	972	100
MW-31	2,3-dicarboxylic acid,1,4,5,6,7,7-hexachloro-(enco,enoo)bicyclo-[2.2.1]hept-5-en	974	30

SHELL/GLT461/45
FILE/GLT461/300

Sample Number	Compound Name	Percent Fit	Estimated Concentration (ug/L)
MW-32	none reported		
MW-33	1,1,2-trichloroethane	994	70
MW-33	dimethoxyethyl ether	974	50
MW-34	methyl sulfide	993	40
MW-34	4-methyl-1,3-dioxane	946	20
MW-34	2-methyl-2,4-pentanediol	961	40
MW-34	dimethoxyethyl ether	985	100
MW-34	2-(2-hydroxypropoxy)-1-propanol	951	20
MW-34	1,4-dione,2,6-bis(1,1-dimethylether)-2,5-cyclohexadiene	979	30
MW-34	methyl sulfide	992	40
MW-34	2-methyl-2,4-pentanediol	979	70
MW-34	dimethoxyethyl ether	986	200
MW-34	2-(2-hydroxypropoxy)-1-propanol	962	70
MW-34	1,4-dione,2,6-bis(1,1-dimethylethyl)-2,5-cyclohexadiene	930	60
MW-34	4-methyl-1,3-dioxane	942	20
MW-35	none reported		
MW-36	-dichlorodifluoromethane (freon)	969	20
MW-93	none reported		

SHELL/GLT461/45
FILE/GLT461/300

MEMORANDUM

TO: File

FROM: John T. Fleissner/GLO

DATE: September 30, 1983
(Revised December 19, 1983)

RE: Chem-Dyne Site Remedial Investigation
Evaluation of Treatment and Disposal of
Groundwater Produced During Onsite
Pump Test and Appendix A, Actual Disposal
Operations for Pump Test Groundwater
Phase III Subtask 3-3.4

JOB NO. W65310.C0

INTRODUCTION

The purpose of this technical memorandum (TM) is to summarize the background and rationale for handling the groundwater generated during the onsite pump test at the Chem-Dyne site.

BACKGROUND

Part of the hydrogeological study being performed at the Chem-Dyne site includes a pump test. The test is to be performed with a well constructed onsite, near the east side of the Ransoloff building.

Past groundwater sampling by E&E, Inc., Roy F. Weston, and CH2M HILL has shown that the groundwater in the upper portion of the aquifer onsite is contaminated. Contamination is primarily volatile organic compounds or VOC's almost entirely chlorinated alkanes and alkenes. Samples of groundwater from a deeper portion of aquifer have shown significantly lower concentrations of VOC's. In general, groundwater generated during the pump test is expected to be contaminated with low concentrations of VOC's. Total VOC concentration is expected to be less than approximately 5 mg/l.

Proper disposal of the groundwater generated during the test is required. Several alternatives were considered and evaluated.

GROUNDWATER DISPOSAL ALTERNATIVES

Several groundwater disposal alternatives were considered. The goal was to select the least expensive disposal method which would also be in accordance with the regulations, technically sound and acceptable to the public.

The volume of groundwater to be handled was estimated based on the flow rate and duration of pumping necessary for the test. Based on available data for the aquifer, the test is expected to be run at approximately 600 gpm for a maximum of 24 hours and it will generate approximately 900,000 gallons. Onsite storage capacity will be 1.0 million gallons.

Five groundwater disposal alternatives were considered:

- Surface discharge (into the Ford Hydraulic Canal) without storage or treatment.
- Surface discharge with storage and treatment.
- Storage and reinjection into the aquifer.
- Storage, treatment, and discharge to the City of Hamilton POTW.
- Storage and discharge to the City of Hamilton POTW without treatment.

The general evaluation of these alternatives is summarized in Table 1. Each alternative is discussed briefly below.

SURFACE DISCHARGE WITHOUT STORAGE OR TREATMENT

This alternative was eliminated from consideration because of the known groundwater contamination. The groundwater sampling protocol used to date for both onsite and offsite wells requires containment of all groundwater purged from each well. In light of past practice, it was judged unreasonable and technically unsound to discharge 900,000 gallons of potentially contaminated groundwater directly to the Ford Canal.

SURFACE DISCHARGE WITH STORAGE AND TREATMENT

Surface discharge could be considered after groundwater treatment to remove VOC's and other organic contaminants. The treatment method would probably be adsorption with granular activated carbon. Air stripping is a technically feasible alternative treatment or pretreatment technology, however, it would generate odors which would be publicly unacceptable. Air stripping was dropped as a potential treatment technology.

Table 1
GROUNDWATER DISPOSAL
ALTERNATIVE EVALUATION SUMMARY

Groundwater Disposal Alternative	Relative Cost	Assumed Public Acceptability	Comments
1. Surface discharge (into the Ford Hydraulic Canal) without storage or treatment	Minimal	Low	Requires NPDES permit
2. Surface discharge with storage and treatment	High	Yes	Requires NPDES permit, GAC treatment assumed
3. Storage and reijection into the aquifer	Low	Possible	Very likely unacceptable by Ohio EPA Groundwater Section although not strictly prohibited by present State regulations.
4. Storage, treatment, and discharge to POTW	High	Yes	GAC treatment assumed; POTW use arranged through City of Hamilton.
5. Storage and discharge to POTW without treatment	Low	Yes	Discharge to POTW limited to approx. 150 gpm; samples analyzed for VOC's prior to discharge.

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The major constraint with this alternative is that a NPDES permit would be required before discharge. The U.S. EPA onscene coordinator (OSC), Don Bruce, cannot circumvent the NPDES permit and obtain an emergency discharge permit because this pump test is not an emergency situation. The NPDES permit requires at least 30 days to process in addition to time required for public review and comment. The permitting process may consume 60 days or more. The tight schedule of the project could not tolerate such a delay.

STORAGE AND REINJECTION INTO THE AQUIFER

This alternative would eliminate the need for treatment and surface discharge by replacing the groundwater in the aquifer, similar to closed loop heat pump systems common to the area around the site.

To investigate the feasibility of groundwater reinjection, CH2M HILL contacted Glen Hartzell/Ohio DNR - Water Division and Russ Stein, Chief of the Groundwater Section at Ohio EPA. According to Stein, Ohio does not presently have regulatory control of injection operations. Regulations are due in 1 to 2 years. However, he said OEPA would probably object strongly to the injection of contaminated groundwater into a drinking water source even if that water came originally from that source. According to Stein, the source of the groundwater is not at issue, but the quality of injected water is an issue.

Based on Stein's comments, reinjection was eliminated as an alternative. Even through the reinjection option fell into a gray area of the regulations, the full support of Ohio EPA is considered necessary for a feasible alternative.

STORAGE, TREATMENT, AND DISCHARGE TO POTW

Another alternative to surface discharge and reinjection is discharge to the City of Hamilton POTW. The constraints on this alternative are the City's sewer use ordinance and the physical capacity of the collection system and the treatment plant. The treatment system is a 32 mgd secondary treatment activated sludge plant which discharges to the Great Miami River and disposes of dewatered sludge in a sanitary landfill.

The Hamilton sewer use ordinance prohibits a variety of specific discharges to the sewerage system and also prohibits discharges which generally degrade the performance of the collection and treatment system. The groundwater from the pump test is not prohibited by the specific restrictions and is not expected to contain contaminants in

concentrations high enough to cause any degradation of treatment performance.

From a technical treatability standpoint, pretreatment prior to discharge to the POTW appears unnecessary. Therefore, this disposal alternative appears feasible but expensive, because any pretreatment would probably require granular activated carbon.

STORAGE AND DISCHARGE TO POTW WITHOUT TREATMENT

Because the groundwater from the pump test is expected to have low concentrations of VOC's, it is reasonable and technically feasible to consider discharge directly to the POTW. The constraints on direct discharge are the physical hydraulic capacity of the collection system and POTW. A second constraint is the actual concentration of VOC's in the groundwater.

In summary, the alternative for disposing of the groundwater to the POTW includes the following steps:

- Onsite storage of all pumped water
- Analysis of representative samples to determine actual VOC concentrations
- Acceptance of lab results by the City and permission for release to POTW
- Controlled discharge of stored water at a selected rate to the POTW

Onsite storage would be provided by O.H. Materials. Storage volume would consist of twenty 50,000-gallon lined, aboveground pools connected through a piping manifold. All water generated during the test would be stored in these pools. Therefore, the pump test could be conducted independently of disposal operations.

During and possibly after the pump test, representative samples of groundwater would be taken. Samples would be analyzed at CH2M HILL's laboratory in Montgomery, Alabama. Analysis would be for VOC's. By notifying the laboratory before sampling and using air freight, the VOC results can be determined within 24 hours of sample shipment.

Based on the laboratory results, the City of Hamilton would decide if it will give permission to discharge the water to the POTW. Permission is expected because contamination is expected to be low concentration.

Upon receiving permission to discharge the water stored onsite, the water would be released to the POTW through the sanitary sewer serving the site. This line is only about 8-inch diameter and has limited hydraulic capacity,

estimated to be 150 gpm. Therefore, the discharge would be throttled to prevent backup or surcharging.

The representative for the City of Hamilton POTW who has cooperated in the arrangements for potential groundwater disposal is Michael L. Wheeler, Wastewater Treatment Supervisor.

GROUNDWATER DISPOSAL ASSUMPTIONS

The most uncertain factor in the pump test water disposal problem is the pumped water quality, specifically the VOC concentration. The discussion below summarizes the assumptions used to estimate the expected groundwater total VOC concentration.

CONTAMINATION CONCENTRATION ESTIMATION

Previous sampling has shown total VOC concentrations of 70 to 80 mg/l total VOC in water sampled from the upper 8 to 12 feet of the aquifer. Water taken from approximately 30 to 40 feet deep in the aquifer from a location west of the pump well (approximately 200 feet) has had a VOC concentration of 0.13 mg/l. Therefore, we assumed that the contamination is mostly limited to the upper portion of the aquifer.

The pump well will be 80 feet deep with screen for the entire length beginning 10 feet below the groundwater surface, which is approximately 25 feet from the ground surface. Initially, the pump will draw groundwater from the entire length of the screened section. After startup, the equilibrium groundwater flowstreams will be primarily from the lower portions of the screened section. The majority of groundwater to be collected onsite is expected to be from the deeper portion of the aquifer and, as discussed above, is expected to have low concentrations of VOC's.

The actual concentration of VOC's in the pump test groundwater is expected to be low. To estimate actual total VOC concentration, the following assumptions were made:

Total VOC concentration at 25 feet to 35 feet = 75 mg/l
Total VOC concentration at 60 feet to 80 feet = 0.20
Assume 20 percent flow from 25 feet to 35 feet
Assume 80 percent flow from 60 feet to 80 feet

The calculated VOC concentration is 15.2 mg/l. A range of 1.5 to 25 mg/l may be expected.

CONTAMINATION TREATABILITY

To assess the significance of these VOC concentrations against experience in other POTW's in the country, the VOC concentrations in one of the shallow onsite monitoring wells (MW-10) were compared to published maximum concentrations reported in the literature. This is a "worst case" situation because it uses the most contaminated, near-surface groundwater for the comparison. The summary of the data is presented in Table 2.

Table 2 shows that even the VOC concentrations in undiluted, contaminated groundwater are not greater than maximum values experienced at POTW's for most compounds. The actual concentrations of these compounds will be diluted two ways: cleaner water from deeper in the aquifer and dilution in the sewage collection system. Dilution by sewage will be approximately 85 to 1 sewage to groundwater based on the drainage flow of 18 mgd to the Hamilton POTW.

Table 2 also includes data on reported removals of most of the organic compounds. The majority of organic compounds are readily removed by conventional secondary treatment. Compounds which do not have reported removals are generally removable by air stripping with the exception of 1,1,2,2-tetrachloroethane which is not a particularly toxic pollutant.

CONCLUSIONS

The most practical cost-effective solution for treatment of the groundwater generated during the pumps test is to discharge this water at a controlled rate to the POTW without pretreatment. All water will be stored onsite before discharge. Representative samples will be analyzed for VOC's and all data will be made available to the City of Hamilton for final approval and permission to discharge.

Based on known contamination of the groundwater, the expected performance of the pump well, and published information on VOC concentrations in POTW's, other conclusions include the following:

- The major organic contaminants in the groundwater consist of the volatile fraction compounds or VOC. No pesticides or unusually toxic compounds have been identified.

- Concentration of VOC's in the most contaminated onsite monitoring (MW-10) is similar to the high values reported in the raw influent of several POTW's.

Table 2
COMPARISON OF VOC CONCENTRATIONS IN MW-10
WITH REPORTED MAXIMUM CONCENTRATIONS IN
POTW INFLUENT AND TREATMENT REMOVALS

Priority Pollutant Organic Compounds	MW-10	Percent of POTW Samples Detected[a]	Maximum Concentration, ug/l[a]	Reported Percent Removals[a]
VOLATILE ORGANICS, ug/l				
Benzene	420	61	1,560	100, 100, 91, 100, 100
Carbon tetrachloride	374	9	1,900	-
Chlorobenzene	107	13	1,500	100
1,2-dichloroethane	3,100	15	76,000	100
1,1,1-trichloroethane	4,967	85	30,000	100, 96, 79, 100, 79, 94
1,1-dichloroethane	303	31	24	100
1,1,2-trichlorethane	7,033	7	135	-
1,1,2,2-tetrachlorethane	5,400	7	52	-
chloroform	1,967	91	430	42, 17, 13, NR, NR
1,1-dichloroethene	1,533	26	243	-
Trans-1,2-dichloroethene	32,300	62	200	100, 100, 91, 100, 100, 100
1,2-dichlorpropane	70	7	2,600	-
Ethylbenzene	767	80	73	88, 100, 100, §50, §62, NR
Methylene chloride	270	92	49,000	61, 73, 14, 28, §50, NR, NR
Tetrachloroethene	2,700	95	5,700	100, 100, 80, 100, 100, 79
Toluene	4,670	96	13,000	100, 67, 100, 98, 100, 99, 100
Trichloroethene	9,700	90	18,000	100, 100, 44, 84, §50
Vinyl chloride	235	6	3,900	93
Chlordibromomethane	-	3	3	-
Chloroethane	-	1	38	NR, 31, NR
ACID ORGANIC, ug/l				
Phenol	290	-	-	§97, §96, 90, 99, 96
BASE/NEUTRAL, ug/l				
1,2-dichlorobenzene	105	23	440	§96, 100, 100
1,4-dichlorobenzene	11	17	200	§80

[a] "Fate of Priority Pollutants in Publicly Owned Treatment Works," Final Report, September 1982, p. 36-38.

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- o VOC concentration in the pump test water are expected to be significantly lower than the most contaminated onsite monitoring well.
- o The dilution factor of sewage flow to groundwater discharge will be approximately 85 to 1.
- o Almost all of the VOC's in the groundwater are found in POTW influent and are removed by typical secondary treatment processes.

GLT432/57

APPENDIX A

ACTUAL DISPOSAL OPERATIONS FOR PUMP TEST GROUNDWATER

MEMORANDUM

TO: File

FROM: John T. Fleissner/GLO

DATE: December 19, 1983

RE: Chem-Dyne Site Remedial Investigation
Actual Disposal Operations for Pump Test Groundwater
Phase III Subtask 3-3.4

PROJECT: W65310.C0

INTRODUCTION

Based on the evaluation of groundwater treatment and disposal alternatives described initially in the September 30 technical memorandum, CH2M HILL pursued the option of discharging collected groundwater directly to the municipal POTW without pretreatment. The purpose of this memorandum is to describe the actual steps taken to execute the groundwater disposal.

PRELIMINARY PLANNING

To investigate availability of the City of Hamilton POTW, Mr. Michael Wheeler, plant supervisor, was contacted by telephone on August 31, 1983. Mr. Wheeler agreed that the POTW could be used for treatment of the pump test groundwater if we met three conditions:

- Analyze the water for toxics.
- Meter the discharge to the POTW; a sewer use charge will be assessed based upon the hydraulic load.
- Control the rate of discharge to prevent surcharging in the 3rd Street interceptor.

These conditions were accepted and the initial plans were confirmed by an exchange of letters. (The design of the pump test was later modified to eliminate a "step drawdown" procedure originally proposed. This design change did not affect the disposal plans.)

PRELIMINARY PUMP TEST WORK

The 12-inch diameter pump test well was completed on October 5. The test well was developed on Friday, October 7 by pumping approximately 25,000 gallons at a maximum rate of approximately 1,100 gpm. All development water was collected in two 12,500-gallon temporary pools located immediately south of the test well.

The onsite groundwater storage equipment was provided by O.H. Materials. Storage equipment consisted of temporary aboveground pools with plastic liners and bolt-together fabricated aluminum walls. The total storage volume erected onsite was 1.0 million gallons in eighteen 50,000-gallon and one 100,000-gallon pools. All pools were set up during the first three weeks of October.

PRELIMINARY GROUNDWATER ANALYSIS

Before beginning the actual pump test, a sample of the groundwater pumped during the development of the pump test well was taken and sent to CH2M HILL's GC/MS laboratory on October 18. The sample was collected directly from one of the 12,500-gallon pools. The water was analyzed for the volatile organic fraction of the priority pollutants.

The results of the VOA analysis were sent to the field crew on the next day and are shown in Exhibit A-1 at the end of this TM. The analysis showed that the total volatile organic priority pollutant concentration was about 0.5 mg/l which was on the low side of the range estimated using historical groundwater data from nearby monitoring wells.

FINAL GROUNDWATER DISPOSAL PLANS

To make final arrangements for groundwater disposal at the POTW, Fleissner/CH2M HILL met with Wheeler, Hamilton POTW Treatment Supervisor, on October 24. At this meeting they reviewed the VOA data from the well development water sample. Because the sample did contain measurable concentrations of several volatile compounds, Wheeler requested that CH2M HILL provide additional background information to support the feasibility of satisfactory disposal at the POTW. Both Wheeler and Fleissner concluded that treatment was feasible; however, to support the treatment action Wheeler felt that the City needed more documentation.

On October 26, Fleissner furnished the City with the September 30 TM, "Evaluation of Treatment and Disposal of Water Produced During Pump Test," backup calculations on VOA concentration estimates and removal estimates, and several reference documents with information on VOA treatment and performance of POTW's in VOA removals, including:

- o Treatability Manual, Vol. I, U.S. EPA, July 1980 (EPA-600/8-80-042a)
- o Fate of Priority Pollutants in Publicly Owned Treatment Works, Vols. I and II, July 1982 (EPA 440/1-82/83)
- o Conway and Ross, Handbook of Industrial Waste Disposal, Van Nostrand Reinhold Co., 1980

On the basis of the results of VOA analysis of the well development water and the background treatability information, Wheeler gave CH2M HILL verbal approval to discharge the pump test water without additional sampling and analysis. The final groundwater disposal plan was to meter the pump test discharge to the storage pools, store all pump test groundwater in pools onsite, and discharge the water at a controlled rate to the POTW.

PUMP TEST OPERATIONS

The actual pump test was preceded by two trial runs which were used to test and calibrate the onsite pumping, distribution, and storage equipment. These trial runs were conducted on Thursday, October 27 and Saturday, October 29. (The actual test was attempted on October 28 but was aborted after only 20 minutes because of a flowmeter failure.)

The actual pump test was started at 11:00 on October 30 and pumping continued at 1,000 gpm until 01:35 on October 31. The total volume of groundwater pumped during the trial runs, aborted run, and the actual test was 962,000 gallons.

According to our understanding with the City of Hamilton, CH2M HILL informed Wheeler of the total volume of water in a letter on November 3. The City invoiced CH2M HILL directly for a sewer use charge based upon the hydraulic load.

GROUNDWATER DISCHARGE OPERATIONS

On Tuesday, November 1, CH2M HILL personnel met with Mr. Thomas Wardlow, City of Hamilton Public Works Superintendent at the site to begin discharge to the POTW. The discharge location initially selected was a manhole northwest of monitoring well MN-15 on the Hamilton Electric Power Company property west of the site.

To use the manhole on the Hamilton Electric Company property, permission was obtained from Don Stuart, supervisor. We coordinated our activities on the plant property to minimize interference with the utility's operations. We also obtained permission from the Chessie System to place irrigation pipe temporarily under their tracks which run between the site and discharge manhole. Mr. Bruce Roe of the

Chessie System gave permission for placement of the temporary line.

Groundwater discharge was begun at approximately 10:00 a.m. Water was pumped from the site through a discharge line placed across the site, under the Chessie System railroad tracks, and across the Hamilton Electric property to the manhole. After approximately 20 minutes, discharge was stopped because there was no flow observed in a downstream manhole. Wardlow concluded that the sewer line must have been plugged with silt, a typical condition for this line in the coal storage yard area.

To bypass the blockage in the sewer line, the discharge point was changed from the initial manhole to the one used for the initial downstream observation point, approximately 25 feet south of the northernmost Hamilton Electric building. Groundwater discharge was restarted on November 2 by CH2M HILL under the observation of Thomas Wardlow.

The discharge flow was adjusted to approximately 100 to 150 gpm and was continued until November 9 when all groundwater had been pumped to the sewer. CH2M HILL supervised the groundwater pumpage from the start until about midday Friday, November 4. The final days of groundwater discharge, from November 4 through November 9, were conducted with the supervision of O.H. Materials, who also dismantled and removed the pools as they were emptied.

CONCLUDING ACTIVITIES

At the conclusion of groundwater discharge on November 9, O.H. Materials notified CH2M HILL. We, in turn, notified both Tom Wardlow and Michael Wheeler at the City of Hamilton by telephone that operations were complete.

During our conversation with Wheeler, we requested a written statement of the City's permission to discharge the pump test groundwater to the POTW. This letter would be to simply confirm the clear understandings which we operated under in the field.

CH2M HILL received the letter from Wheeler on November 21 confirming the authorization from the City to discharge the pump test groundwater. This letter is attached at the end of this memorandum as Exhibit A-2. Shortly thereafter CH2M HILL received the invoice from the City for use of the sewerage system based on a hydraulic load charge of $0.60/100CF plus a $0.60 basic billing charge or a total charge of approximately $775.

The letter confirming discharge authorization with the sewerage use invoice and payment concluded the operations for treatment and disposal of the pump test groundwater.

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CH2M HILL

Exhibit A-1 (Page 1 of 2)

ORGANIC ANALYSIS

SAMPLE INFORMATION

Client: Chem Dyne Attn: John Fleissner

Address: CH2M HILL Post Office Box 2090 Milwaukee, WI 53201

Date Received: October 19, 1983 Date Reported: October 19, 1983

Types and Quantity of Samples: One Water Sample

Analysis Requested:

1. Priority Pollutants
   - Volatiles X
   - Base/Neutrals
   - Acids
   - Pesticides
2. SDWA Pesticides & Herbicides
3. Trihalomethanes
4. PCB's
5. Other

ANALYTICAL INSTRUMENTATION

X Finnigan Model 4021 Gas Chromatograph/Mass Spectrometer/Data System equipped with a Tekmar LSC-1 Liquid Sample concentrator.

____ Varian Model 3700 Gas Chromatograph equipped with flame ionization, electron capture, and thermionic specific detectors.

ANALYTICAL METHODOLOGY

1. Priority Pollutants—The samples are analyzed in accordance with procedures described in Methods 608, 624, and 625, EPA-600/4-82-057 (1982)
2. Phenoxyacid Herbicides—Samples are analyzed in accordance with procedures outlined in Methods 7, *Federal Register*, Vol. 38, No. 75, Part II, November 28, 1973.
3. Pesticides and PCB's (soil, sediment, etc.)—Samples are analyzed in accordance with procedures outlined in EPA Method 8.08, *Test Methods for Evaluating Solid Waste*, 1980.

Respectfully submitted,

Harold E. Cole

Harold E. Cole, Mass Spectroscopist/Manager Organics

Craig O. Vinson

Craig O. Vinson, Laboratory Director

Exhibit A-1 (Page 2 of 2)

CH2M HILL

VOLATILE COMPOUNDS

GC/MS Report

Analyst H. Cole

Date of Analysis 10/19/83

Client Chem Dyne

Laboratory No.

Sample Description Labeled 23276052

Compounds	MDL[1] PPB	Conc.[2] PPB
Chloromethane	10	BMDL
Bromomethane	10	BMDL
Vinyl Chloride	10	96
Chloroethane	10	BMDL
Methylene Chloride	5	6
Trichlorofluoromethane	5	BMDL
1,1-Dichloroethene	5	31
1,1-Dichloroethane	5	*
Trans-1,2-Dichloroethene	5	140
Chloroform	5	12
1,2-Dichloropropane	5	BMDL
1,1,1-Trichloroethane	5	BMDL
Carbon Tetrachloride	5	BMDL
Bromodichloromethane	5	BMDL
1,2-Dichloroethane	5	5
Trans-1,3-Dichloropropene	5	BMDL
Trichloroethylene	5	45
Benzene	5	6
Dibromochloromethane	5	BMDL
1,1,2-Trichloroethane	5	170
Cis-1,2-Dichloropropene	5	BMDL
2-Chloroethyl vinyl ether	10	BMDL
Bromoform	5	BMDL
1,1,2,2-Tetrachloroethane	5	33
Tetrachloroethylene	5	55
Toluene	5	BMDL
Chlorobenzene	5	BMDL
Ethyl Benzene	5	7
Acrylonitrile	100	BMDL
Acrolein	100	BMDL
Dichlorodifluoromethane	ND[3]	BMDL

[1]MDL = Method Detection Limit

[2]BMDL = Below Method Detection Limit

[3]ND = Not Determined

Comments *Detected, but less than stated method detection limit.

MUNICIPAL BUILDING •20 HIGH STREET AT MONUMENT 45011
WASTEWATER TREATMENT PLANT, 2451 RIVER RD. (45015)

Hamilton Ohio

Exhibit A-2

November 18, 1983

Mr. John T. Fleissner
CH2M Hill
310 West Wisconsin Ave.
P.O. Box 2090
Milwaukee, Wis. 53201

Dear John:

As we discussed, this letter is to verify for your files that authorization was given for discharge of the well test water from Chem-Dyne into the City of Hamilton sewer system. Based on the meter readings, the amount of discharge was 962,000 gallons.

Based on the current sewer ordinance, the fee for that discharge is computed as $0.60/100 cu. ft. plus $0.60 basic billing charge. The analytical data from samples collected indicate that no further charges will be required.

An invoice is being sent out under separate cover to cover the fees due for the above referenced discharge.

I appreciate your cooperation and enjoyed working with you on this project.

Very truly yours,

Michael L. Wheeler

Michael L. Wheeler, Supervisor
Wastewater Treatment Plant

MLW:re

MEMORANDUM

TO: File

FROM: Bruce L. Cutright/GLO
David J. Bennett/GLO

DATE: February 14, 1984

SUBJECT: Chem-Dyne Site Remedial Investigation
Aquifer Pump Test
Phase III - Subtask 3-3.5

JOB NO: W65310.C0

INTRODUCTION

This memorandum summarizes the activities, events, and results of the aquifer pump test conducted at the Chem-Dyne site in Hamilton, Ohio. Field activities for the tests conducted between October 26 and November 2 include setup and equipment check-out, field verifications, pump testing, and personnel and equipment decontamination. Water generated from the test was temporarily stored onsite for later disposal by direct discharge to the City of Hamilton Wastewater Treatment System (see Task 3-3.4).

The pump test was planned and implemented under the direction and review of EPA personnel.

PURPOSE

The pump test was conducted in partial satisfaction of EPA Work Assignment WA 21.5M10.0. The purpose of the test was to obtain data necessary to quantify the hydraulic properties of the aquifer in the area of the site.

DESCRIPTION OF SITE CONDITIONS RELEVANT TO THE TEST

Within a radius of approximately 1,500 feet from the test well there are 36 monitoring wells used to provide data on groundwater quality and water levels. The locations for these wells are shown in Figure 1. Table 1 summarizes available well construction information. During the pump test, water levels in the test well and thirty-five of the monitoring wells were monitored. MW-14 was dry and, therefore, was not monitored.

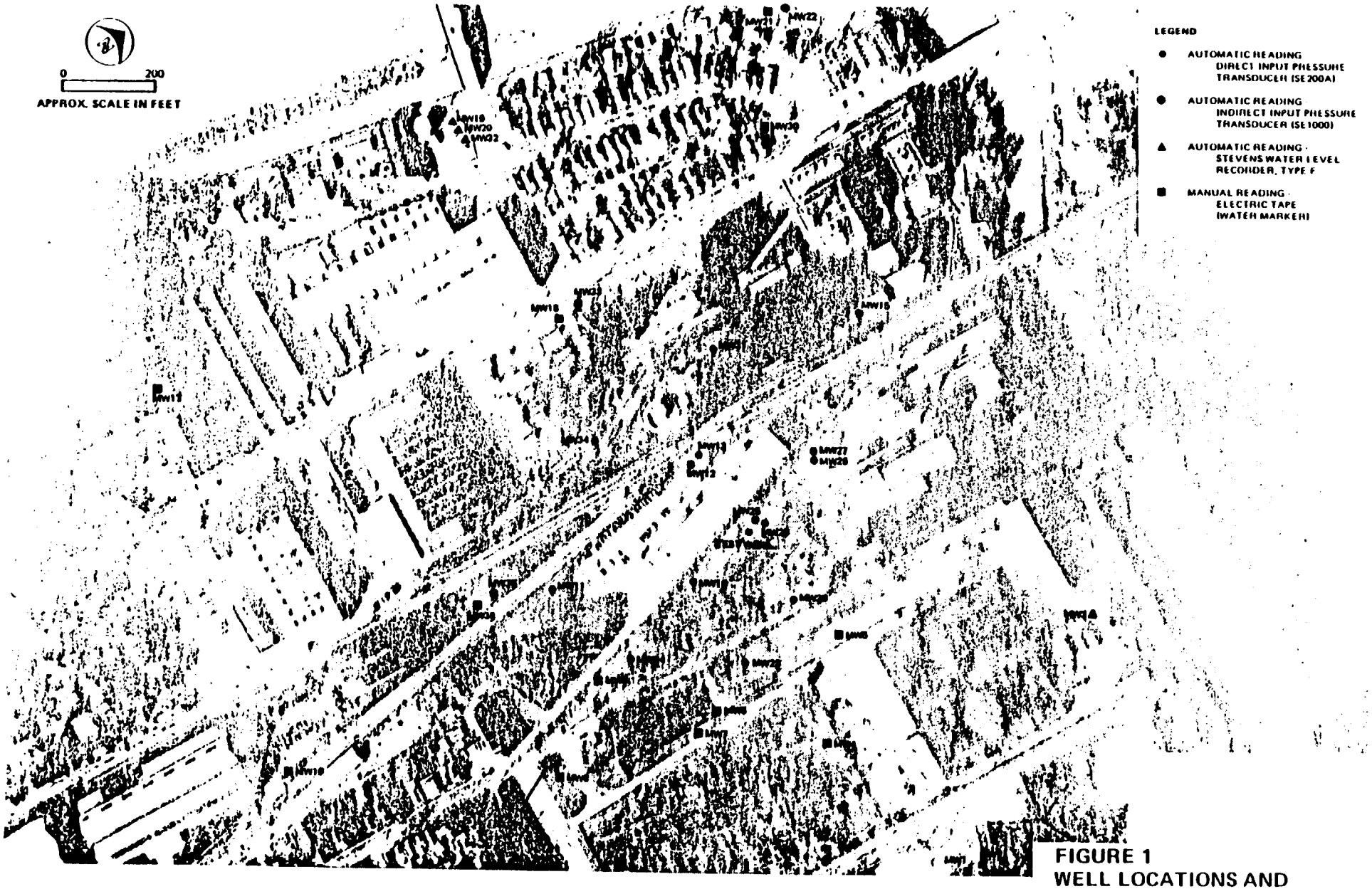

FIGURE 1
WELL LOCATIONS AND TYPE OF MONITORING AT OBSERVATION WELLS DURING PUMP TEST
CHEM-DYNE RI

Table 1
WELL CONSTRUCTION INFORMATION

Monitoring Well	Elevation Top of Casing (ft)	Well Depth (ft)	Screened Interval (ft)	Static Water Elevation (ft)[a]	Materials	Diameter (inches)
MW-1	591.12	62	Unknown[c]	563.68	Galvanized steel	4
MW-2	591.52	36	Unknown[c]	563.72	Galvanized steel	4
MW-3	591.14	35	Unknown[c]	563.96	Galvanized steel	4
MW-4	592.89	32	21-30	563.26	Galvanized steel	2
MW-5	591.62	34	23-34	563.31	Galvanized steel	2
MW-6	592.19	31	19-30	564.40	Galvanized steel	2
MW-7	593.30	34	25-33	563.30	Galvanized steel	2
MW-8	597.91	40	Unknown[c]	563.01	Galvanized steel	4
MW-9	592.83	33	23-34	563.08	Galvanized steel	2
MW-10	591.58	35	25-33	563.29	Galvanized steel	2
MW-11	598.36	40	27-37	563.02	Galvanized steel	2
MW-12	593.18	58	Unknown[c]	562.96	Galvanized steel	4
MW-13	593.20	32	22-32	563.19	Galvanized steel	2
MW-14	594.39	31	19-30	-[b]	Galvanized steel	2
MW-15	595.56	40	Unknown[c]	563.22	Galvanized steel	4
MW-16	594.82	41	Unknown[c]	562.44	Galvanized steel	4
MW-17	597.32	44	Unknown[c]	560.83	Galvanized steel	4
MW-18	594.65	38	27-37	562.67	Galvanized steel	2
MW-19	591.42	65	Unknown[c]	559.79	Galvanized steel	4
MW-20	592.02	40	Unknown[c]	562.11	Galvanized steel	4
MW-21	598.06	48	Unknown[c]	561.30	Galvanized steel	4
MW-22	597.57	78	Unknown[c]	560.29	Galvanized steel	4
MW-23	590.32	35	25-35	563.07	Stainless steel	4
MW-24	591.32	35	25-35	563.07	Stainless steel	4
MW-25	591.25	35	25-35	563.06	Stainless steel	4
MW-26	590.52	65	55-65	562.96	Stainless steel	4
MW-27	590.71	35	25-35	563.13	Stainless steel	4
MW-28	591.56	65	55-65	563.00	Stainless steel	4
MW-29	590.85	35	25-35	563.22	Stainless steel	4
MW-30	592.77	40	30-40	561.25	Galvanized steel	4
MW-31	594.07	40	30-40	562.84	Galvanized steel	4
MW-32	592.52	95	85-95	559.57	Galvanized steel	4
MW-33	595.29	65	55-65	562.05	Galvanized steel	4
MW-34	596.25	40	30-40	562.86	Galvanized steel	4
MW-35	595.76	65	55-65	562.92	Galvanized steel	4
MW-36	594.73	40	30-40	563.03	Galvanized steel	4
Test Well	591.72	80	40-80	562.97	Black Iron	12

[a] Water elevation before pumping October 30, 1983.
[b] Well was dry at time of measurement.
[c] Well was installed by Roy F. Weston, Inc., and no record of screened interval is available.

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Minor or background changes in the monitoring well water levels were related to events beyond the control of the test, such as trends in the water table, passing trains, barometric pressure changes, fluctuations in the level of the river or canal and nearby wells. When possible, data on these events during the testing period were recorded at the site or acquired from public agencies such as the National Weather Service. Known nearby pumping wells and the time for each train passing during the test are shown in Table 2. Barometric pressure fluctuations, temperature and humidity are included in Table 3. Changes in stage of the canal and river were monitored at a station near well MW-22. Total change in stage of the canal (100 feet from confluence with the Great Miami River) was a drop of one inch during the test and is shown in Table 4.

Weather conditions during the week prior to the test were rainy and overcast. Approximately one inch of rain fell between October 17 and 22. October 23 through 25 was overcast with occasional traces of precipitation. October 26 through November 2 was clear to partly cloudy with temperatures ranging from the mid-40's to the high 60's. Standing water was evident on the site until October 28 to 29. By October 30, only occasional small puddles remained.

Contamination in the water pumped during the test prohibited discharge to the Ford Canal or the Great Miami River. All of the water pumped during the test was stored onsite until adequate disposal methods could be implemented (see TM, Subtask 3-3.4, Appendix).

In planning the test, preliminary calculations based on estimates of the transmissivity and storage coefficient of the aquifer indicated that a pumping rate between 500 gallons per minute (gpm) and 1,500 gpm would be reasonable for the test. Storage capacity for pumped water was limited to one million gallons. For analysis purposes it was desirable for the test to run for at least 1,000 minutes. With the available storage capacity of 1 million gallons a maximum pumping rate of 1,000 gpm was selected to be compatible with the test requirements.

PERSONNEL

The primary participants in the pump test and their responsibilities were as follows:

Table 2
OFFSITE AND ONSITE ACTIVITIES WHICH POTENTIALLY AFFECT WATER LEVELS DURING THE PUMP TEST

PUMPAGE FROM OTHER WELLS:

- City Electric Plant (Don Stewart, 868-5863)
  one well pumped continuously at 600 gpm; might have run a second well for a short period of time.

- Champion Paper (Bill Huston, 868-5232)
  More than one well could have been pumping during the test; total pump rate may have been as high as 2,000 gpm; effects on MW-19, MW-20, MW-32 observed prior to initiating pump test.

- City Water Production (Tom Shinnon, 868-5993)
  North well field should not have significant impact on water levels in the test area.

- Hamilton Fire Department (Chief Beckett, 868-5914)
  Discharges from hydrants for emergencies, annual cleaning and training; none of these activities were predicted to occur during the pump test.

- Beckett Paper (Cecil Lakes, Burt McGanghey, 863-5641)
  Three wells run continuously at 1,800 gpm; maintained at that level for production reasons.

TRAIN PASSAGES:

Time of Train Passages (10/30 - 10/31)	Description (where available)
11:18 - 11:19	Single-engine train, with 6 cars
12:01 - 12:10	Three-engine train, with 140 cars
3:27 - 3:47	Three-engine train arrived
3:47 - 3:48	Three-engine train stopped on tracks
3:48 - 3:55	Three-engine train departed
3:58 - 4:03	Single-engine train
4:22 - 4:26	Single-engine train
5:14 - 5:18	Two-engine train
6:33 - 6:42	Three-engine train
22:06 - 22:15	
22:15 - 22:19	
22:58 - 23:04	
23:20 - 23:25	
1:07 - 1:11	
1:55 - 2:05	Three-engine train
2:26 - 2:29	
2:45 - 2:50	Two-engine train

Table 3
NATIONAL WEATHER SERVICE DATA DESCRIBING METEOROLOGICAL CONDITIONS DURING PUMP TEST (OCTOBER 30, 1983)

Date	Time	Temperature (F°)	Humidity (%)	Barometer Pressure (inches mercury)
10/30/83	11:00	49	54	30.49
	13:00	55	45	30.44
	15:00	56	38	30.40
	17:00	55	45	30.37
	19:00	49	63	30.38
	21:00	47	58	30.38
	23:00	47	58	30.38

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Table 4
CANAL LEVEL FLUCTUATIONS DURING PUMP TEST

Time (Hours)	Depth to Canal[a]	Change in Water Level from Preceding Measurement (inches)
13:20:00		
11:55:00	River Stage 5' 8-1/4"	0
12:54:00		
13:47:00	River Stage 5' 8-1/4"	0
15:08:30	River Stage 5' 8-1/2"	- 1/4
16:23:30		
18:02:00		
19:35:00	River Stage @ 5' 8"	+ 1/2
23:07:00		
01:04:00	River Stage @ 5' 8-1/2" @ 0128	- 1/2
03:01:00	Recovery began 0135	
03:39:00		
04:15:00	River Stage @ 5' 9-1/4" @ 0420	- 1 1/4
04:55:00		

[a]Depth to canal measured at outfall structure near well MW-22 100' from the confluence of the pond canal and the Great Miami River.

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CH2M HILL

Larry Holm, Project Manager. Responsible for overall project coordination. During the test, he monitored the storage tanks and discharge lines, site safety procedures and coordinated the various subcontractors.

Bruce Cutright, Project Hydrogeologist. Responsible for test set-up and procedures. Monitored and controlled pump discharge during the test.

John Fleissner, Project Engineer. Responsible for offsite data collection.

Brad Berggren, Geotechnical Engineer. Responsible for onsite monitoring well measurements.

In-Situ, Inc.

Roger Lewis, Field System Engineer. Responsible for setup, verification and operation of In-Situ data acquisition equipment.

Ted Way, Computer Systems Engineer. Assisted Roger Lewis during equipment setup and checkout. Departed October 28 prior to test.

Tetra Tech, Inc.

Robert Scholar, Member of Technical Assistance Team. Approved to be onsite by EPA regional site project officer. Assigned the responsibilities of monitoring well MW-9 and assisted at the hotline.

Observers:

Joe Keely, U.S. EPA, Ada, Oklahoma
David Strayer, Ohio EPA
Leonard Wood, S.S. Papadopulos and Associates
Paul Plummer, Miami River Conservancy District

O.H. Materials, Inc. personnel provided and assembled the water storage pools and assisted in operating the discharge lines. The pump and motor were operated by GMC Associates, Inc.

TEST SETUP

The test was conducted using as guidelines the methods and procedures described in Stallman(1). The data collected during the test consisted of water levels in the monitoring wells, pump discharge rate and time.

Water level data were collected in 35 of the 36 monitoring wells and the test well. Water levels in MW-10, MW-11, MW-12, MW-13, MW-15, MW-23, MW-24, MW-25, MW-26, MW-27, MW-28, MW-29, MW-31, MW-34 and the test well were measured by pressure transducers connected to an automatic data acquisition system (ADAS) provided by and operated by In-Situ, Inc., at the command center. Monitoring wells MW-22, MW-33 and MW-35 had pressure transducers installed that recorded on remote recorders provided by In-Situ, Inc. At the completion of the test the records were re-recorded onto the same tape as the above mentioned 15 wells.

The selection of the monitoring method for each of the wells was somewhat dictated by equipment availability, especially the number and the length of transducer cable.

Stevens type F water level recorders with 48-hour clocks and 1:1 gear ratios were installed on MW-3, MW-19, MW-20 and MW-32. These recorders were setup on October 25 and operated continuously until November 1. Water level records for these recorders are included in Attachment 1.

In addition to the automatic water level measurements, wells, MW-1, MW-2, MW-4, MW-5, MW-6, MW-7, MW-8, MW-9, MW-16, MW-17, MW-18, MW-21, MW-30, and MW-36 were periodically monitored throughout the test with electrical water level probes (Water Marker) manufacturered by Johnson Well, Inc. Because of limited personnel and distance between the wells, water level data in these manually measured wells were collected at longer intervals than those wells monitored by the automatic systems. These data were collected to cross-check and backup the pressure transducers in the event of failure of the ADAS. The method of water level measurement is summarized in Figure 1 and Table 5. Time for all the measurements was measured by digital wrist watches carried by the test participants and synchronized with the data acquisition computer. Water level and pump rate data are included in Attachment 1 at the end of this TM.

The well was pumped by a shaft driven pump powered by a four cylinder diesel engine. Pump discharge was measured by an

Table 5
MONITORING INFORMATION

Well Number	Distance from[a] Test Well (r) (feet)	Monitoring[b] System
MW-1	957	MM
MW-2	965	MM
MW-3	848	SR
MW-4	537	MM
MW-5	313	MM
MW-6	420	MM
MW-7	480	MM
MW-8	740	MM
MW-9	487	MM
MW-10	186	PT:SE200A
MW-11	502	PT:SE200A
MW-12	232	PT:SE200A
MW-13	232	PT:SE200A
MW-14	701	-[c]
MW-15	611	PT:SE200A
MW-16	1,275	MM
MW-17	1,518	MM
MW-18	692	MM
MW-19	1,204	SR
MW-20	1,225	SR
MW-21	1,259	MM
MW-22	1,261	PT:SE1000
MW-23	298	PT:SE200A
MW-24	398	PT:SE200A
MW-25	53	PT:SE200A
MW-26	62	PT:SE200A
MW-27	272	PT:SE200A
MW-28	248	PT:SE200A
MW-29	167	PT:SE200A
MW-30	993	MM
MW-31	465	PT:SE200A
MW-32	1,236	SR
MW-33	690	PT:SE1000
MW-34	454	PT:SE200A
MW-35	651	PT:SE1000
MW-36	696	MM
Test Well	0	PT:SE200A

[a] Calculated from survey data rounded to the nearest foot.

[b] PT:SE1000 - Automated monitoring made by a pressure transducer (model SE200A), automatically.

PT:SE200A - Automated monitoring made by a pressure transducer (model SE1000); not linked to central computer system; discrete measurements.

MM - Manual monitoring using electric tape; discrete measurement.

SR - Automatic monitoring using Stevens Recorder Type F; continuous measurements.

[c] No data collected.

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8-inch, in-line totalizing meter manufactured by Hersey Products, Inc., of Dedham, Massachusetts (serial number 831127). This meter replaced the original meter that malfunctioned during the false start of the pump test on October 28, 1983. It was factory calibrated on January 27, 1983. A digital stop watch was used to determine the volume of flow per unit time. Adjustment of the flow rate was accomplished by an 8-inch gate valve located between the totalizing meter and the pump. The pumping rate throughout the test is shown in Figure 2. As described by Stallman(1) the discharge should not vary more than ±10 percent. During the test as valves were opened and closed to different discharge tanks the pump rate varied slightly. Adjustments were made to maintain constant discharge rate by adjusting the gate valves or the pump rpm. The discharge was held to within ±5 percent of the planned 1000 gpm for the entire test.

DATA VERIFICATION AND QUALITY CONTROL

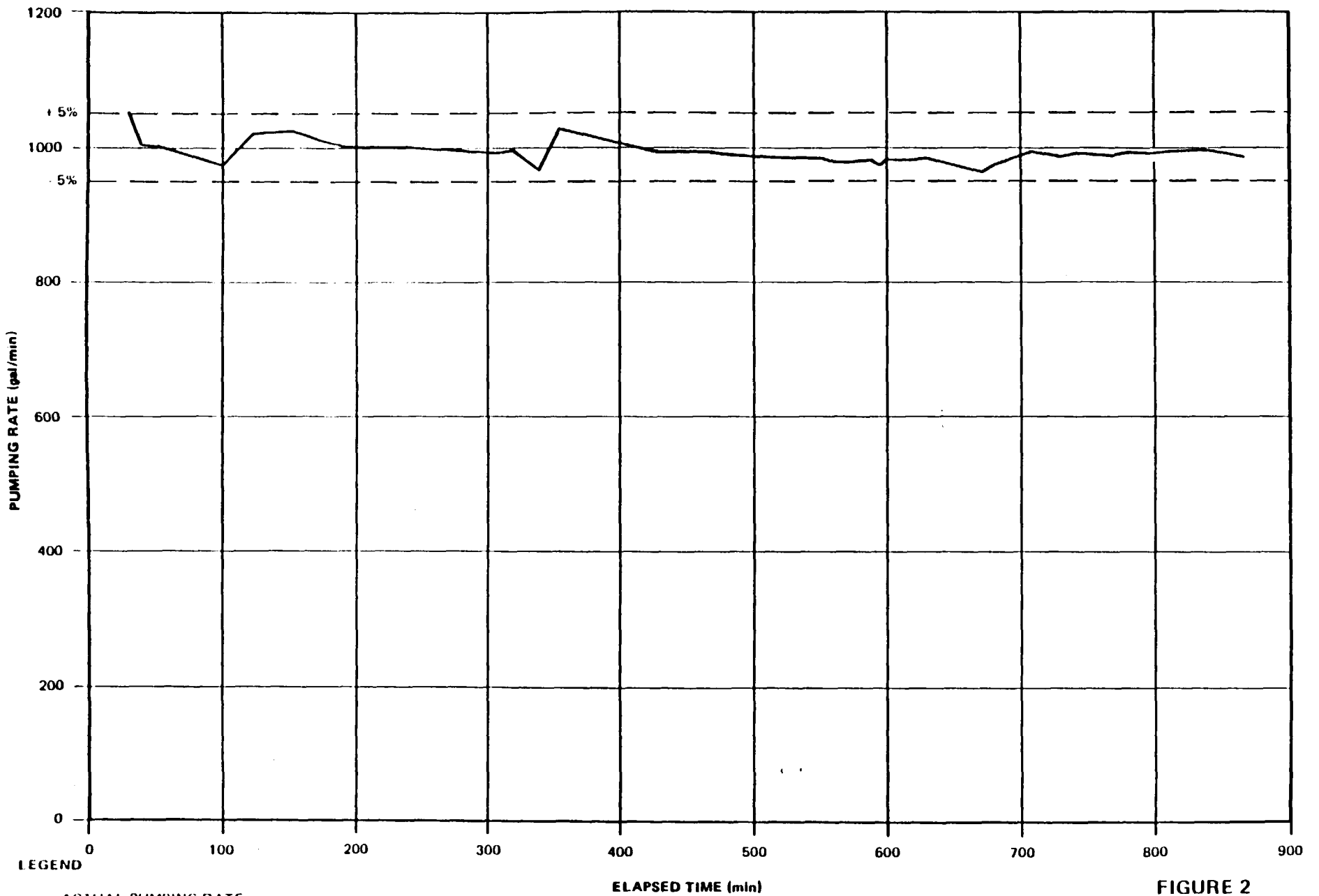
Water level measurements in all the wells were taken prior to the test with Johnson Water Marker electrical tapes and steel pocket tapes. The probes were rinsed with either distilled or tap water between each measurement to avoid cross contamination of the wells. This procedure was followed before, during and after the test. The transducers were set at known depths below the water level in each well. To confirm that the transducers were accurately responding to changes in water levels, each transducer was lifted one foot and the response monitored at the remote readout. When the appropriate change was confirmed, the probe was lowered and checked to determine if it had returned to the previous level. All the probes responded correctly. Communication between the field personnel and the command center where the data acquisition computer was located was by hand-held Motorola FM radio units.

CHRONOLOGY OF EVENTS

The following summarizes the major activities and events immediately preceding, during and following the pumping test.

OCTOBER 24, 1983, MONDAY

Larry Holm, Brad Berggren, and John Fleissner were onsite. Bruce Cutright arrived on October 23 and examined the area



LEGEND

— ACTUAL PUMPING RATE

- - ±5% OF 1000 gal/min WHERE 1000 gal/min IS THE DESIGN PUMPING RATE

FIGURE 2
PUMPING RATE DURING PUMP TEST
CHEM-DYNE RI

to be a thick blue clay layer [Spieker, (2)] that appears to the west of the site and extends below the Great Miami River.

The aquifer responded to the pump test generally as an unconfined aquifer, particularly in the shallow wells. Unconfined to semiconfined aquifer response was observed in the deeper wells. There were delayed yield components to the drawdown data in many of the wells. A discussion of the methods of analysis applied to the drawdown data follows. Due to excessive background interference, instrument failure or inaccurate instrument readings data from monitoring wells MW-11, MW-12, MW-15, MW-22, MW-24 and MW-31 are less reliable for analysis than the remaining wells. Table 6 summarizes the results obtained from the drawdown data analysis and includes comments on the data quality from each well equipped with a pressure transducer monitoring system.

Appropriate type curve and approximate analytical methods were chosen based on the observed response of the aquifer.

Type Curves for Unconfined Aquifers with Vertical Movement

Lohman(3) presents a series of type curves that provide solutions to the equation describing flow in an unconfined aquifer having vertical flow components. Sets of curves are presented for various depths of penetration of the monitoring well and for both a fully and partially penetrating test well. Although the test well did not fully penetrate the aquifer, the fully penetrating type curves were used because the actual condition is more closely approximated by the fully penetrating case than the specific condition represented by the type curves for the partially penetrating case.

In analyzing the drawdown data, the type curves corresponding to a monitoring well penetrating the upper 25 percent of an aquifer were used for monitoring wells set at depths of 30-40 feet. Type curves corresponding to penetration of the upper 50 percent of an aquifer were used to analyze data from deeper monitoring wells. These sets of type curves are presented by Lohman(3), as Plates 6C and 6D, respectively.

The type curve matching method for determining the aquifer parameters is illustrated in Figure 3 which shows the drawdown data for MW-26.

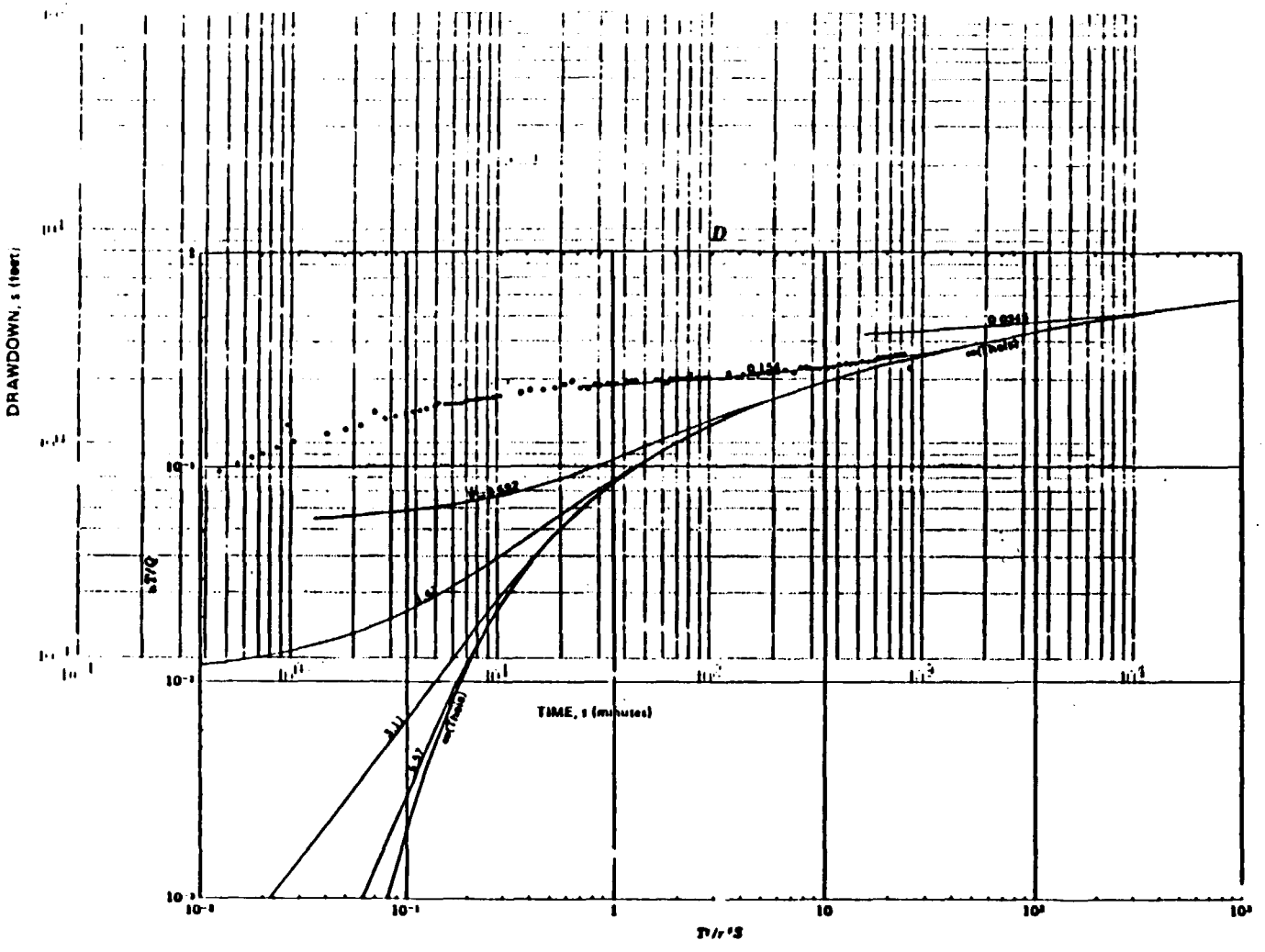
A log-log plot of drawdown versus time data collected during the pumping test for each well was prepared by In-Situ, Inc.

Table 6
AQUIFER TRANMISSIVITY AND STORAGE COEFFICIENT

Well Number	Distance from Test Well r (feet)	Well Depth (feet)	Quality of Data	Transmissivity, T (gal/day/ft)					Storage Coefficient, S			
				Unconfined, Vertical Movement	Delayed Yield Early	Delayed Yield Late	Jacob Drawdown	Jacob Recovery	Unconfined, Vertical Movement	Delayed Yield Early	Delayed Yield Late	Jacob Drawdown
MW-10	186	35	Poor	0.16×10^5	3.8×10^5	0.29×10^5	-- [b]	-- [a]	.30	.11	.27	-- [b]
MW-11	502	40	Unusable									
MW-12	232	58	Unusable									
MW-13	232	32	Poor	1.0×10^5	-- [a]	1.04×10^5	-- [b]	-- [a]	.32	-- [a]	.33	-- [b]
MW-15	611	40	Unusable									
MW-22	1261	78	Unusable									
MW-23	298	34	Poor	1.2×10^5	-- [a]	1.5×10^5	-- [b]	-- [b]	.20	-- [a]	.19	-- [b]
MW-24	398	35	Unusable									
MW-25	53	33	V. Good	1.2×10^5	1.1×10^5	1.4×10^5	1.2×10^5	0.7×10^5	.071	.008	.074	.076
MW-26	62	65	V. Good	1.9×10^5	2.9×10^5	1.6×10^5	2.7×10^5	2.6×10^5	.15	.001	.24	.020
MW-27	277	36	Good	0.85×10^5	-- [a]	0.57×10^5	-- [b]	-- [b]	.074	-- [a]	.098	-- [b]
MW-28	248	65	Fair	3.9×10^5	3.8×10^5	-- [a]	-- [a]	-- [a]	.0076	.0009	-- [a]	-- [a]
MW-29	167	35	V. Good	1.6×10^5	-- [a]	1.6×10^5	-- [b]	-- [b]	.12	-- [a]	.11	-- [b]
MW-31	465	40	Unusable									
MW-33	690	67	V. Good	2.2×10^5	6.4×10^5	3.9×10^5	-- [b]	5.9×10^5	.073	.0008	.045	-- [b]
MW-34	454	40	Poor	--	-- [a]	-- [a]	--	4.2×10^5	-- [a]	-- [a]	-- [a]	-- [a]
MW-35	651	66	Fair	6.9×10^5	6.0×10^5	6.0×10^5	-- [a]	-- [a]	.0045	.0002	.0048	-- [a]

[a] Data points too scattered to apply method.
[b] Method not valid; u greater than 0.01.

GLT460/9



LEGEND

- OBSERVED DRAWDOWN

NOTE:
Type curve taken from Lohman (1972) plate 6D.

FIGURE 3
MATCHING THE TYPE CURVE FOR AN UNCONFINED AQUIFER AND THE PLOT OF AQUIFER RESPONSE MEASURED AT MW26
CHEM-DYNE RI

and is included in Attachment 1. The type curve is superimposed on the data plot and shifted, while keeping the horizontal and vertical axes of the type curve and data plot parallel, until the type curve matches the data plot. A match point is then selected on the overlapping areas of the two curves. The values of unity for drawdown and time on the data plot corresponding to values on the vertical and horizontal axes, respectively, of the type curve are obtained. These values are substituted into the following equation to determine the transmissivity (T) and storage coefficient (S).

$$T = Q/s$$
$$S = Tt/r^2$$

where,
- T = transmissivity, (ft^2/sec or gal/day/ft)
- S = storage coefficient, (dimensionless)
- Q = flow rate, (ft^3/sec or gal/min)
- s = drawdown, (ft)
- t = time, (sec or min)
- r = distance between monitoring well and test well, (ft)

The ratio of vertical to horizontal hydraulic conductivities is related to the parameter, ψ, for the matching type curve by the following equation:

$$K_z/K_r = [\psi/(r/b)]^2$$

where,
- K_z = vertical hydraulic conductivity, (ft/sec or gal/day/ft^2)
- K_r = radial hydraulic conductivity, (ft/sec or gal/day/ft^2)
- b = saturated aquifer thickness, (ft)
- ψ = type curve parameter from Lohman(3), (dimensionless)
- r = radial distance between monitoring well and pumped well, (ft)

This method was applied to data from wells MW-10, MW-13, MW-23, MW-25, MW-26, MW-27, MW-28, MW-29, MW-33 and MW-35.

Type Curves for Unconfined Aquifers with Delayed Yield

Unconfined aquifers often exhibit a delayed yield phenomenon in which water is not immediately released from the aquifer in response to a drop in the water table. Lohman(3) presents

type curves for analyzing pumping test data that reflect this condition. The solution procedure is illustrated in Figure 4 for pumping test data from MW-26. The same curve matching technique as described in the previous section is used to obtain the values for the transmissivity and storage coefficient. The left-hand portions of the type curves are used to analyze data during early pumping times and the right-hand portions of the curves are used for later times. The aquifer parameters were computed using the following equations.

$$T = Q/4\pi s$$
$$S = 4Tt/r^2$$

where, T, S, Q, S, t, r as previous defined

The type curves shown in Figure 4 are a modification based on type curves for delayed yield presented by Freeze and Cherry(4) of Lohman's Plate 8. Values for the parameter, η, have been assigned to the type curves. The value for η is used to estimate the ratio of vertical to radial hydraulic conductivities given by the following equation.

$$K_z/K_r = \eta/(r/b)^2$$

where, r, b as previously defined

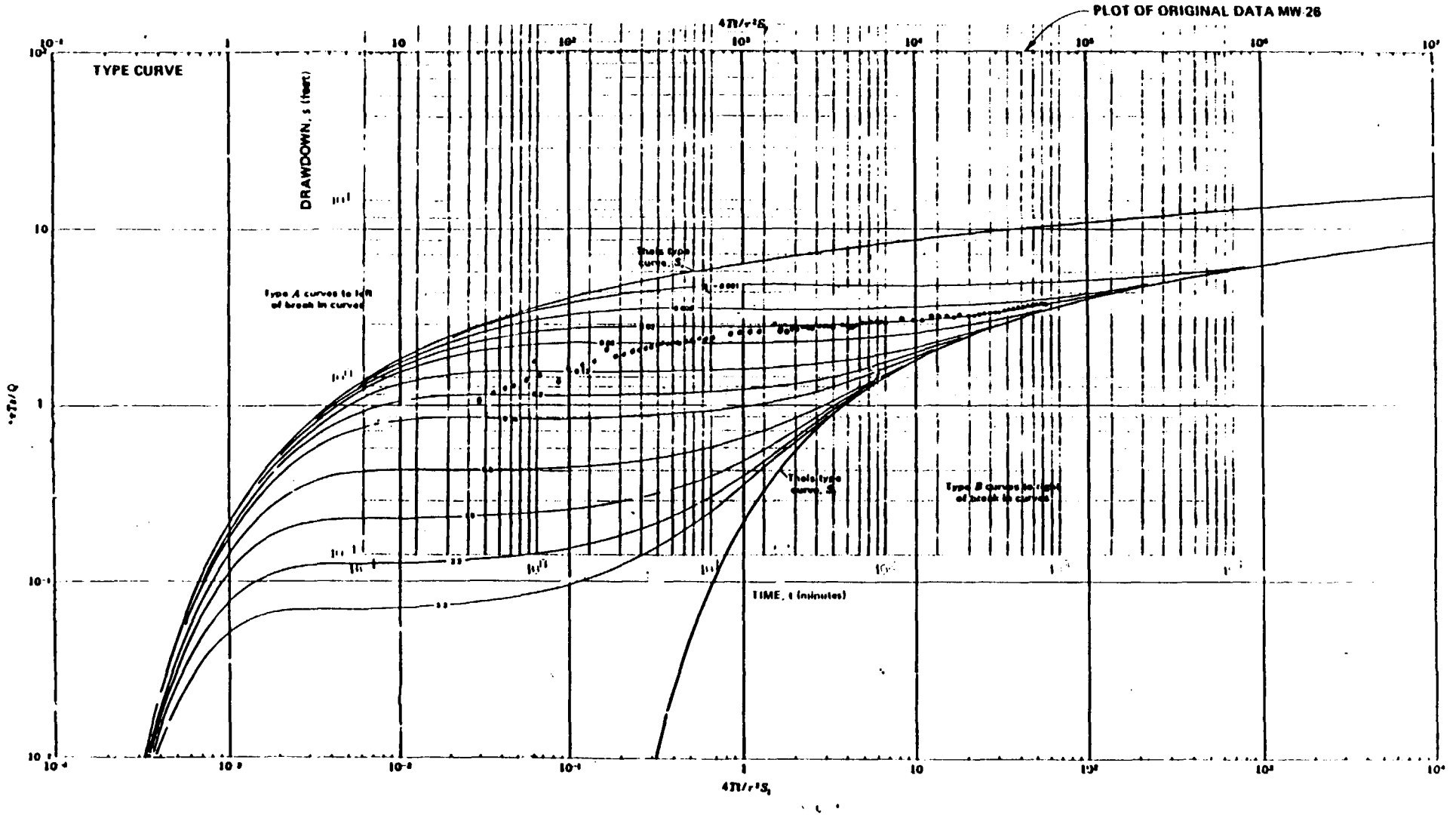
This method of analysis was applied to MW-10, MW-13, MW-23, MW-25, MW-26, MW-27, MW-28, MW-29, MW-33 and MW-35.

Approximate Method for Drawdown Data

Cooper and Jacob(5) developed a simplified solution for determining aquifer characteristics that avoids the use of type curves. This procedure, commonly referred to as the Jacob method, is illustrated in Figure 5. A semilog plot of drawdown versus time data was prepared. A straight line is drawn through the data points corresponding to later pumping times (where the value of $r^2S/4Tt$ is less than 0.01). The change in drawdown occurring over one log cycle of time is determined and used to compute the transmissivity with the following equation.

$$T = 2.3Q/4\pi\Delta s$$

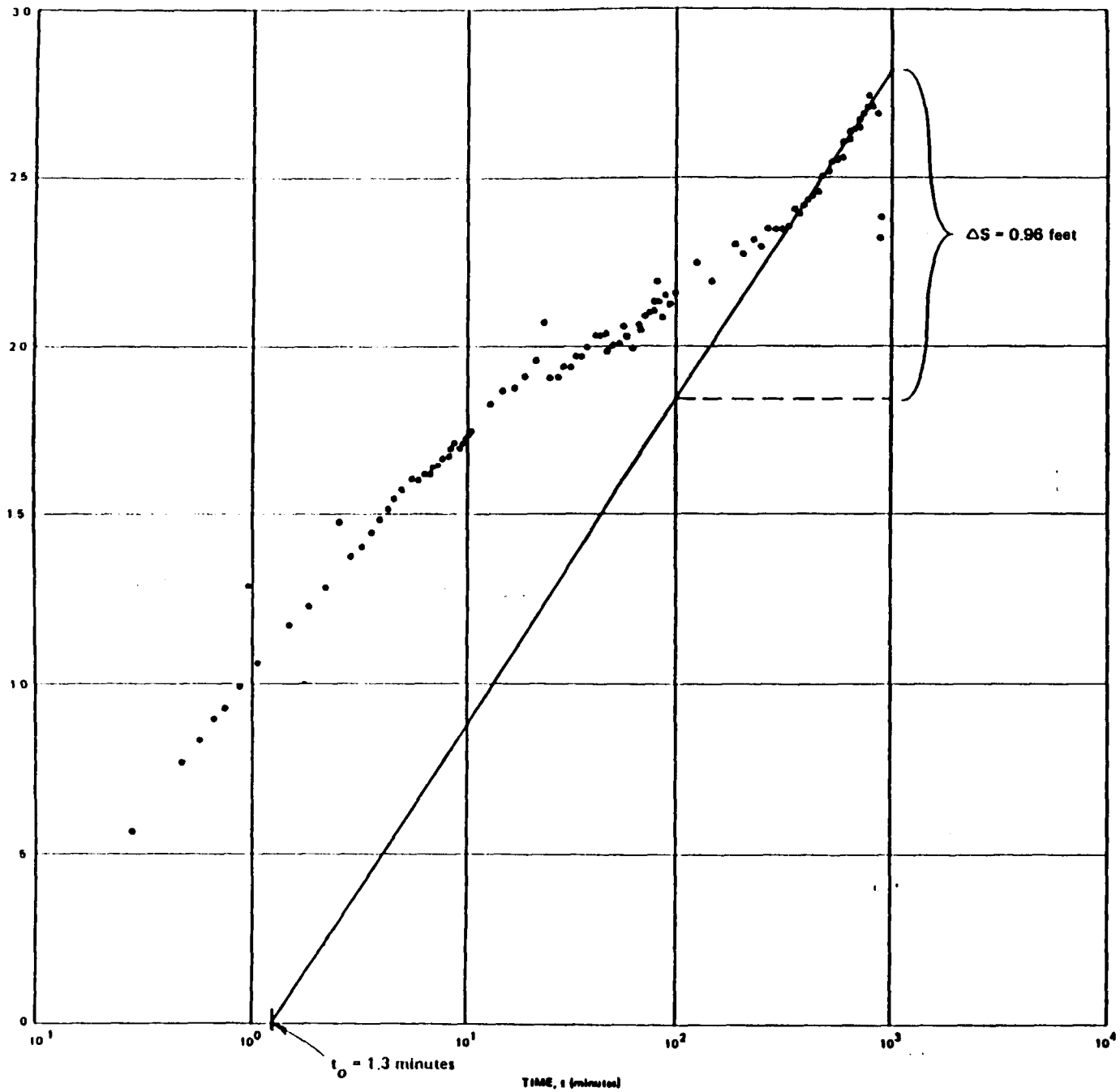
where, Δs = change in drawdown over one log cycle
T, Q as previously defined



LEGEND

- ● OBSERVED DRAWDOWN, MW26
- — THEORETICAL ACQUIFER RESPONSE

FIGURE 4
MATCH OF THE TYPE CURVE FOR AN UNCONFINED AQUIFER SHOWING DELAYED YIELD FROM STORAGE AND THE PLOT OF AQUIFER RESPONSE MEASURED AT MW26
CHEM-DYNE RI



LEGEND

- ● OBSERVED DRAWDOWN (FT)
- — LINE FIT-BY-EYE THROUGH LATER DATA POINTS (TIME 700 MINUTES)

NOTE:
Method as described by Cooper and Jacob (1946).

FIGURE 5
JACOB METHOD
MW26 DRAWDOWN DATA
CHEM-DYNE RI

The straight line is extended until it intersects the time axis at the point of zero drawdown. The time value of this point is used in the following equation to compute the storage coefficient.

$$S = 2.25\ Tt_o/r^2$$

where, t_o = time value corresponding to zero drawdown
S, T, r as previously defined

This method is only valid when the parameter u <0.01 where,

$$u = r^2S/4tT$$

where, r, s, t, T as previously defined

The Jacob method was developed for confined aquifer conditions. However, it is also a valid, approximate method for analyzing unconfined conditions under certain circumstances. It was applied to drawdown data for wells MW-25, and MW-26.

Approximate Method for Recovery Data

The Jacob method may also be applied to the recovery data from the pumping test. The residual drawdown is plotted against a time ratio on a semilog plot. The time ratio is the ratio of time since the beginning of the pumping test to the time since the start of aquifer recovery.

This method is illustrated in Figure 6 which shows a plot of recovery data for MW-26. The time ratio decreases as time increases and approaches a value of one as time approaches infinity. In Figure 6, time increases from right to left on the plot.

As discussed previously, the Jacob method is only valid for u <0.01. It was applied to wells MW-25, MW-26, MW-33 and MW-34.

Modified Papadopulos Method

Walton(6) presents a method developed by Papadopulos to determine the directional variation of transmissivity for an anisotropic aquifer. Papadopulos developed the method for a

Upon substituting values, three equations with three unknowns are obtained and solved simultaneously for the products, ST_{xx}, ST_{yy}, and ST_{xy}. These products are substituted into the following equation to determine an average storage coefficient.

$$S_{ave}^2 = [(ST_{xy})(ST_{yy}) - (ST_{xy})^2]/T_{ave}^2$$

where, S_{ave} = average storage coefficient (dimensionless)

T_{ave} = average of transmissivity values obtained from type curve matching procedure for the three wells.

S, Txy, Tyy, Txy as previously defined.

These values are substituted into the following equations to determine the major and minor components of transmissivity (T_{xx}, T_{yy}).

$$T_{XX} = 1/2\ [T_{xx} + T_{yy} + [(T_{xx} - T_{yy})^2 + 4T_{xy}^2]^{1/2}]$$

$$T_{YY} = 1/2\ [T_{xx} + T_{yy} - [(T_{xx} - T_{yy})^2 + 4T_{xy}^2]^{1/2}]$$

The direction of the major component of transmissivity with respect to the monitoring well coordinate system is given by:

$$\theta = \arctan[(T_{XX} - T_{xx})/T_{xy}]$$

where θ is the angle between the x and X axes measured counterclockwise from the x axis. This method was applied using MW-23, MW-26, MW-28, MW-29, MW-33 and MW-35.

RESULTS

General

Plots of the pumping test data were generated for those wells monitored by the SE200A automatic data acquisition system and the SE1000A remote systems. Unusable data were obtained for some of the wells because of interference from background noise or equipment malfunctions.

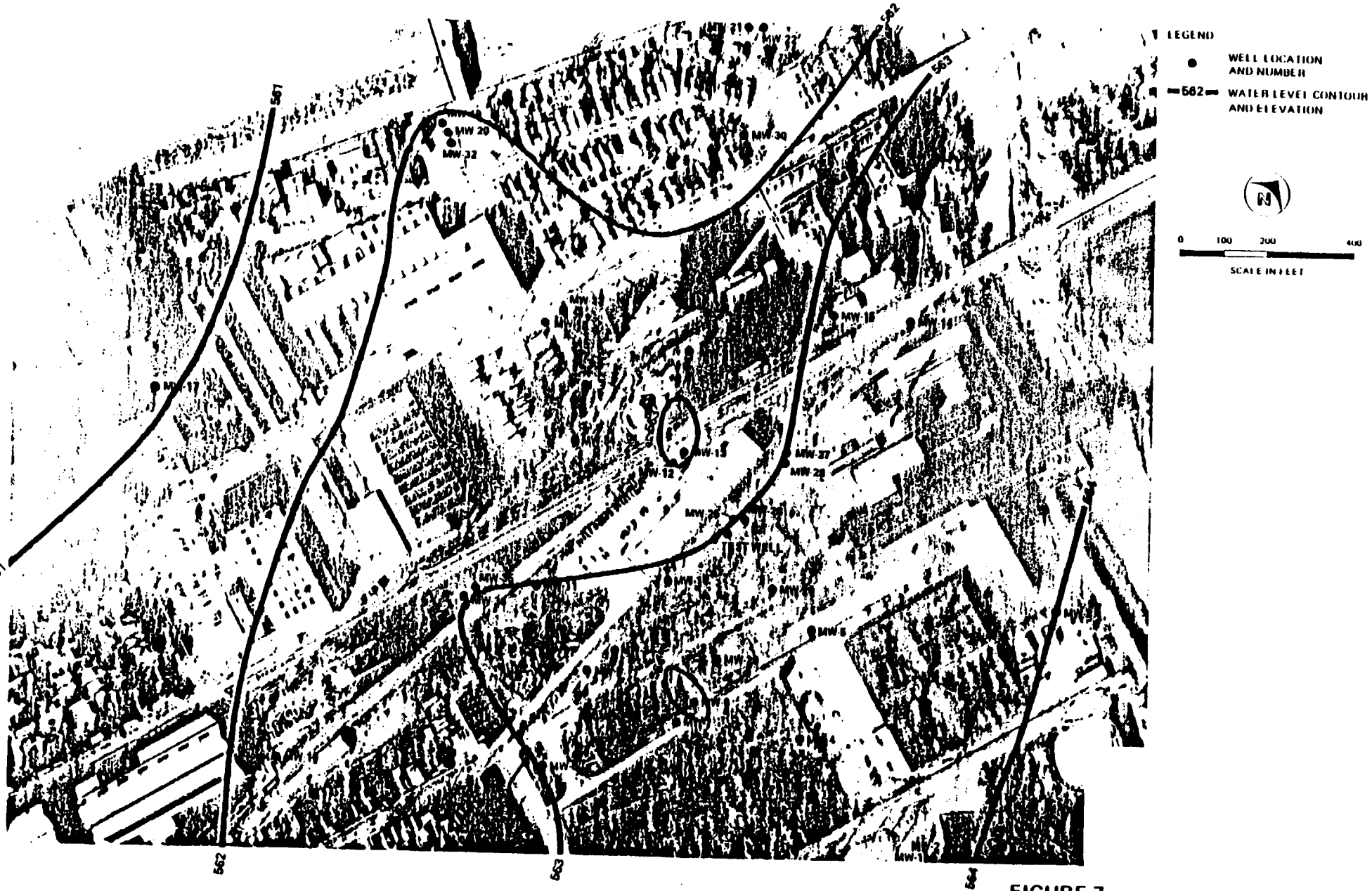
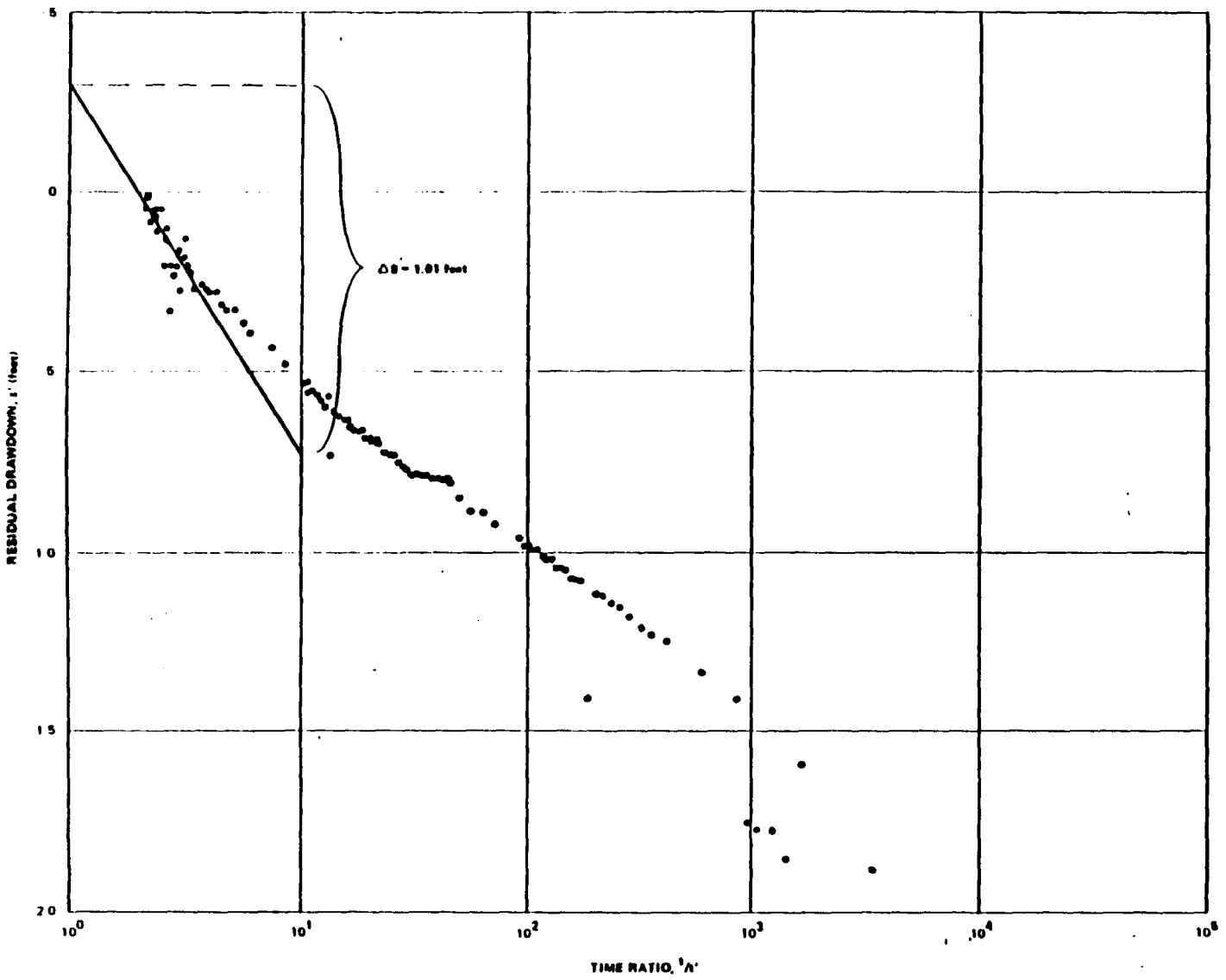


FIGURE 7
WATER LEVEL CONTOURS
SHALLOW WELLS
BEFORE START OF PUMPING TEST
CHEM-DYNE RI



LEGEND

- ● OBSERVED RESIDUAL DRAWDOWN (FT)
- —— LINE FIT-BY-EYE THROUGH LATER DATA POINTS (SMALL t/t' RATIOS)

NOTE:
Method as described by Cooper and Jacob (1946).

FIGURE 6
JACOB METHOD
MW26 RECOVERY DATA
CHEM-DYNE RI

nonleaky, anisotropic aquifer with fully penetrating wells and a constant discharge test well. The aquifer at the Chem-Dyne site is generally unconfined and the wells at the site are not fully penetrating. Therefore, the method must be modified to be applied directly. The method was modified by using type curves for an unconfined aquifer with vertical movement, as described previously, rather than the confined aquifer type curves presented with the Papadopulos method. This required that the Papadopulos equations be modified to be consistent with the type curves representing the solutions for unconfined aquifers with vertical movement. The results obtained from using this method are approximate since the conditions at the Chem-Dyne site are not a strict conformance with the conditions for which the Papadopulos method was developed.

This method requires drawdown data from three monitoring wells at different distances and directions from the pumped well. The transmissivity is determined from data for each of the three wells using the type curves for unconfined aquifers with vertical movement. The following equation is written for each of the wells:

$$S\ (T_{xx}y^2 + T_{yy}\ x^2 - 2T_{xy}\ xy) = tT^2$$

where, T_{xx}, T_{yy}, T_{xy} = components of the transmissivity tensor

x,y = coordinates of monitoring wells with respect to test well as origin, (ft)

t = time value corresponding to match point from type curve matching procedure.

T = transmissivity computed from type curve matching procedure, (ft^2/sec or gal/day/ft)

S as previously defined

In applying the method, the individual values of transmissivity obtained from type curve matching for each of the three wells were used, rather than a single average transmissivity as suggested by Papadopulos.

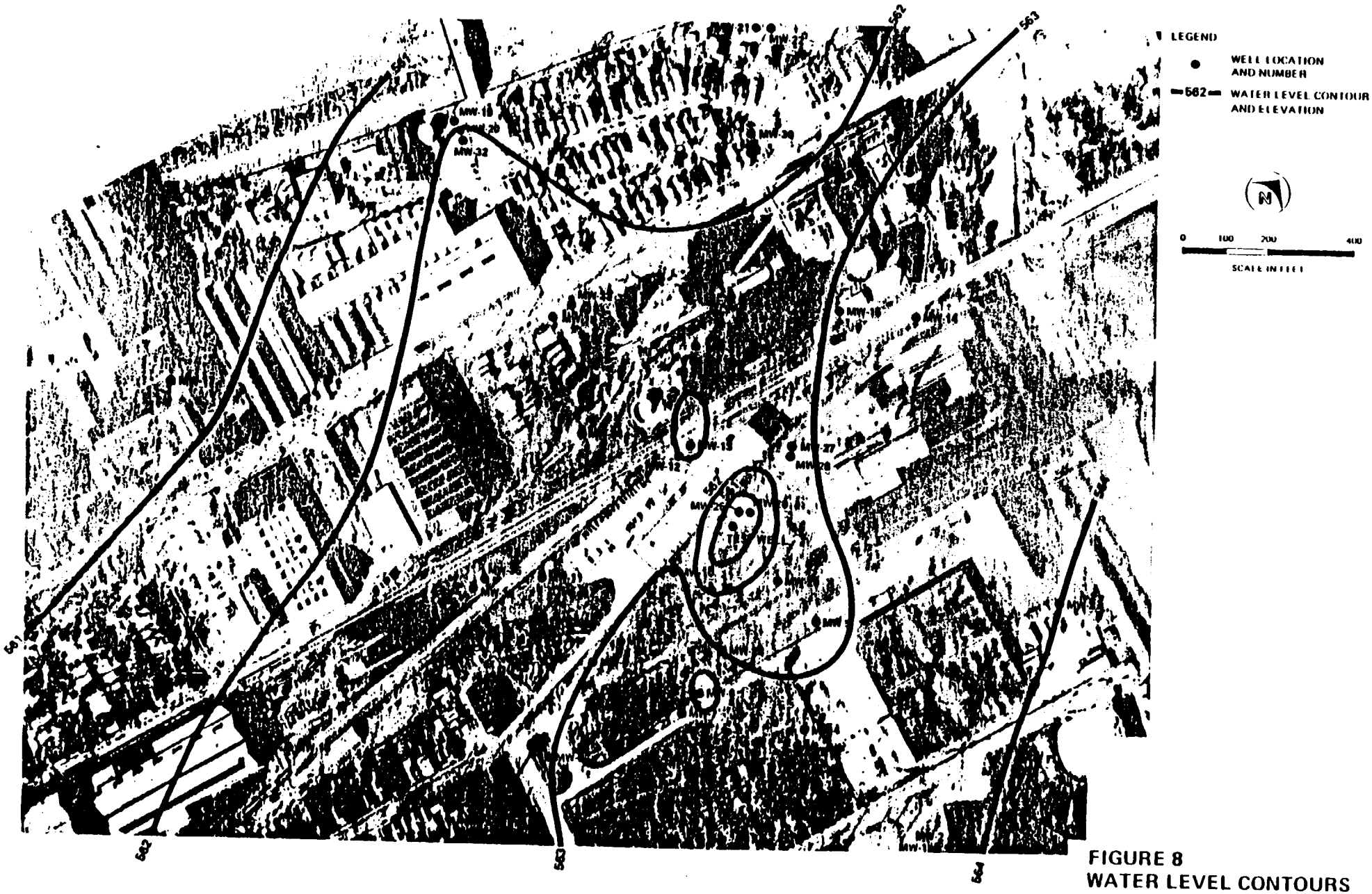


FIGURE 8
WATER LEVEL CONTOURS
SHALLOW WELLS
2 HOURS AFTER START OF
PUMPING TEST
CHEM DYNE RI

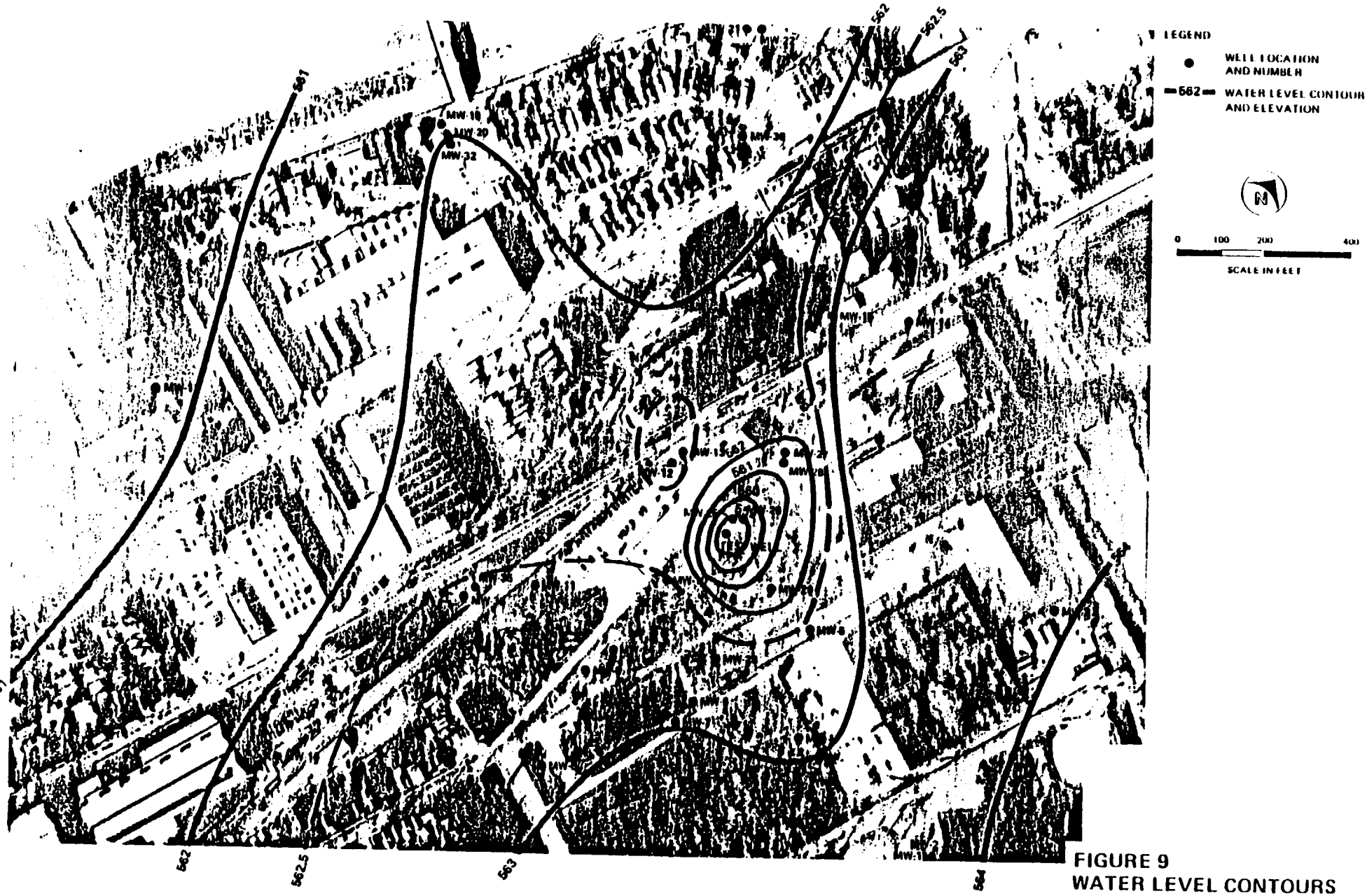


FIGURE 9
WATER LEVEL CONTOURS
SHALLOW WELLS
12 HOURS AFTER START OF
PUMPING TEST
CHEM DYNE RI

Data from the shallow wells were used to plot contours of water levels at various times during the pumping test. The water level contours before the pumping test began, two hours after the start of the test, and 12 hours after the start of the test are shown in Figures 7, 8 and 9, respectively.

An apparent groundwater mound exits around MW-13. This mound was evident throughout the pumping test. Well drilling logs indicate that the screened zone of MW-13 is located above a silty clay layer that results in restricted vertical flow at this location. Thus, as the surrounding water table is drawn down, the response of the water level in MW-13 is delayed because of the silty clay layer.

Data obtained from wells monitored by the automatic systems were used for the pumping test analysis. The wells monitored manually are located at relatively large distances from the test well and exhibited small drawdowns during the pumping test.

The analysis methods appropriate for the conditions exhibited by each data plot were applied. Not all methods were appropriate for analyzing data from all of the wells. A summary of the transmissivities and storage coefficients determined from the analysis are presented in Table 6.

Transmissivity

Reasonably consistent results were obtained for the transmissivity calculations. Values ranging from approximately 0.3 x 10^5 to 6.9 x 10^5 gal/day/ft were obtained. For most wells, the various analysis methods produced transmissivity values of 1 x 10^5 gal/day/ft to 3 x 10^5 gal/day/ft. The values obtained in the vicinity of MW-28, MW-33 and MW-35 are somewhat larger than those obtained for the other wells, with the aquifer around MW-35 showing the largest transmissivity. There is evidence from the well logs and water quality data to indicate that the transmissivity is indeed greater near MW-33 and MW-35 than in other portions of the aquifer. Contaminant concentrations found in MW-33 are relatively high compared to other offsite wells, possibly indicating a preferred direction of flow (higher transmissivity) toward this well. Previous geophysical information suggests that the aquifer thickens in the direction of MW-33 and MW-35 from the pumping center, which would also result in a higher transmissivity.

The modified Papadopulos method was applied in an attempt to determine directional variation in the transmissivity. The method was applied for two sets of three wells.

Using MW-23, MW-26, and MW-29, the results indicate a major transmissivity equal to 2.0×10^5 gal/day/ft in the east-west direction and a minor transmissivity equal to 1.2×10^5 gal/day/ft in the north-south direction. This variation is not considered significant because the difference is within the range to be expected, given the accuracy of the methods used to obtain the transmissivity for the individual wells.

The second set of wells analyzed included MW-28, MW-33, and MW-35. The major and minor transmissivities were found to be 1.4×10^6 gal/day/ft and 1.3×10^5 gal/day/ft, respectively. The major transmissivity is along a line having a bearing of approximately N22°E. This line parallels the Great Miami River. If the aquifer material was deposited in the direction of the existing course of the Great Miami River, it is quite reasonable that the aquifer transmissivity is greater in this direction. However, the depositional direction is not certain since the river may have meandered across the river valley throughout geologic time.

The modified Papadopulos method was applied to four other sets of wells. However, solutions were indeterminate. Because of the uncertainty found in the results of the method applied no signficance can be attached to the results.

The transmissivity values obtained from the pump test are consistent with values reported in the literature for this area. Pump tests performed by Smith(7) in an area immediately to the west and south of the Chem-Dyne site produced transmissivity values of 1.61×10^5 gal/day/ft and 3.08×10^5 gal/day/ft. Spieker(2) reports a transmissivity in the range of 3×10^5 gal/day/ft to 5×10^5 gal/day/ft for the regional aquifer system underlying the Chem-Dyne site.

Storage Coefficient

The computed values for the aquifer storage coefficient show a great deal of variation. Values range from 0.00024 to 0.33. For an unconfined aquifer, typical storage coefficients are 0.1-0.3. Storage coefficients typically range from 0.00005 to 0.005 for confined aquifers. The storage

coefficients for early portions of the test, computed with the delayed yield method, are consistently less than those computed for later times.

With the exception of the values computed for MW-28, MW-33, and MW-35, the storage coefficient ranges from approximately 0.07 to 0.3 based on the type curve methods. These are typical values for an unconfined aquifer. MW-33 and MW-35 are located on the edge of the (suspected) clay confining layer that lies to the west of the Chem-Dyne site. The aquifer is at least partially confined in this area. The storage coefficients computed from the data for these wells are reasonable for semiconfined conditions. Smith(8) reports a storage coefficient of 0.0003 obtained from a pump test in a confined portion of the aquifer in an area west of the Great Miami River and north of the Chem-Dyne site.

Values of the storage coefficient were also computed using the modified Papadopulos method. The computed values represent an "average" based on the data from the three wells used in the analysis. A storage coefficient equal to 0.15 was obtained using the data from MW-23, MW-26, and MW-29. This is a reasonable value for the unconfined portion of the aquifer in which these wells are located. The analysis of wells MW-28, MW-33, and MW-35 yielded a storage coefficient equal to 0.012. This may reflect the suspected, semi-confined nature of the aquifer in the area of MW-33 and MW-35. Again, there is a degree of uncertainty attached to these values.

Hydraulic Conductivity

The type curve methods used to analyze the drawdown data also provide a means for estimating the ratio of vertical to horizontal hydraulic conductivities. The derived ratios are shown in Table 7 and range from 1 to 0.005. A large variation is evident. This variation is the result of the discontinuous nature of clay and silt stratifications in the aquifer. Such stratifications have a minimal impact on the horizontal hydraulic conductivity, but can be expected to have a greater impact locally on vertical hydraulic conductivities.

Using a value of 2.0×10^5 gal/day/ft for the average transmissivity of the aquifer and an aquifer thickness of 180 feet, the average horizontal hydraulic conductivity is 1.1×10^3 gal/day/ft^2. Using the derived hydraulic conductivity ratios,

Table 7
VERTICAL-HORIZONTAL HYDRAULIC CONDUCTIVITY RATIOS

Well Number	K_z/K_r Unconfined, Vertical Movement	Delayed Yield Early	Delayed Yield Late
MW-10	Theis curve[a]	0.19	Theis curve
MW-13	Theis curve	No fit[b]	Theis curve
MW-23	Theis curve	No fit	Theis curve
MW-25	Theis curve	0.012	No fit
MW-26	0.20	0.0084	0.17
MW-27	0.95[c]	No fit	1.0[c]
MW-28	Theis curve	0.0005	No fit
MW-29	1.1[c]	No fit	1.5[c]
MW-33	0.32	0.0041	0.014
MW-34	No fit	No fit	No fit
MW-35	0.0018	0.0015	0.0015

[a]Plot of drawdown data matched the Theis type curves for an isotropic unconfined aquifer.
[b]Plot of drawdown data could not be fit to the standard type curves.
[c]Calculated values are suspect.

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the vertical hydraulic conductivity ranges from 0.6 gal/day/ft^2 to 1.1 x 10^3 gal/day/ft^2.

Summary of Results

Drawdown data recorded at 11 monitoring wells during the pumping test were analyzed to determine the aquifer parameters at the Chem-Dyne site. Four methods were used to determine the transmissivity, three methods were used in computing the storage coefficient, and two methods were used to estimate the vertical hydraulic conductivity, based on data from individual monitoring wells. Directional variations in transmissivity and the storage coefficient were estimated using data from three-well combinations.

The aquifer transmissivity ranges from 1 x 10^5 gal/day/ft to 3 x 10^5 gal/day/ft throughout most of the aquifer.

A definite horizontal, directional variation in the transmissivity cannot be concluded from the analysis.

The storage coefficient for the aquifer ranges from 0.3 to 0.0002.

Reliable values for the vertical hydraulic conductivity of the aquifer are difficult to obtain from pumping test data. Based on the methods of analysis used, it is estimated that the vertical hydraulic conductivity ranges from 0.6 gal/day/ft^2 to 1.1 x 10^3 gal/day/ft^2.

The variability in the derived aquifer parameters is to be expected because of the nonuniform nature of the aquifer materials. The results obtained from this analysis define ranges for the parameter values.

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APPENDIX A
WATER LEVEL RECORDS

Table of
FLOW RATES FROM FLOW METER
DURING ABORTED TEST OCTOBER 28, 1983

Time (Hours)	Pump Rate (gpm)	Remarks
13:15	100	Start @ 1:15:12; initial meter reading: 26,450 gallons
13:17	100	
13:19	1200	Large change in metered flow rate
13:22	1200	
13:25	100	Large drop in metered flow rate; discharge appears to be constant
13:26	400	
13:27	600	
13:28	400	Observed discharge still appears to be constant
13:29	700	
13:30	1000	
13:31	400	Flow meter must be malfunctioning; decided to abort test
13:38	0	Stopped aquifer pump test

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Table of
PUMP DISCHARGE VERIFICATION TEST
OCTOBER 29, 1983

Time (Hours)	Pump Rate (gpm)	Remarks
15:45	909	Start; reading on new flow meter (#831127 Hersey Products, Inc.) is 0.
15:46	895	
15:47	910	
15:48	952	
15:49	952	
15:50	967	
15:51	983	
15:52	952	
15:53	969	
15:54	1091	
15:55	1017	
15:57	1017	
15:59	1012	
15:59	1034	
16:02	1034	
16:04	1034	Excellent control, even during valve changes for distribution of discharge to separate holding ponds.
16:06	0123	Pump turned off; meter reading: 22,000 gallons; recovery initiated on SE200A transducers.
16:07	0	
16:10	0	Train passage initiated.
16:15	0	Train passage completed.

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Table of (Page 1 of 3)
FLOW RATES FROM FLOW METER DURING
PUMP TEST OCTOBER 30-31, 1983

Time (Hours)	Pump Rate (gpm)	Remarks
11:10	0	Initial meter reading: 20,580 gallons[a]
11:11	-	
11:12	1030	
11:13	1023	
11:14	1030	
11:15	1027	
11:16	1013	
11:17	1038	
11:18	1030	
11:19	1063	
11:20	1036	
11:22	1034	
11:30	1032	
11:36	1032	
11:38	-	Meter reading: 50,000 gallons, Q_{ave} = 1050
11:45	1010	Pump rpm adjustment
11:47	1020	
11:51	1006	
11:59	1009	Meter reading: 70,000 gallons, Q_{ave} = 1009
12:07	977	
12:09	983	
12:10	990	
12:15	1023	
12:15	1013	
12:22	1034	
12:23	-	Valve adjustment
-	960	
-	1008	
12:30	1010	
12:40	996	
12:45	1023	Meter reading: 118,000 gallons, Q_{ave} = 1025
12:51	995	
12:56	997	
13:01	1001	
13:05	1003	
13:14	997	Meter reading: 146,000 gallons, Q_{ave} = 1011
13:23	970	Valve adjustment
13:28	980	
13:30	960	
13:32	977	Meter reading: 165,000 gallons, Q_{ave} = 1017
13:39	981	
13:45	983	
13:51	981	Meter reading: 184,000 gallons, Q_{ave} = 1015
14:05	981	Valve adjustment
14:07	1001	
14:20	996	Meter reading: 211,000 gallons, Q_{ave} = 1002

Table of (Page 2 of 3)
FLOW RATES FROM FLOW METER DURING
PUMP TEST OCTOBER 30-31, 1983

Time (Hours)	Pump Rate (gallons)	Remarks
14:23		Meter reading: 214,000 gallons, Q_{ave} = 1002
14:32	995	
14:45	995	Meter reading: 235,000 gallons, Q_{ave} = 997
14:56	992	
15:06	996	
15:13	971	
15:16	980	Valve adjustment
15:21	1003	
15:24	1000	
15:33	1000	Meter reading
15:40	1000	
15:44	985	
15:51	983	
15:53	982	
15:58	982	
16:03	980	
16:16	983	Meter reading: 324,000 gallons, Q_{ave} = 992
16:27	979	
16:38	982	
16:50	978	Meter reading: 350,000 gallons, Q_{ave} = 969
17:04	978	
17:05	978	
17:16	979	Meter reading: 385,000 gallons, Q_{ave} = 996
17:21	973	Valve adjustment
17:24	990	
17:25	973	
17:30	978	
17:41	978	
17:53	980	
18:07	980	
18:18	981	Meter reading: 446,0000 gallons, Q_{ave} = 994
18:31	990	
18:32	932	
18:32	996	
18:35	986	
18:39	990	
18:40	991	
18:52	990	
19:00	990	Meter reading: 488,000 gallons, Q_{ave} = 995
19:52	989	Meter reading: 537,000 gallons, Q_{ave} = 989

Table of (Page 3 of 3)
FLOW RATES FROM FLOW METER DURING
PUMP TEST OCTOBER 30-31, 1983

Time (Hours)	Pump Rate (gallons)	Remarks
20:06	985	
20:11	995	Meter reading: 557,000 gallons, Q_{ave} = 992
20:17	996	
20:22	995	
20:28	995	
20:33	1000	
20:37	995	
20:45	996	
20:49	1016	
20:57	1015	
21:02	1017	
21:08	1034	
21:08	1016	
21:12	1013	Meter reading: 617,000 gallons, Q_{ave} = 991
21:24	1013	
21:56	1011	
22:11	1012	
22:21	1014	
22:29	1016	
22:42	1030	
23:05	1027	
	1024	
23:19	1025	Meter reading: 747,000 gallons, Q_{ave} = 1009
23:29	1022	
23:31	1022	
23:40	1023	
23:46	1025	
23:58	1024	
00:09	1000	Valve adjustment
00:12	1000	Meter reading: 801,000 gallons, Q_{ave} = 998
00:27	1001	
00:39	1001	
00:52	1002	
01:09	1002	Meter reading: 858,000 gallons, Q_{ave} = 998
-	0134	
-	983	
-	983	
01:22	983	
-	750	
01:30	784	
01:35	0	Valve closed; pump turned off; final meter reading: 881,800 gallons; total time = 14 hours and 25 minutes
		Average pumping rate for 865 minutes = 996 GPM

[a] Time noted for total meter readings may be slightly inaccurate (I 10 minutes) as primary concern of field technician was instantaneous discharge.

Table of
WATER LEVELS IN PUMP AND MONITORING WELLS PRIOR TO AQUIFER PUMP TEST

Well No.	Water Level Elevation (feet) 10/26/83	10/28/83	10/30/83
MW-1	563.68	563.70	563.68
MW-2	563.74	563.76	563.74
MW-3	-[a]	-[a]	563.96
MW-4	563.35	563.31	563.27
MW-5	563.54	-[a]	563.31
MW-6	563.23	-[a]	564.40
MW-7	563.49	563.30	563.30
MW-8	563.08	563.06	563.01
MW-9	-[a]	-[a]	568.08
MW-10	563.23	563.49	563.29
MW-11	562.74	563.26	562.90
MW-12	563.07	562.47	562.39
MW-13	563.37	563.31	563.19
MW-14	-[b]	-[b]	-[b]
MW-15	563.37	563.02	563.10
MW-16	562.22	562.36	562.47
MW-17	560.36	562.07	560.03
MW-18	-[a]	-[a]	562.67
MW-19	-[a]	-[a]	559.80
MW-20	-[a]	-[a]	562.10
MW-21	562.31	560.94	561.29
MW-22	561.07	560.67	559.95
MW-23	563.38	563.45	563.07
MW-24	563.15	563.25	563.07
MW-25	563.25	563.23	563.04
MW-26	562.75	562.81	562.96
MW-27	563.00	562.59	563.13
MW-28	563.08	563.11	562.99
MW-29	563.43	562.89	563.23
MW-30	561.79	561.58	561.25
MW-31	562.93	562.84	562.78
MW-32	-[a]	-[a]	559.56
MW-33	-[a]	562.12	562.06
MW-34	562.96	562.94	562.29
MW-35	562.97	562.97	562.93
MW-36	563.06	463.04	562.69
Test Well	563.12	563.35	562.97

[a] Not measured
[b] Dry well, omitted from the monitoring system

Table of
WATER LEVELS IN MONITORING WELLS (FINAL READINGS) ON
OCTOBER 31, 1983

Well No.	Water Level Elevations (feet)	Time (hours, minutes)
MW-8	562.97	14:43
MW-7	563.25	14:49
MW-4	563.27	14:53
MW-1	563.54	14:58
MW-2	563.80	15:01
MW-11	562.79	15:11
MW-12	562.64	15:17
MW-13	562.37	15:20
MW-14	563.49	15:30
MW-15	563.08	15:35
MW-31	562.65	15:40
MW-33	561.83	15:45
MW-30	561.27	15:49
MW-22	560.09	15:54
MW-21	561.25	15:58
MW-17	560.92	16:09
MW-16	562.32	16:18
MW-36	563.08	16:23
MW-35	562.71	16:26
MW-10	562.68	17:42
Test Well	562.95	17:45
MW-25	562.71	17:48
MW-26	563.04	17:51
MW-28	561.85	17:54
MW-27	562.63	17:56
MW-29	563.02	18:00
MW-32	563.11	18:03
MW-23	563.72	18:08
MW-6	563.13	18:11
MW-24	562.88	18:19

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Table of
WATER LEVEL DATA RECORDED ON STEVENS RECORDER CHARTS

Well No.	Water Elev. (ft) Before Pump Test (Oct. 30, 1983)	Water Elev. (ft)[a] After Pump Test (Oct. 31, 1983)	Change in Water Depth (ft)
MW-3	563.96	564.06	+ 0.10
MW-19	559.79	559.71	- 0.08
MW-20	562.11	561.93	- 0.18
MW-32	559.57	559.48	- 0.09

[a]Recorders were removed from wells.

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APPENDIX B

AQUIFER PUMP TEST
PHOTOGRAPHIC LOG
CHEM-DYNE RI

GLT460/25-3

AQUIFER PUMP TEST
PHOTOGRAPHIC LOG
CHEM-DYNE SITE
(W65310.C0)

Photo 1: A view of the interior of the site decontamination and storage trailer.

Photo 2: Same as photo No. 1.

Photo 3: A view of the apparatus or setup used to hold breathing air bottled for onsite work.

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Photo 4: A view of the northern portion of the site and the structures located there.

Photo 5: A view of the guard shack and entrance gate at the south end of the site.

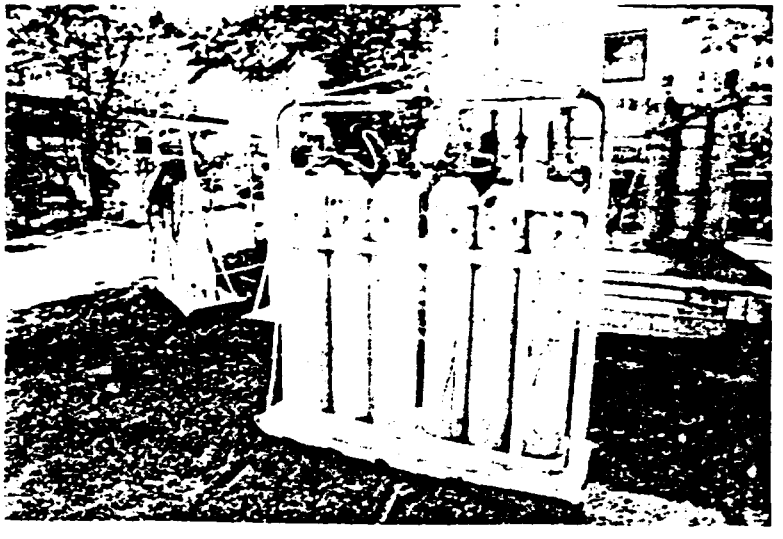

Photo 6: A view of the breathing air bottles and container used for onsite work involving air.

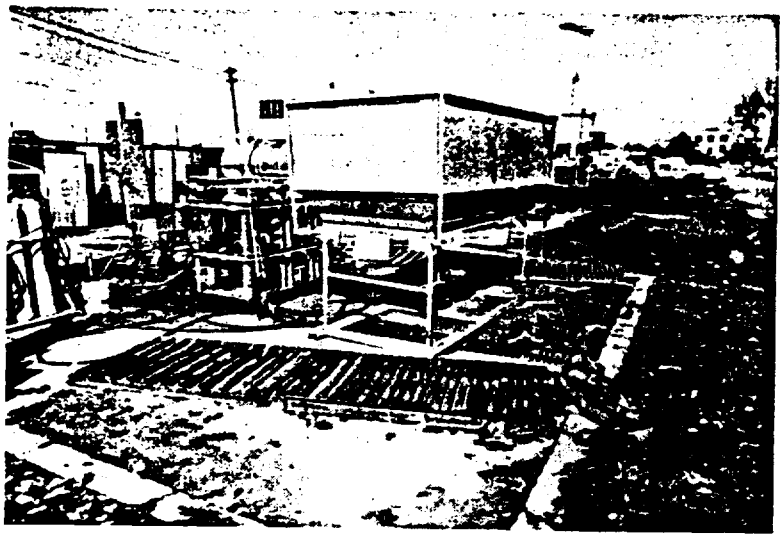

Photo 7: A view of the decontamination pad at the south end of the site. Resting on the decontamination pad is the apparatus used by O&H Materials for drumming solidified waste.

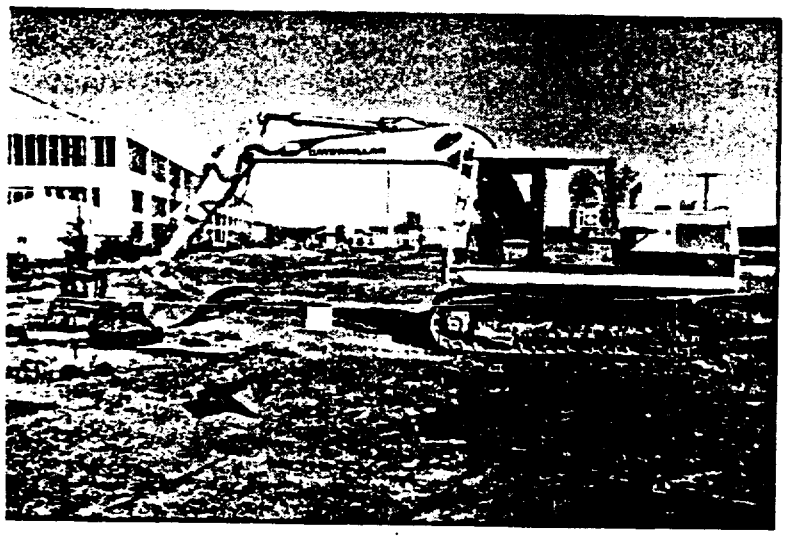

Photo 8: A view of the crawler equipped with a drum grappling arm.

Photo 9: A view of the central portion of the site showing the erected 100,000-gallon storage pool.

Photo 10: Same as photo No. 9 viewing north.

Photo 11: Same as photo No. 9.

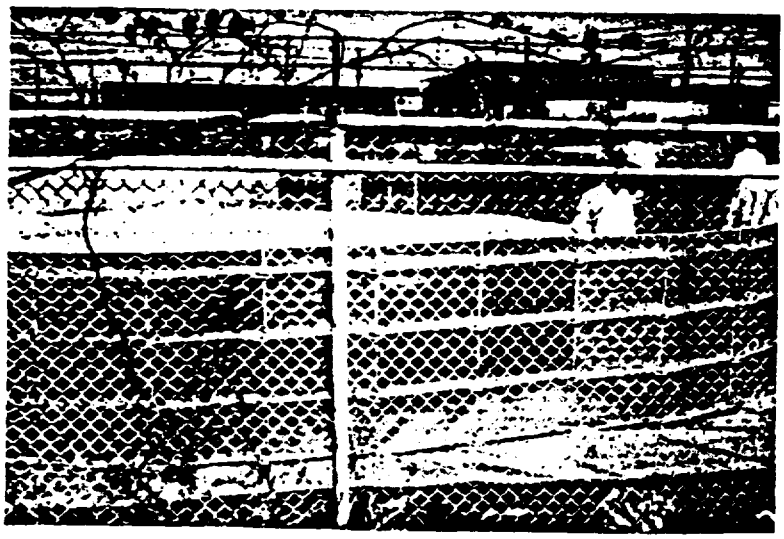

Photo No. 12: A view of the constuction or erection of the storage pools used during the aquifer pump test.

Photo 13: A view of several already erected storage pools onsite.

Photo 14: Same as photo No. 13.

Photo 15: A view of the sidewalls and bracing used on the 100,000-gallon rectangular storage pool.

Photo 16: A view of the sidewalls used in the smaller 50,000-gallon storage pools.

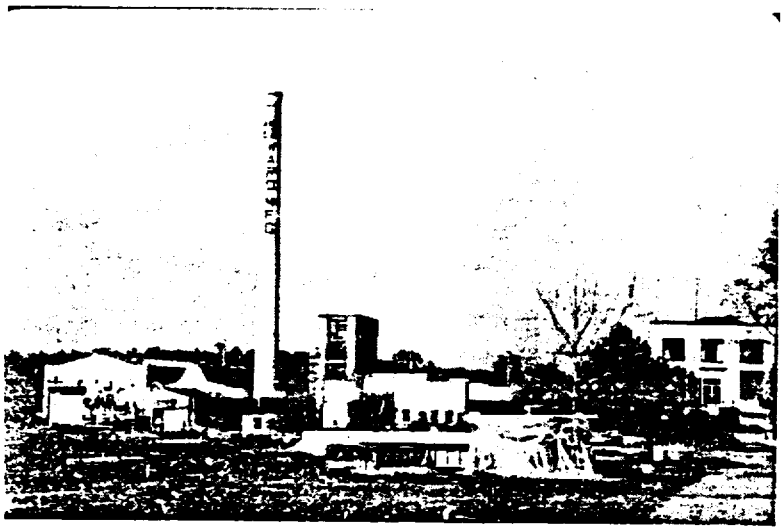

Photo 17: A view of the northern portion of the site and the structures located there.

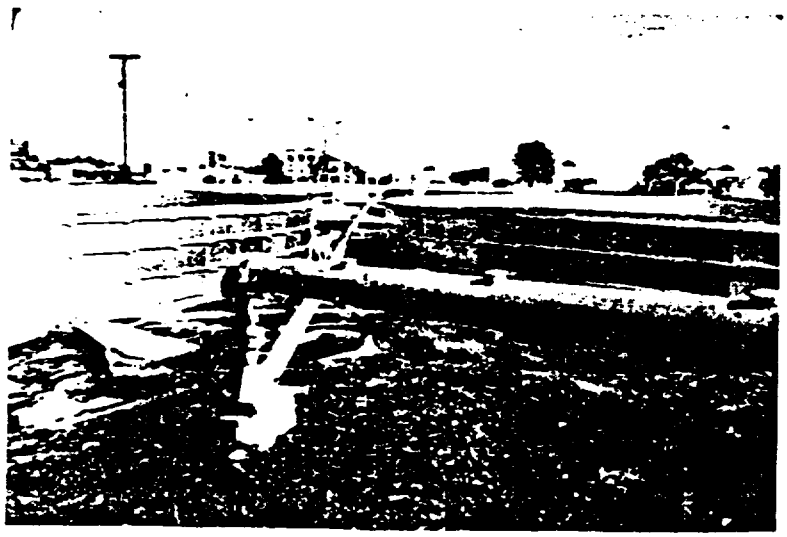

Photo 18: A view of the distribution piping leading from the pump well showing the discharge arrangement allowing for a pipe to pivot and discharge into one of four different storage pools.

Photo 19: A view of the automatic recording devices used. Reels of cable and their associated pressure transducers, which were inserted into the wells are shown.

Photo 20: Same as photo No. 19.

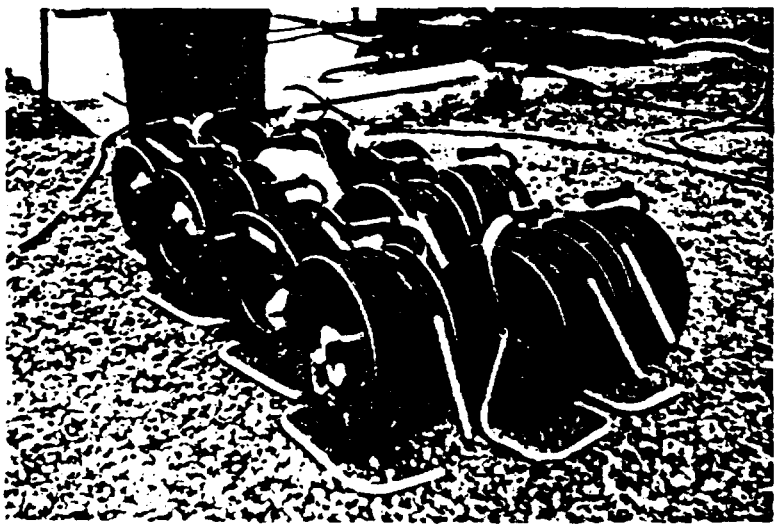

Photo 21: A closeup view of the cables and pressure transducers used in the automatic recording of water levels during pump tests.

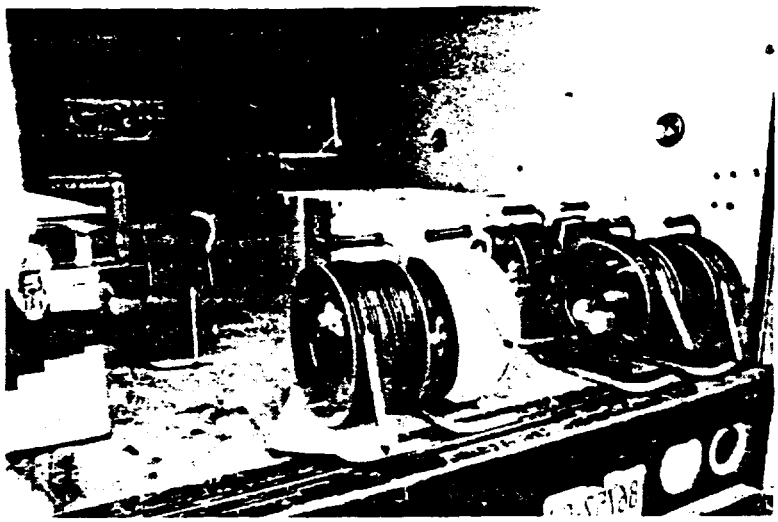

Photo 22: Same as photo No. 21.

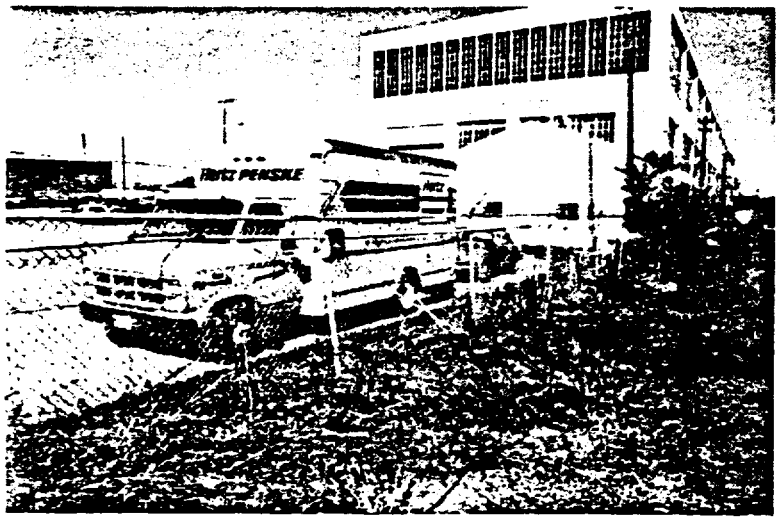

Photo 23: A view of the van used to house the computer which received the automatically recorded data during the pump test. This van was located along the western boundary of the site.

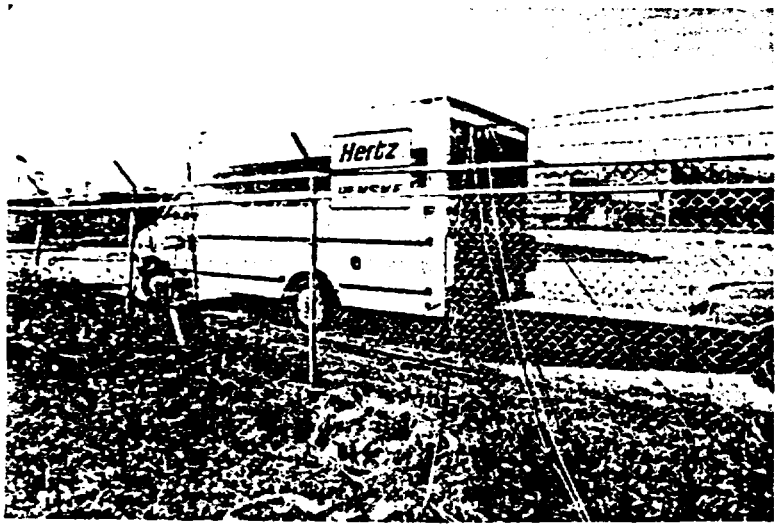

Photo 24: A view of the command post van and cables leading from it to onsite recorders.

Photo 25: A view of the preparation for installment of the automatic recorders onsite.

Photo 26: Same as photo No. 25.

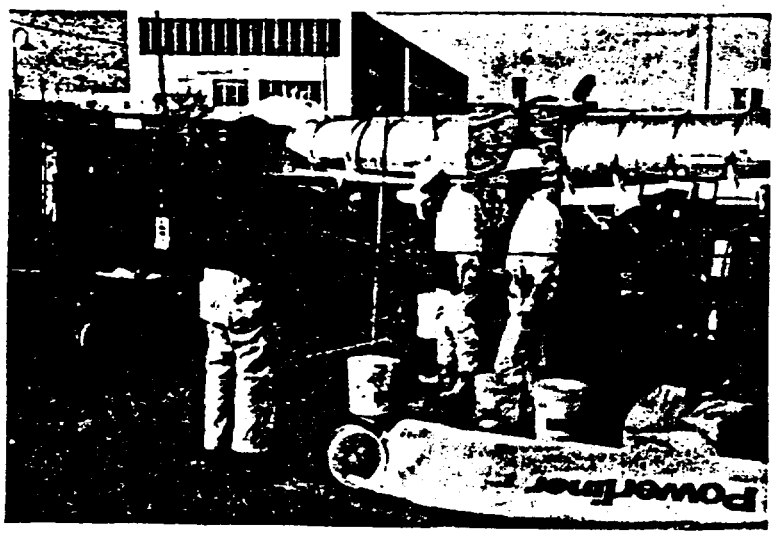

Photo 27: Sames as photo No. 25.

Photo 28: A view of onsite personnel during installation of the onsite recorders.

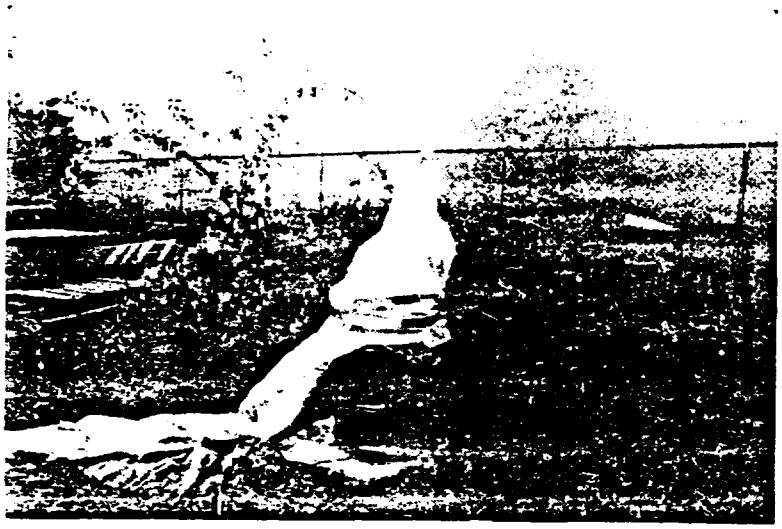

Photo 29: A view of the Stevens Recorder used to record groundwater levels in monitoring well No. 3.

Photo 30: A view of monitoring well No. 4 viewing northwest.

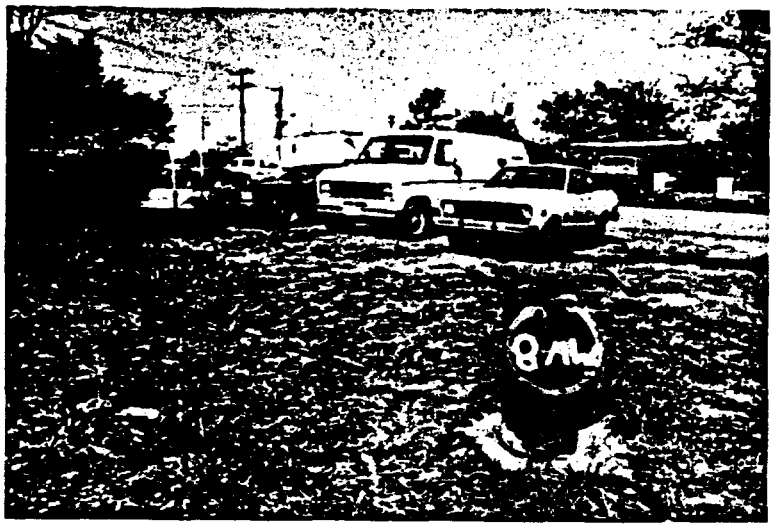

Photo 31: A view of monitoring well No. 8 viewing north.

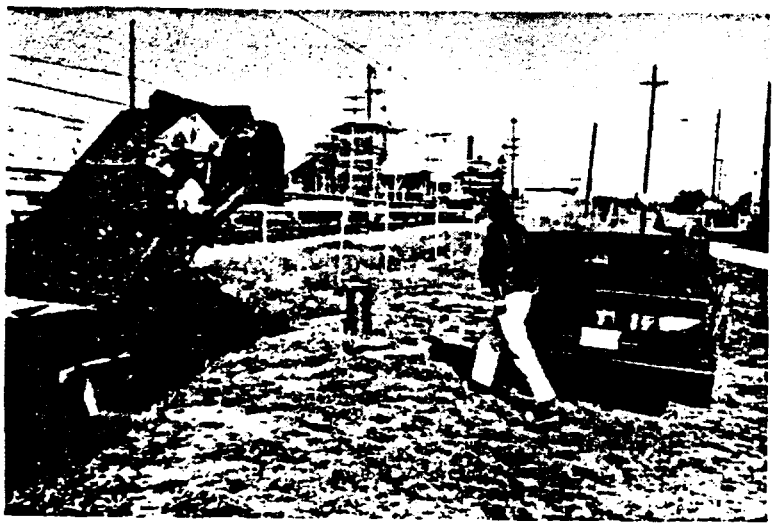

Photo 32: A view of monitoring well No. 12 viewing north.

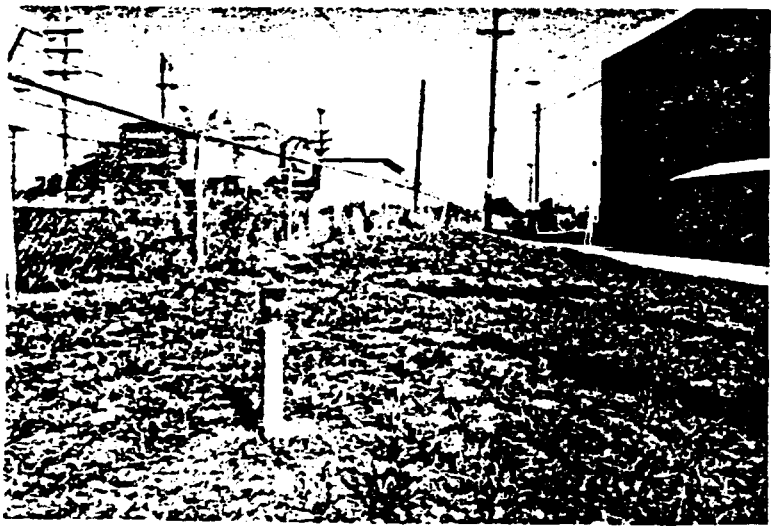

Photo 33: A view of monitoring well No. 13 viewing north.

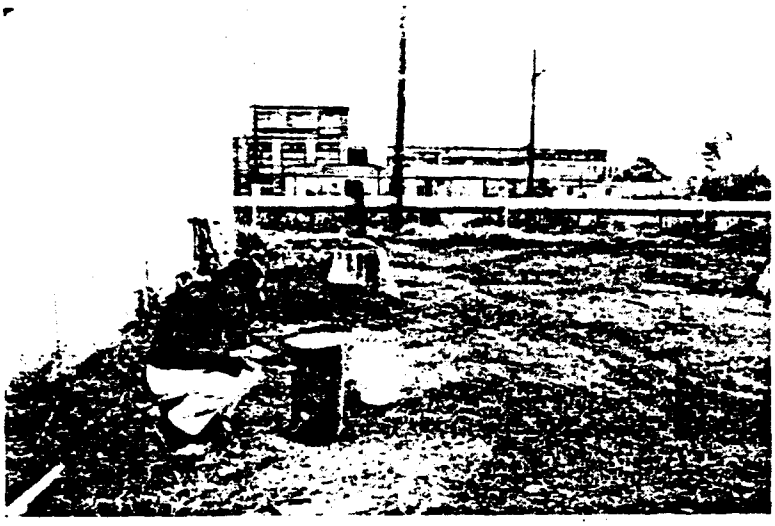

Photo 34: A view of monitoring well No. 15 viewing east towards the site.

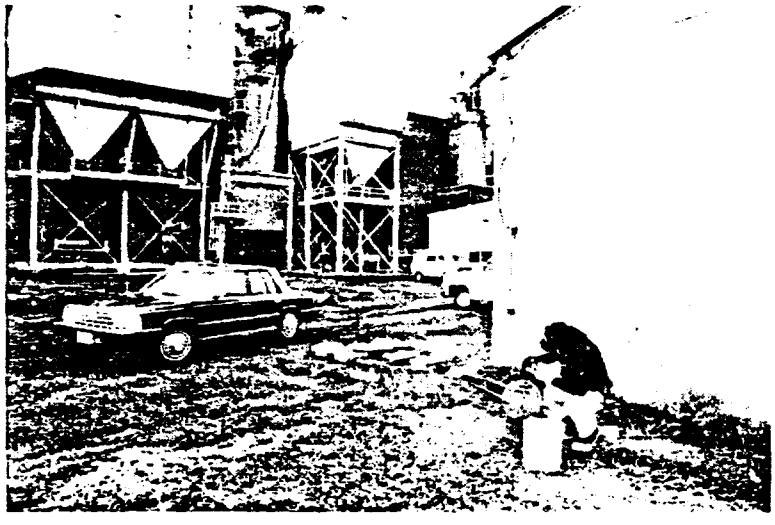

Photo 35: A view of monitoring well No. 15 viewing northwest.

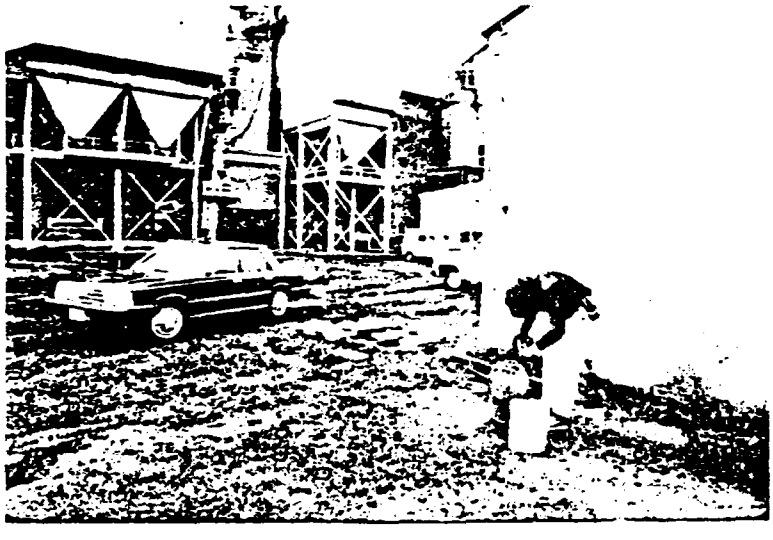

Photo 36: Same as photo No. 35.

Photo 37: A view of monitoring well No. 16 viewing northwest.

Photo 38: A view of monitoring well No. 17.

Photo 39: A view of monitoring well No. 22.

Photo 40: A view to the south of monitoring No. 22 in the foreground and monitoring well No. 21 in the background.

Photo 41: Sames as photo No. 40.

Photo 42: A view of the installation of the automatic recorder at monitoring well No. 23.

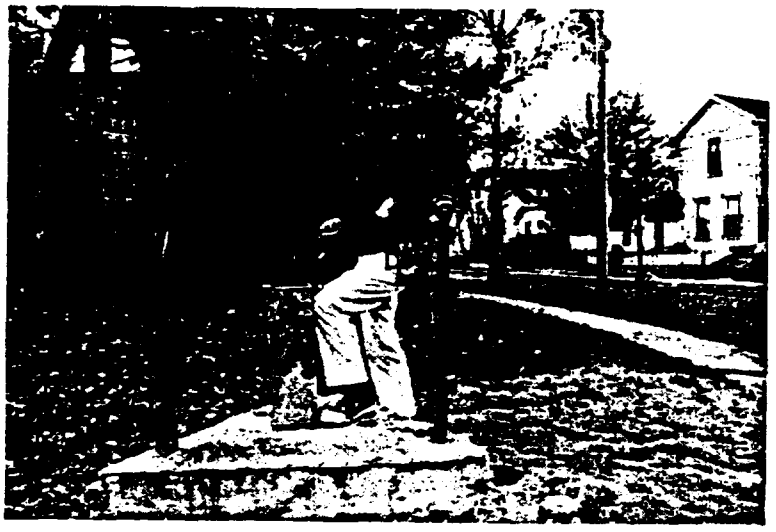

Photo 43: A view of monitoring well No. 30 viewing southwest.

Photo 44: A view of monitoring well No. 30 viewing east.

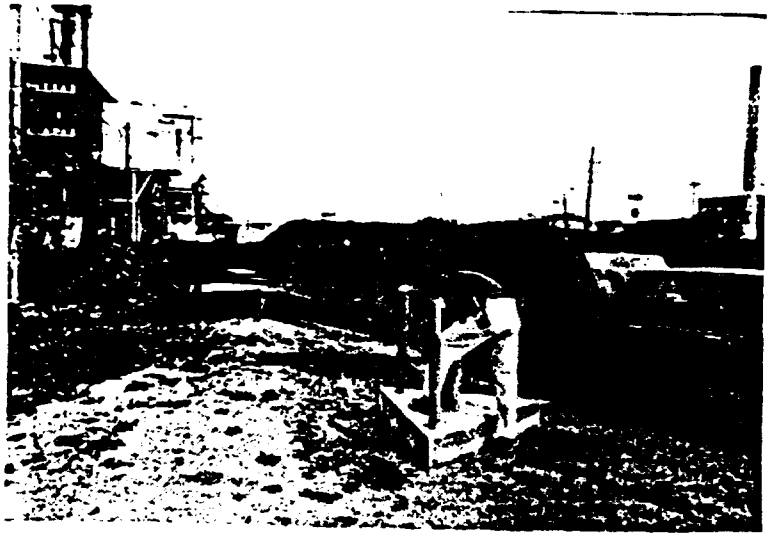

Photo 45: A view of monitoring well No. 31 looking north.

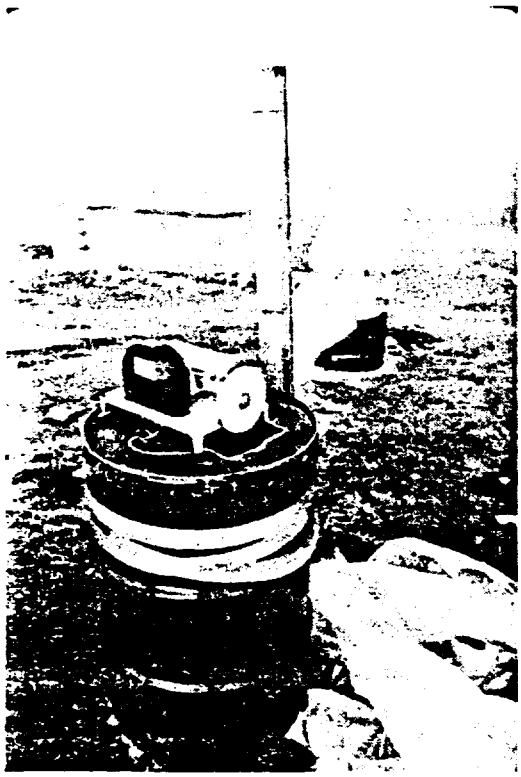

Photo 46: A view of the installation or setup used for the Stevens Recorder at monitoring well No. 32.

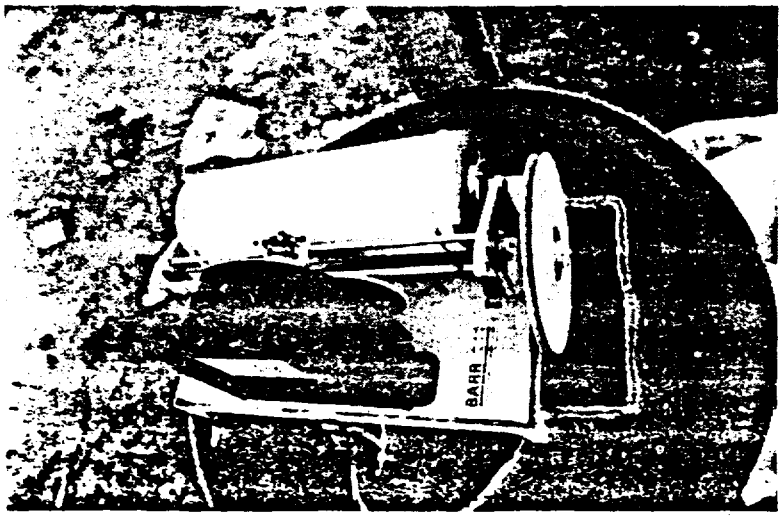

Photo 47: A closeup of the Stevens Recorder used at monitoring well No. 32.

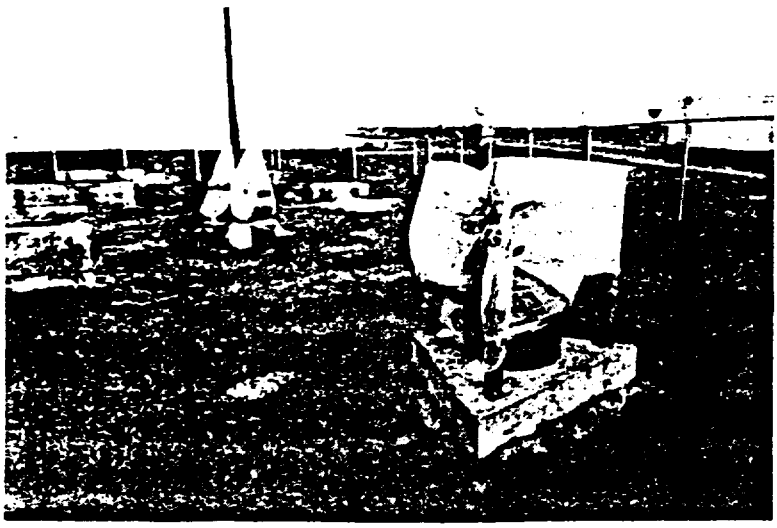

Photo 48: A view of the Stevens Recorder setups on monitoring well Nos. 32, 19 and 20.

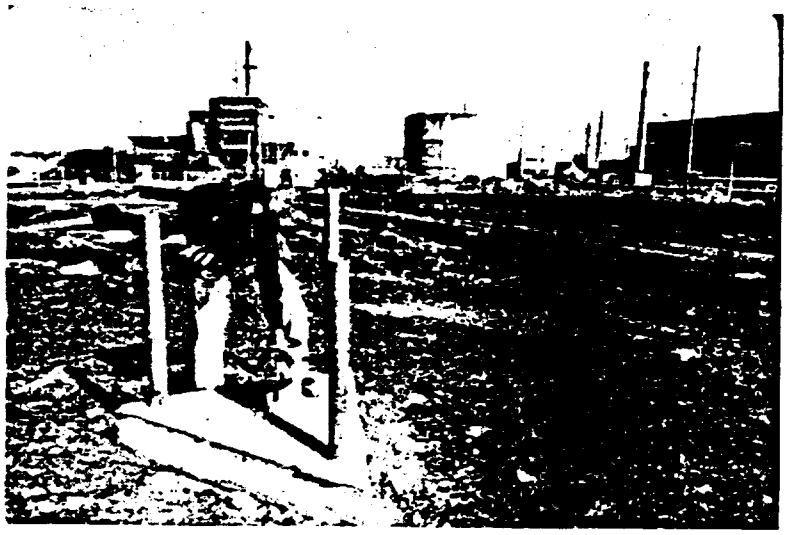

Photo 49: A view of monitoring well No. 34 toward the north.

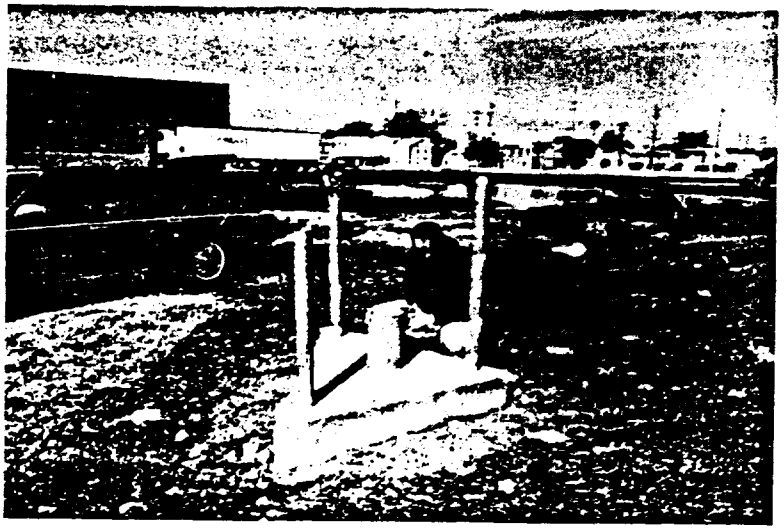

Photo 50: A view of monitoring well No. 34 toward the southwest.

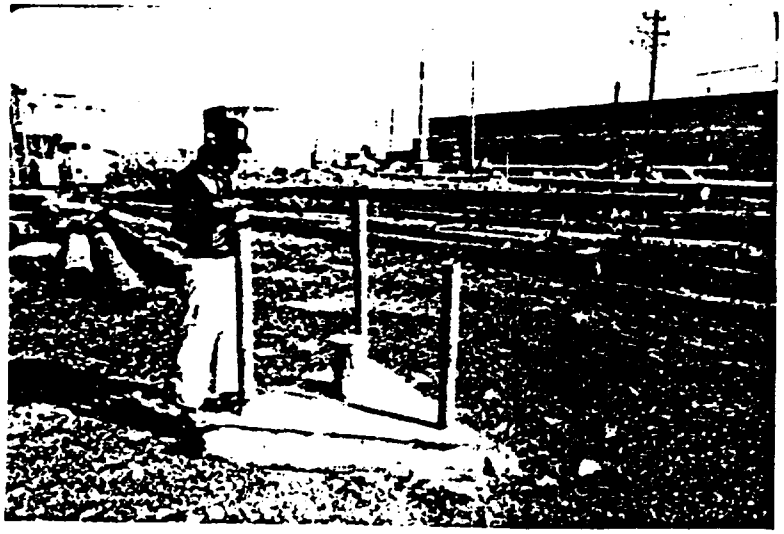

Photo 51: A view of monitoring well No. 34 toward the north.

Photo 52: A view of monitoring well No. 35 toward the north.

Photo 53: A view of monitoring well No. 35 in the foreground and a view of monitoring well No. 36 in the background.

Photo 54: A view of the onsite installation of the automatic recorders at MW-24.

Photo 55: Same as photo No. 54.

Photo 56: Same as photo No. 54.

Photo 57: Same as photo No. 54.

Photo 58: Same as photo No. 54.

Photo 59: Same as photo No. 54.

Photo 60: Same as photo No. 54.

Photo 61: A view of the decontamination of cables and transducers, used in the onsite wells, after the pump test.

Photo 62: A view of the flow meter section used for measurement of the flow or discharge from the pumping well during the pump test.

Photo 63: A view of the onsite pumping well and equipment surrounding it.

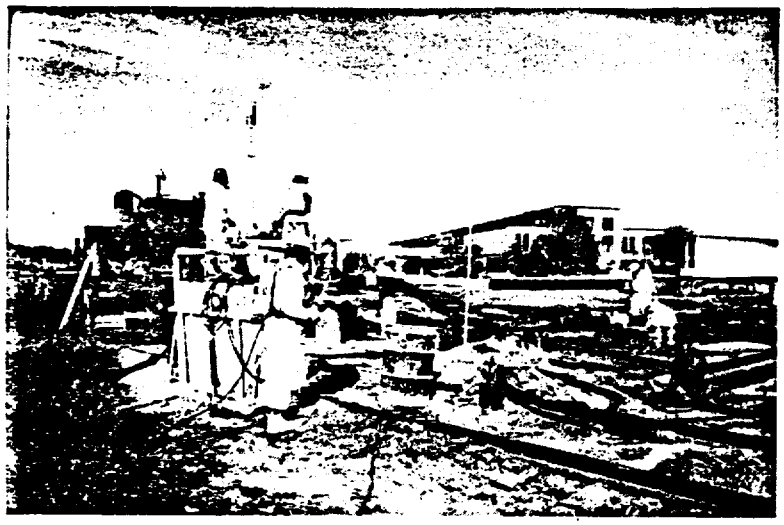

Photo 64: A view of the onsite pumping well and personnel.

Photo 65: A view of the air monitoring during pumping of the onsite well.

Photo 66: Same as photo No. 65.

Photo 67: A view of the pumping well discharge line and personnel during operation of the pump.

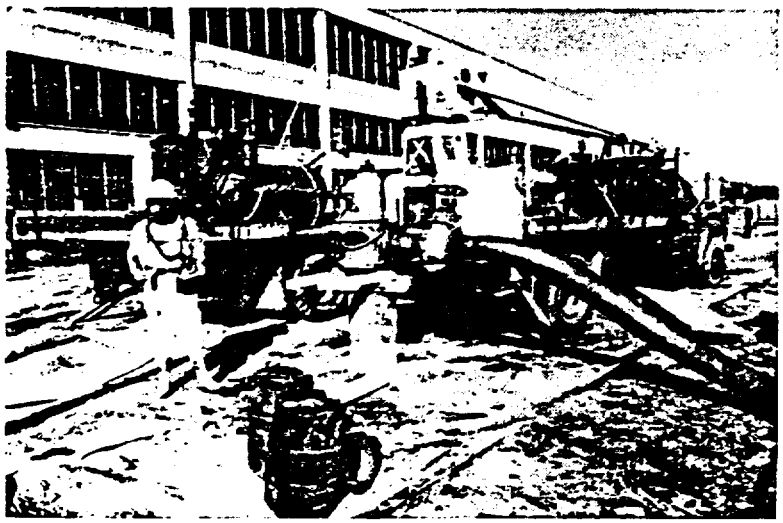

Photo 68: A view of the onsite pumping well pump, discharge line, and related equipment.

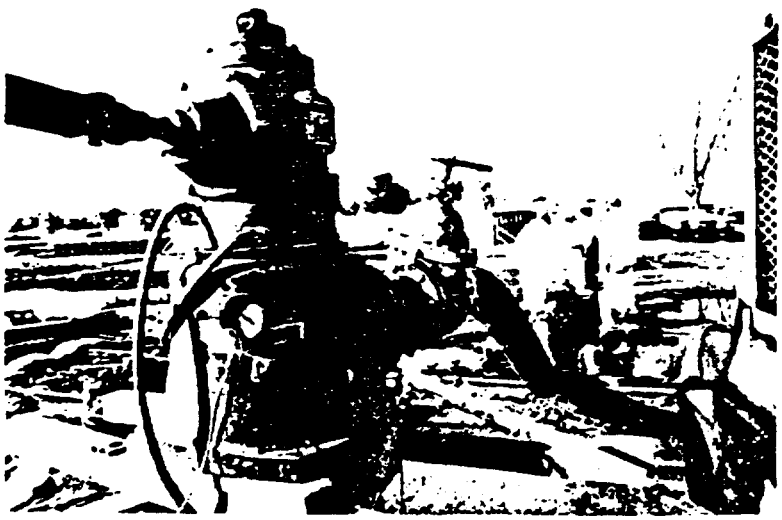

Photo 69: A closeup of the onsite pumping well and discharge line viewing toward the east.

Photo 70: A view of the onsite pumping well and discharge line.

Photo 71: Closeup view of the onsite pumping well and discharge line.

Photo 72: Same as photo No. 71.

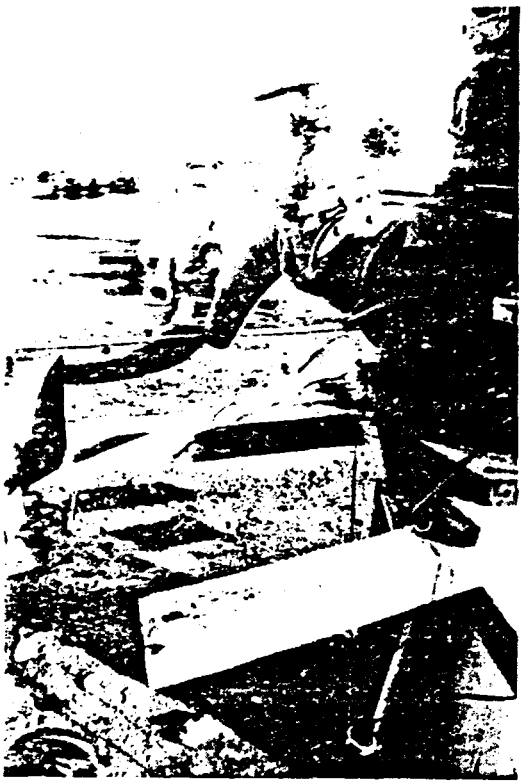

Photo 73: Same as photo No. 71.

Photo 74: A view of the onsite pumping well, discharge line and flow meter located at the right-hand portion of the photo.

Photo 75: A view of the inline flow meter located in the discharge line of the pump test well.

Photo 76: A view of the discharge into the 100,000-gallon storage pool onsite.

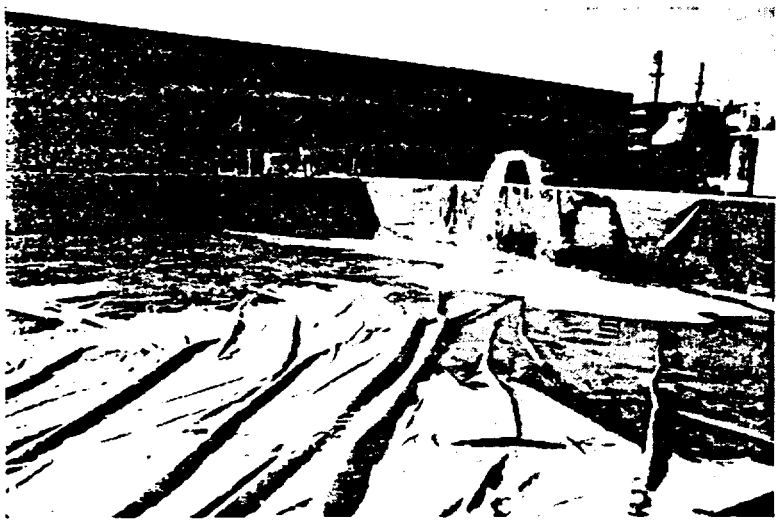

Photo 77: Same as photo No. 76.

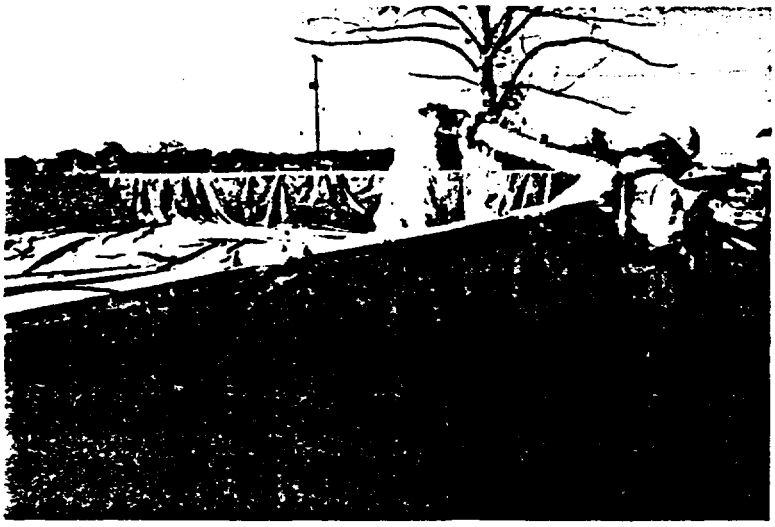

Photo 78: A view of air monitoring operations during the discharge of pumping water into the 100,000-gallon storge pond.

Photo 79: A view of air monitoring operations during discharge of pumped water into a 50,000-gallon storage pool.

Photo 80: Same as photo No. 79.

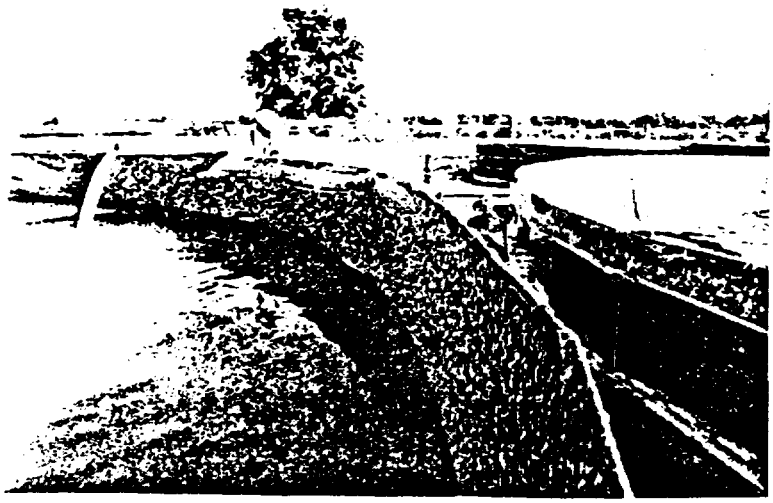

Photo 81: A view of the onsite air monitoring operations during the discharge of pump water into the 50,000-gallon storage pools. Air monitoring was conducted with an HNu photoionizing detector.

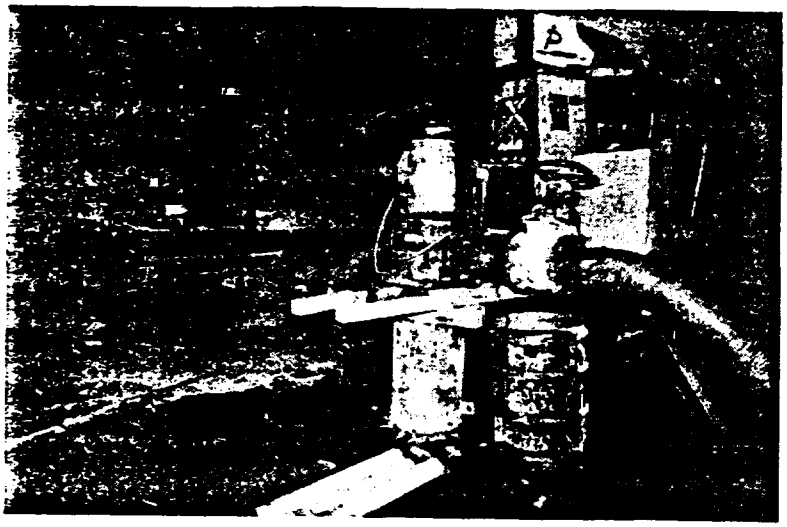

Photo 82: A view of the night time operation of the onsite pumping well during the pump test.

Photo 83: A view of the inline flow meter reading during the pump test operation.

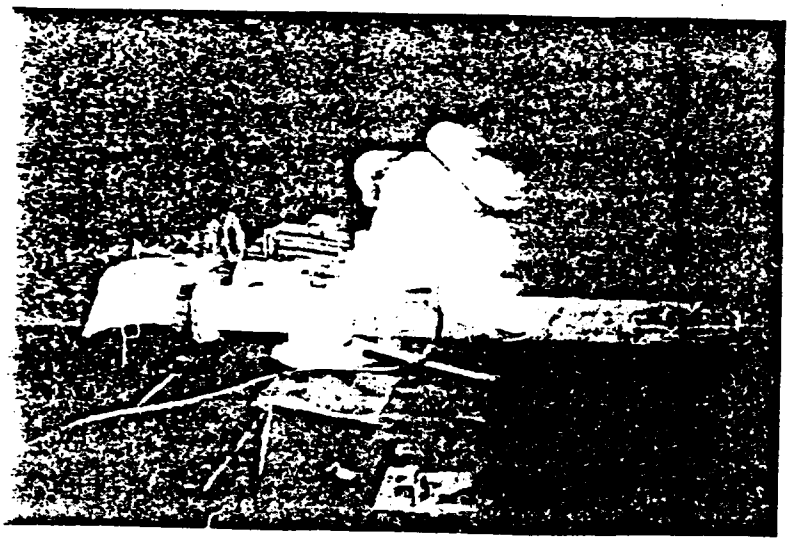

Photo 84: A closeup view of discharge readings from the inline flow meter during the pump test.

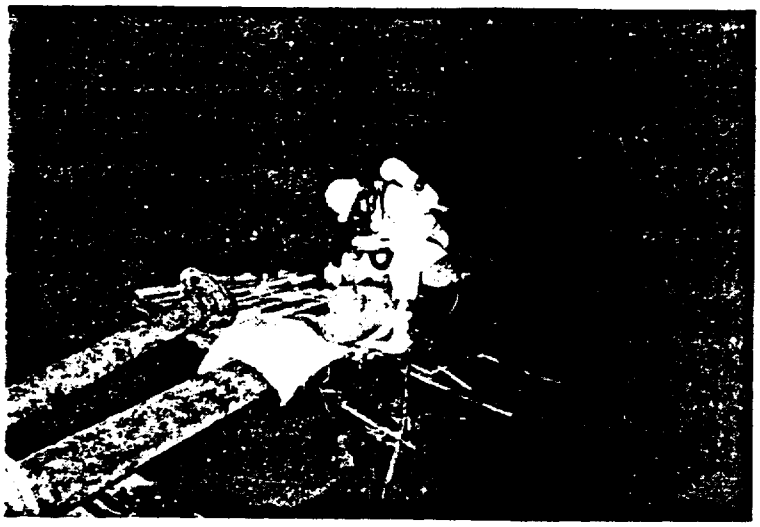

Photo 85: The same as photo 84.

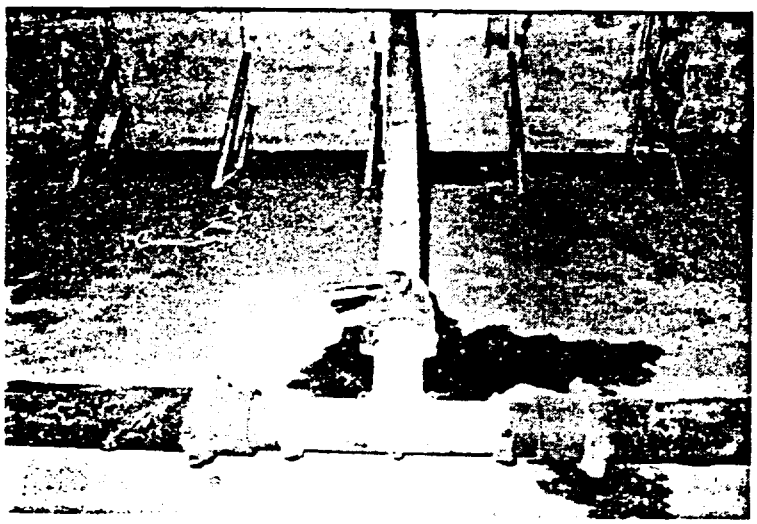

Photo 86: A view of the valve controlling discharge to the 100,000-gallon storage pool.

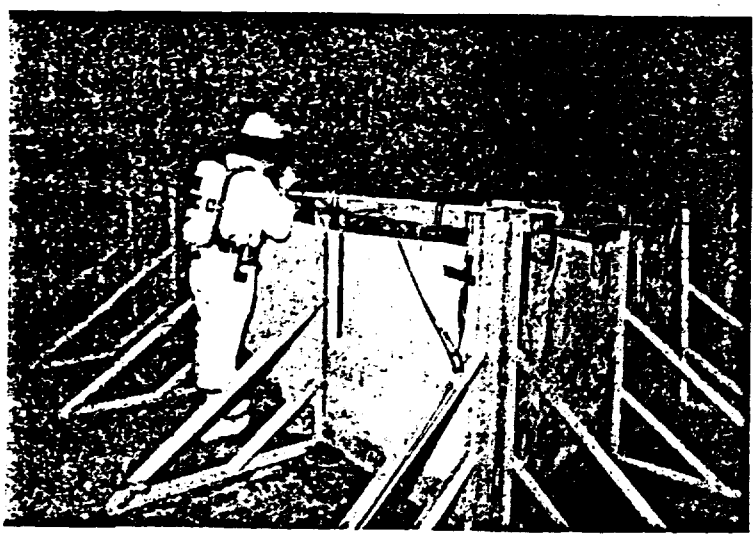

Photo 87: A view of the 100,000-gallon storage pool taken at night.

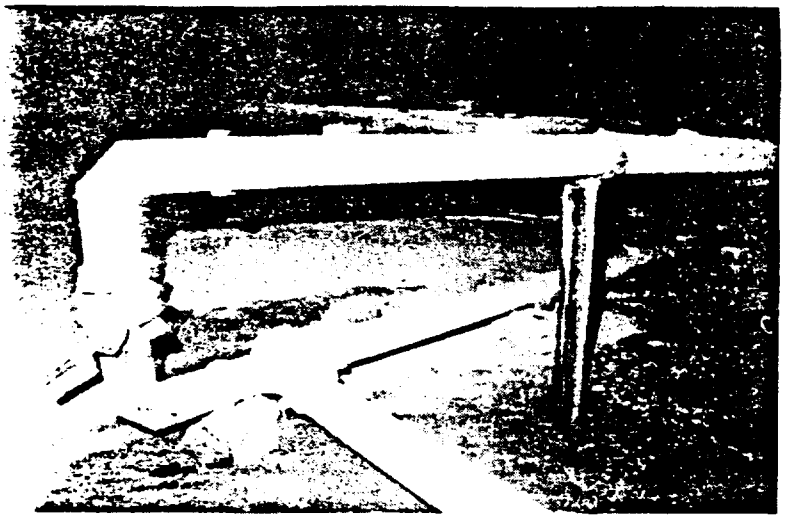

Photo 88: A view of one of four valves controlling discharge to the 50,000-gallon storage pools.

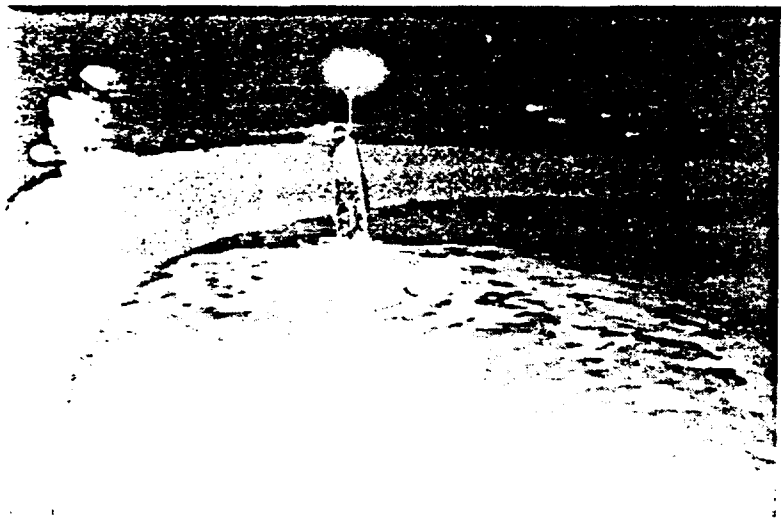

Photo 89: A view of the discharge to one of the 50,000-gallon storage pools taken at night.

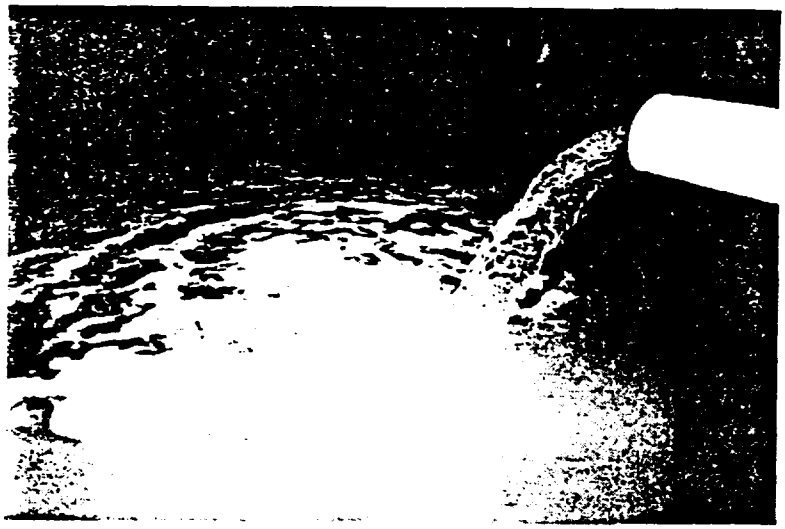

Photo 90: A view of the discharge to one of the 50,000-gallon storage pools taken at night during the pump test.

Photo 91: Same as photo No. 90.

Photo 92: Same as photo No. 90.

Photo 93: Same as photo No. 90.

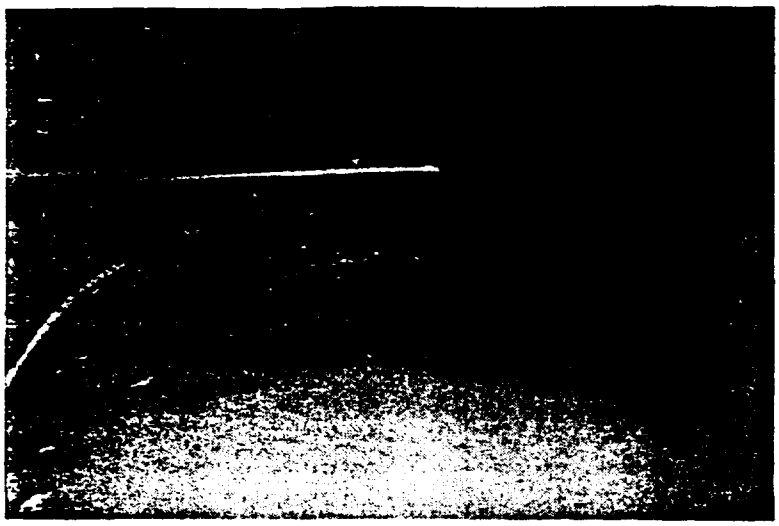

Photo 94: Same as photo No. 90.

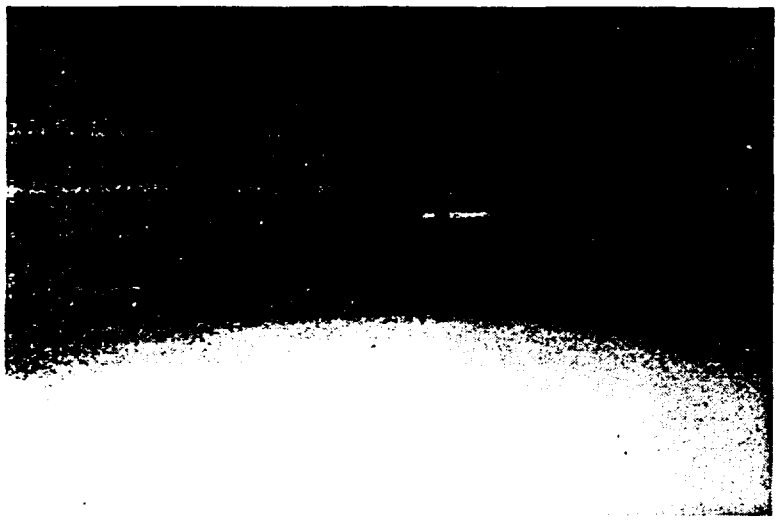

Photo 95: A view of the discharge contained in the 50,000-gallon storage pools taken at night.

Photo 96: A view of the interior of the decontamination shed at the hot line on the south end of the site. Also shown is the level of protection worn by onsite personnel conducting hand measurements of water levels in onsite monitoring wells during the pump test.

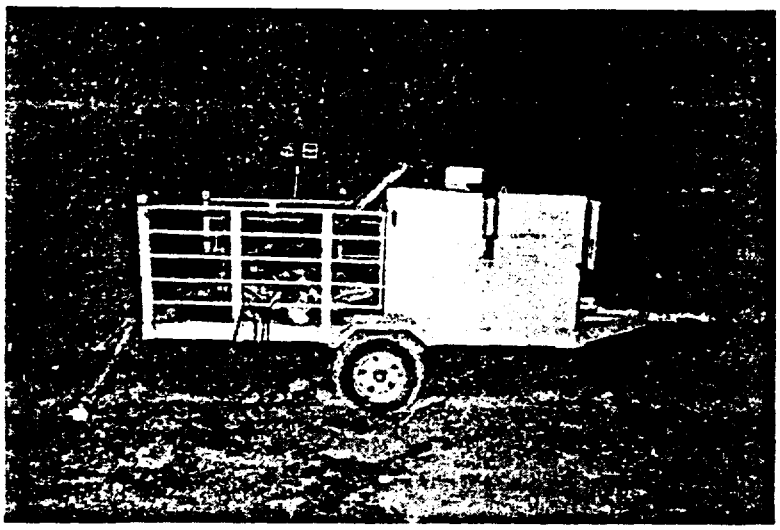

Photo 97: A view of the onsite generator used for lighting during the pump test.

GLT461/1

- Tentatively identified compounds detected in test pit and grab samples are presented in Appendix C.

GLT432/81

Table 3 (Page 1 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF TEST PIT SOIL SAMPLES AT CHEM-DYNE
CASE NO. 1964 AUGUST 1983

Compound[a]	TEST PIT SOIL SAMPLES											
	TP-1-1[b,c]	TP-1-3	TP-2-2[b]	TP-2-4	TP-2-5	TP-3-3[b]	TP-3-4[b]	TP-3-5[b]	TP-4-2[b]	TP-4-3[b]	TP-4-5	TP-4-6
Acid Compounds, ug/kg												
Phenol												
Base/Neutral Compounds, ug/kg												
Hexachloroethane												
1,2,4-Trichlorobenzene												
1,2-Dichlorobenzene												
1,3 Dichlorobenzene												
1,4-Dichlorobenzene												
Fluoranthene	LT		LT		800	LT	1,260					
Naphthalene							1,100		1,300			
Diethyl phthalate			LT			LT						
Benzo(a)anthracene					750	LT	1,008					
Benzo(a)pyrene							2,772					
Benzo(b)fluoranthene							1,260					
Benzo(k)fluoranthene							2,016					
Chrysene					890	LT	2,318		LT			
Benzo(ghi)perylene							LT					
Phenanthrene					700	LT	860		2,100			
Pyrene			LT		470	488	1,200		LT	LT		
Bis(2-ethylhexyl)phthalate												
Di-N-butyl phthalate												
2,4-Dinitrotoluene												
Acenaphthene												
Anthracene												
Bis(2-chloroethyl)ether												
Volatiles, ug/kg												
Benzene												
Chlorobenzene												
1,2-Dichloroethane												
1,1-Dichloroethane												
1,1,2-Trichloroethane												
1,1,2,2-Tetrachloroethane												
Chloroform									32			
Methylene chloride	47	6	3.41	15	4.5	16	LT	52	39	LT	14	
Toluene	4		2.86	17	32			26	LT	14		
Trans-1,2-dichloroethene												
Ethylbenzene												
1,1-Dichloroethene												
Tetrachloroethene												
Trichloroethene												
Vinyl chloride												
Pesticides, ug/kg												
Aldrin												
Dieldrin												
4,4'-DDT												
4,4'-DDE												
4,4'-DDD												
Endrin												
Heptachlor												
a-BHC												
b-BHC												
g-BHC (lindane)												
Endosulfan sulfate					10							
PCB-1254	PN 111											
PCB-1260	PN 81											
Nonpriority Pollutants												
Hazardous Substances, ug/kg												
2-Methylnaphthalene							LT		2,600			
Acetone												
Carbon Disulfide												
2-Hexanone												
2-Methylphenol												
2-Butanone												
Dibenzofuran												
Total xylenes												
Dioxins, ug/kg												
2,3,7,8-Tetrachlorodibenzo-p-dioxin												

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]LT denotes compound identified at less than (LT) the specified detection limit but greater than one-half the detection limit, i.e., present but below the detection limit.
[c]PN represents pesticide or PCB which cannot be confirmed by GC/MS.
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Table 3 (Page 2 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF TEST PIT SOIL SAMPLES AT CHEM-DYNE
CASE NO. 1964 AUGUST 1983

TEST PIT SOIL SAMPLES

Compound[a]	TP-5-1	TP-5-2	TP-5-3	TP-6-1	TP-6-3	TP-6-4	TP-7-1	TP-7-2	TP-7-3	TP-7-5
Acid Compounds, ug/kg										
Phenol						90				
Base/Neutral Compounds, ug/kg										
Hexachloroethane							30,000			
1,2-4-Trichlorobenzene										
1,2-Dichlorobenzene										
1-3-Dichlorobenzene									44	
1,4-Dichlorbenzene							37,000			
Fluoranthene						220				
Naphthalene						780				
Diethyl phthalate										
Benzo(a)anthracene										
Benzo(a)pyrene										
Benzo(b)fluoranthene										
Benzo(k)fluoranthene						190				
Chrysene						620				
Benzo(ghi)perylene										
Phenanthrene						1,700			46	
Pyrene						220				
Bis(2-ethylhexyl)phthalate						260	2,000	2,200		2,300
Di-N-butyl phthalate						350	2,200		44	150
2,4-Dinitrotoluene										
Acenapthene										
Anthracene										
Bis(2-chloroethyl)ether										
Di-n-octyl phthalate										520
Volatiles, ug/kg										
Benzene	6.5				6.0	30				
Chlorobenzene		3.7					290		1.9	
1,1-Dichloroethane				16	9.0	70	48	88		
1,2-Dichloroethane										
1,1,2-Trichloroethane									4.8	29
1,1,2,2-Tetrachloroethane									9.7	29
Chloroform					9.3	26				
Methylene chloride	160	98	80	100	174	220			23	250
Toluene	5.8				5.6	25	930	6,700	3.4	
Trans-1,2-dichlorethene	19			9.3	103	770				
Ethylbenzene						2.3	41	100		
1,1-Dichloroethene										
Tetrachloroethene	2.4	5.1		1.3	2.6	11	11,000	1,900	3.6	
Trichloroethene	30	110	15	19	27	82				1.5
Vinyl chloride						30				
Pesticides, ug/kg										
Aldrin								2,990		2.1
Dieldrin							1,410	24,600		
4,4'-DDT							2,380	7,900		
4,4'-DDE								326		
4,4'-DDD										
Endrin							2,490	6,530		
Heptachlor							2,290	3,500		3.7
a-BHC							39			
b-BHC							367			
g-BHC (lindane)							2,970	3,140		
Endosulfan sulfate										
PCB-1254										
PCB-1260										
Endosulfan										2.1
Nonpriority Pollutants										
Hazardous Substances, ug/kg										
2-Methylnaphthalene						1,600				
Acetone						28	31,000	11,000	360	
Carbon Disulfide				1.6	6.1	1.7				
2-Hexanone				1.5						
2-Methylphenol				760						
2-Butanone							43,000	19,000	290	
Dibenzofuran						550				
Dioxins, ug/kg										
2,3,7,8-Tetrachlorodibenzo -p-dioxin										

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]LT denotes compound identified at less than (LT) the specified detection limit but greater than one-half the detection limit, i.e., present but below the detection limit.
[c]PM represents pesticide or PCB which cannot be confirmed by GC/MS.

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Table 3 (Page 3 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF TEST PIT SOIL SAMPLES AT CHEM-DYNE
CASE NO. 1964 AUGUST 1983

Compound[a]	TEST PIT SOIL SAMPLES											
	TP-8-2	TP-8-3	TP-8-6	TP-8-7	TP-9-2	TP-9-3	TP-9-5	TP-10-1	TP-10-2	TP-10-3	TP-10-4	TP-11-1
Acid Compounds, ug/kg												
Phenol								660,000			6,500	
Base/Neutral Compounds, ug/kg												
Hexachloroethane												
1,2,4-Trichlorobenzene												
1,2-Dichlorobenzene	1,700	LT	680	LT	LT			2,200,000	1,400	36,000	9,000	
1,3-Dichlorobenzene	4,100	780	1,100	LT	600		LT	1,800,000	4,400	61,000	13,000	
1,4-Dichlorobenzene	950		LT					900,000	3,000	32,000	8,100	
Fluoranthene	LT							LT	2,800		LT	
Naphthalene	810				510							
Diethyl phthalate												
Benzo(a)anthracene	LT								1,400		LT	
Benzo(a)pyrene								LT	1,100			
Benzo(b)fluoranthene									LT			
Benzo(k)fluoranthene									LT			
Chrysene	LT							LT	1,200		LT	
Benzo(ghi)perylene												
Phenanthrene	1,000				840			LT	1,700		LT	
Pyrene	LT							LT	2,300		LT	
Bis(2-ethylhexyl)phthalate												180,000
Di-N-butyl phthalate												LT
2,4-Dinitrotoluene												
Acenaphthene												
Anthracene									460			
Bis(2-chloroethyl)ether												
Volatiles, ug/kg												
Benzene	11				25							
Chlorobenzene					6		6	120	51	298	35	189
1,2-Dichloroethane												
1,1-Dichloroethane										32		
1,1,2-Trichloroethane	39	10	37		180	13	25	269	6	62		
1,1,2,2-Tetrachloroethane	32	22	32	18		50	483	119		5		384
Chloroform					5				3	30	2	
Methylene chloride	22	6	6		6	6		17	8	34	23	
Toluene	20		5		20			17		13	2	1,031
Trans-1,2-dichlorethene					9						11	
Ethylbenzene												4,483
1,1,-Dichloroethene					6							
Tetrachloroethene	19		9		187			92		8	15	948
Trichloroethene	4				183						16	
Vinyl chloride						30						
Pesticides, ug/kg												
Aldrin												
Dieldrin												
4,4'-DDT												
4,4'-DDE												
4,4'-DDD												
Endrin												720
Heptachlor												
a-BHC												310
b-BHC												
g-BHC (lindane)												
Endosulfan sulfate												
PCB-1254												
PCB-1260												
Nonpriority Pollutants												
Hazardous Substances, ug/kg												
2-Methylnaphthalene	1,500				1,000							34,000
Acetone	83							446	8	517	80	
Carbon Disulfide												
2-Hexanone												
2-Methylphenol												
2-Butanone												
Dibenzofuran	LT				LT							
Total xylenes												
Dioxins, ug/kg												
2,3,7,8-Tetrachlorodibenzo-p-dioxin												

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]LT denotes compound identified at less than (LT) the specified detection limit but greater than one-half the detection limit, i.e., present but below the detection limit.
[c]PN represents pesticide or PCB which cannot be confirmed by GC/MS.

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Table 3 (Page 4 of 4)
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF TEST PIT SOIL SAMPLES AT CHEM-DYNE
CASE NO. 1964 AUGUST 1983

Compound[a]	TEST PIT SOIL SAMPLES						
	TP-11-2	TP-11-4	TP-12-1	TP-12-3	TP-13-2	TP-13-3	TP-13-4
Acid Compounds, ug/kg							
Phenol							
Base/Neutral Compounds, ug/kg							
Hexachloroethane						LT	4,700
1,2,4-Trichlorobenzene			LT		41,000	4,200	440
1,2-Dichlorobenzene			LT		57,000	35,000	1,600
1,3-Dichlorobenzene					23,000	5,300	750
1,4-Dichlorbenzene		430					
Fluoranthene			LT				
Naphthalene							
Diethyl phthalate		LT					
Benzo(a)anthracene							
Benzo(a)pyrene							
Benzo(b)fluoranthene							
Benzo(k)fluoranthene							
Chrysene		LT					
Benzo(ghi)perylene							
Phenanthrene		LT					
Pyrene		470					
Bis(2-ethylhexyl)phthalate		690					
Di-N-butyl phthalate							
2,4-Dinitrotoluene							
Acenapthene							
Anthracene							
Bis(2-chloroethyl)ether						LT	
Volatiles, ug/kg							
Benzene							
Chlorobenzene	281	171	815				
1,2-Dichloroethane					27	152	
1,1-Dichloroethane							
1,1,2-Trichloroethane		135	15	8	181	1,231	469
1,1,2,2-Tetrachloroethane	60	491	52	21	556	1,779	1,445
Chloroform							
Methylene chloride		7		8	8		76
Toluene	78	265					
Trans-1,2-dichlorethene		11					
Ethylbenzene	4,329	295					
1,1,-Dichloroethene							
Tetrachloroethene	78			14		203	490
Trichloroethene		19			5		45
Vinyl chloride							
Pesticides, ug/kg							
Aldrin							
Dieldrin							
4,4'-DDT							
4,4'-DDE							
Endrin	280		20			35	
Heptachlor						48	
a-BHC							
b-BHC							
g-BHC (lindane)							
Endosulfan sulfate							
PCB-1254							
PCB-1260							
Nonpriority Pollutants							
Hazardous Substances, ug/kg							
2-Methylnaphthalene	45,000						
Acetone							
Carbon Disulfide					507		
2-Hexanone							
2-Methylphenol							
2-Butanone							
Dibenzofuran							
Dioxins, ug/kg							
2,3,7,8-Tetrachlorodibenzo-p-dioxin							

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]LT denotes compound identified at less than (LT) the specified detection limit but greater than one-half the detection limit, i.e., present but below the detection limit.
[c]PM represents pesticide or PCB which cannot be confirmed by GC/MS.

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Table 4 (Page 1 of 4)
SUMMARY OF INORGANIC ANALYSES OF TEST PIT SOILS AT CHEM-DYNE
CASE NO. 1746 JUNE 1981

Constituent[a]	TP-1-1	TP-1-3	TP-2-2	TP-2-4	TP-2-5	TP-3-3	TP-3-4	TP-3-5	TP-4-2	TP-4-3	TP-4-5	TP-4-6
Aluminum	4,440	8,300	6,800	11,000	9,050	13,100	3,900	11,300	7,600	6,800	9,600	3,990
Chromium	14.7	12.5	12.4	13.1	12.1	16.2	74.5	15.7	11.2	14.4	13	6.7
Barium	149	69	207	102	35	77	63.5	112	86.5	53.5	69.5	37.6
Beryllium	0.85	0.65	0.95	0.25	0.35	0.5	0.3	0.65	1.7	<0.25	0.45	<0.25
Cadmium	5.5	2.6	2.8	2.7	2.6	1.5	2.3	2.1	1.8	2.0	1.8	2.2
Cobalt	6.2	7.4	8.6	8.0	8.0	9.0	6.1	9.9	8.6	8.5	7.5	3.1
Copper	94	35.3	73	20.7	18.9	105	785	25.4	60	309	21.8	8.1
Iron	14,700	16,000	18,000	16,900	15,700	16,900	26,700	17,600	10,800	49,500	13,500	8,200
Lead	150	59.5	230	46	32.5	30	368	31	18.5	11,900	27.5	22
Nickel	14.2	14.1	21.5	14	14.7	16.3	20.2	19	13.1	21.1	13.7	5.9
Manganese	210	390	535	371	358	286	368	585	188	366	225	225
Zinc	127	63	110	48.4	33.6	62	83.5	60.5	23.7	146	47.9	17.2
Boron	<50	14.1	7.6	<5.0	7.3	8.4	<5	7.4	13.5	<5.0	6.2	<5.0
Vanadium	14.9	19.3	18	21.7	15.6	25.9	31	23.1	21.9	22.2	20.2	10.2
Arsenic	11.7	86	21	16	17.8	9.2	21	13.5	8.7	15.5	14	16.5
Antimony	<1	<1	<1	<1	<1	8.1	<1	8.5	2.4	2.0	<1	<1
Selenium	0.9	2.3	2.7	1.8	2.3	0.3	2.1	0.8	0.9	1.0	1.5	2.0
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	6.6	1.9	2.3	1.4	0.75	0.75	2.5	2.2	3.8	3.0	1.0	5.8
Tin	34	24.5	37.5	9.8	9.1	22	43.5	22.5	52.5	25.5	21	10
Silver	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	3.2	<0.5	0.8	<0.5
Cyanide	SPOT TEST(S) NEGATIVE											

[a]All concentrations reported as mg/kg.

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Table 4 (Page 2 of 4)
SUMMARY OF INORGANIC ANALYSES OF TEST PIT SOILS AT CHEM-DYNE
CASE NO. 1746 JUNE 1983

Constituent[a]	TP-5-1	TP-5-3	TP-5-5	TP-6-1	TP-6-3	TP-6-4	TP-7-1	TP-7-2	TP-7-3	TP-7-5
Aluminum	2,900	1,840	4,200	7,850	10,700	3,620	9,850	8,300	2,390	10,900
Chromium	4.4	4.7	7.6	10.9	12.9	4.5	26.9	10.4	1.0	11.7
Barium	17.2	10.2	36.6	62	78.5	85	62	51	21.4	80.0
Beryllium	<0.25	<0.25	0.50	1.0	0.90	1.6	0.7	0.60	0.45	0.70
Cadmium	<0.05	0.08	2.7	2.2	1.5	2.3	0.35	0.07	0.12	0.2
Cobalt	<2.5	<2.5	3.8	5.5	5.7	3.7	4.1	4.6	3.0	4.7
Copper	10.1	5.6	25.5	112	39.2	21.5	182	28.1	17.0	18.5
Iron	5,500	4,350	8,000	26,000	19,800	4,150	20,200	13,400	371	12,300
Lead	8.8	6.8	42.2	414	88.5	35.3	131	18.5	4.9	25.8
Nickel	5.9	6.7	8.6	14.2	14.2	7.2	13.7	11.7	9.2	12.5
Manganese	192	239	228	326	510	51	311	418	305	330
Zinc	21.4	15.9	39.4	94	69	19	1,240	41.4	33.7	47.9
Boron	6.2	6.5	8.1	10.9	5.8	8.2	<5	<5	<5	6.7
Vanadium	<10	<10	10.3	21.9	23.7	10.4	21.5	16.5	<10	21.3
Arsenic	4.0	3.6	4.2	13.0	6.7	3.5	6.7	7.4	<0.5	7.4
Antimony	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Selenium	<0.1	0.2	0.1	0.15	<0.1	0.5	0.1	<0.1	<0.1	0.1
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	0.15	0.15	<0.1	<0.1	0.75	0.4	0.25	<0.15	<0.1	<0.1
Tin	<1	1.9	1.6	3.0	1.2	<1	<1	<1	<1	<1
Silver	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide	SPOT TEST(S) NEGATIVE									

[a]All concentrations reported as mg/kg.

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Table 4 (Page 3 of 4)
SUMMARY OF INORGANIC ANALYSES OF TEST PIT SOILS AT CHEM-DYNE
CASE NO. 1746 JUNE 1983

Constituent[a]	TP-8-2	TP-8-3	TP-8-6	TP-8-7	TP-9-2	TP-9-3	TP-9-5	TP-10-1	TP-10-2	TP-10-3	TP-10-4
Aluminum	2,920	4,130	10,700	2,350	4,310	4,320	7,600	5,200	4,700	5,900	8,650
Chromium	4.4	5.1	11.9	3.8	6.5	5.3	8.3	7.9	7.8	12.2	11.4
Barium	39.2	41.8	74	21.4	81	57	74	62.5	40.1	174	77
Beryllium	0.65	<0.25	0.55	<0.25	0.8	0.5	0.4	0.6	0.7	0.85	0.70
Cadmium	0.12	0.13	0.24	0.10	3.3	0.16	0.25	1.95	0.65	0.40	0.38
Cobalt	<2.5	<2.5	5.1	<2.5	4.1	2.5	3.9	3.6	<2.5	4.9	5.2
Copper	22.9	23.9	20.5	5.3	21.400	11.4	13.6	48.7	10.2	230	124
Iron	4,940	6,050	10,600	3,940	17,200	6,700	10,100	14,000	5,900	16,300	19,200
Lead	128	41.7	22.2	3.1	3,320	5.9	7.4	105	13	83.5	80
Nickel	5.5	5.6	13.4	4.5	8.7	8,0	11.3	9.2	6.0	39.2	53.5
Manganese	103	195	322	139	221	251	364	256	675	375	382
Zinc	39.8	32.2	52	13.4	1,370	34.1	39.5	197	18.2	125	99
Boron	<5	5.9	9.0	5.6	11.7	<5	<5	8.2	8.4	14.5	8.5
Vanadium	<10	<10	20.5	<10	13.8	<10	15.0	12.2	11.1	16.5	19.1
Arsenic	5.8	2.9	6.2	2.0	8.5	2.8	3.7	9.0	2.8	8.3	5.9
Antimony	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Selenium	0.15	<0.1	0.15	<0.1	<0.1	<0.1	0.1	0.2	<0.1	0.1	0.2
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	0.6	<0.1	<0.1	<0.1	<0.15	<0.1	0.15	1.15	0.55	0.55	0.8
Tin	<1	<1	<1	<1	109	<1	<1	<1	1.4	2.4	<1
Silver	<0.5	<0.5	<0.5	<0.5	0.85	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cyanide	SPOT TEST(S) NEGATIVE										

[a]All concentrations reported as mg/kg.

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Table 4 (Page 4 of 4)
SUMMARY OF INORGANIC ANALYSES OF TEST PIT SOILS AT CHEM-DYNE
CASE NO. 1746 JUNE 1983

Constituent[a]	TP-11-1	TP-11-2	TP-11-4	TP-12-1	TP-12-3	TP-13-2	TP-13-3	TP-13-4
Aluminum	4,960	4,510	2,720	3,950	2,550	5,500	8,450	3,400
Chromium	74	8.7	5.0	9.5	5.7	8.5	11.1	8.5
Barium	76.5	80.1	29.0	52.5	15.9	34.1	90.5	426
Beryllium	0.60	0.40	<0.25	0.6	<0.25	<0.25	0.60	0.40
Cadmium	0.80	0.26	0.15	0.30	0.06	0.13	0.24	2.5
Cobalt	4.8	3.2	<2.5	3.4	<2.5	2.9	3.9	2.6
Copper	61	27.2	11.4	30.8	11.0	19.4	16.6	50.5
Iron	20,600	9,250	5,650	8,400	4,610	13,400	14,400	8,250
Lead	96.5	96.5	86	52.5	7.1	20.4	22.5	451
Nickel	14.6	8.3	6.2	9.5	5.8	9.8	10.3	10.9
Manganese	259	239	194	281	215	124	433	228
Zinc	69.5	35.8	26.8	55.5	15.9	44.1	37.4	338
Boron	10.9	5.3	<5	9.1	7.5	<5	6.2	9.9
Vanadium	16.4	10.6	<10	11.6	<10	14.2	18.1	9.1
Arsenic	7.8	6.4	2.4	7.3	2.5	2.8	3.5	4.4
Antimony	<1	<1	<1	<1	<1	<1	<1	<1
Selenium	0.3	0.1	0.25	0.15	<0.1	0.1	<0.1	<0.1
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	8.15	0.9	<0.1	0.95	0.25	0.85	<0.1	0.4
Tin	2.0	<1	<1	<1	<1	294	189	3.0
Silver	<0.5	<0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5
Cyanide	SPOT TEST(S) NEGATIVE							

[a]All concentrations reported as mg/kg.

GLT432/90-4

Table 5
SUMMARY OF PRIORITY POLLUTANT ORGANIC ANALYSIS OF
GRAB SAMPLES AT CHEM-DYNE CASE NO. 1964 SEPTEMBER 1983

Compound[a]	GS-1[c]	GS-2[c]	GS-2[c]	GS-3[c]	GS-4[c]	GS-5[c]	GS-6[c]
Acid Compounds, ug/kg							
2-Chlorophenol						1,200	
2,4-Dimethylphenol					LT	725	
Phenol		LT			6,500	20,000	310,000
Base/Neutral Compounds, ug/kg							
1,2,4-Trichlorobenzene		LT	LT				
Hexachlorobenzene	LT	6,400	8,000		9,300		
Hexachloroethane		3,400	8,500				
1,2-Dichlorobenzene		5,600	5,700		LT	3,300	
1,3-Dichlorobenzene		9,600	9,000	90,000	5,200	3,300	LT
1,4-Dichlorobenzene		4,300	4,000	78,000	2,400	10,000	
Fluoranthene				LT	17,000		
3,3'-Dichlorobenzidine							32,000
Naphthalene		890	LT		2,700	LT	LT
Bis(2-ethylhexyl)phthalate		2,700	5,200	150,000		7,100	150,000
Benzyl butyl phthalate		LT	LT			LT	LT
Di-n-butyl phthalate		LT	LT	7,200	2,900		27,000
Diethyl phthalate				LT			
N-nitrosodiphenylamine						33,000	
Benzo(a)anthracene					6,400		
Benzo(k)fluoranthene					15,000		
Chrysene			LT		13,000		
Anthracene					LT		
Phenanthrene		LT		LT	600		
Pyrene				LT	32,000		
Volatiles, ug/kg							
Chlorobenzene	7,125		7		430	62,000 ug/g	120 ug/g
1,2-Dichloroethane		LT	19				
1,1,2-Trichloroethane	89	30	34				
1,1,2,2-Tetrachloroethane	444	39	25				
Chloroform			5				
Trans-1,2-dichloroethene			LT				
Ethylbenzene							29 ug/g
Methylene chloride		40	44		1,700		
Tetrachloroethene	218	24	33	60,000			6 ug/g
Toluene	42			LT			11 ug/g
Trichloroethene			5				
Pesticides, ug/kg							
Dieldrin	146		PC 7,500	PN 60			
Endrin			PC 40,000	PN 251			
Heptachlor	2,240		PC 16,000			PN 22	
PCB-1248					PN 90,000		PN 18,000
Heptachlor epoxide	135						
Nonpriority Pollutants							
Hazardous Substances, ug/kg							
Benzoic acid			LT				
4-Methylphenol				97,000	3,300	2,600	140,000
O-xylene							37 ug/g
2-Methylnaphthalene					LT		
Dioxins, ug/kg							
2,3,7,8-Tetrachlorodibenzo-p-dioxin							

[a]NA denotes that the compound was not analyzed for in this sample. Only compounds identified in samples are listed in this table. Compounds not identified in any sample are not listed.
[b]PC denotes pesticide or PCB confirmed by GC/MS (CLP abbreviation).
[c]LT denotes compound identified at less than (LT) detection limit but greater than one-half of the detection limit, i.e., present but BDL.
[d]PN denotes pesticide or PCB cannot be confirmed by GC/MS.

GLT432/102

Table 6
SUMMARY OF INORGANIC ANALYSIS OF GRAB SAMPLES AT CHEM-DYNE

Constituent[a]	GS-1	GS-2	GS-3	GS-4	GS-5	GS-6
Aluminum	6,200	4,200	8,200	3,870	3,020	3,800
Chromium	12	8.9	90	135	16.6	22.4
Barium	92.5	46.7	446	158	207	745
Beryllium	0.72	1.1	2.25	0.85	0.45	0.75
Cadmium	1.4	1.4	4.4	4.5	20.5	38
Cobalt	4.3	24.3	9.8	15.5	3.0	3.8
Copper	65	76	125	13,500	119	261
Iron	11,400	19,600	15,700	20,200	10,300	19,600
Lead	155	52	335	610	477	202
Nickel	14.5	1,020	23.7	33.7	16.8	14.0
Manganese	289	291	82.6	109	3,110	385
Zinc	132	131	2,670	5,650	160	424
Boron	9.3	23.8	28.0	17.2	8.0	7.7
Vanadium	14.5	14.9	32.7	14.3	21.3	17.5
Arsenic	6.5	8.2	20	14.6	5.0	9.2
Antimony	<1	1.9	9.4	<1	1.4	<1
Selenium	0.2	0.35	0.75	0.1	<0.1	0.1
Thallium	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	1.45	0.1	6.3	6.9	0.5	2.15
Tin	<1	4.6	9.3	6.4	4.4	17.3
Silver	<0.5	<0.5	0.5	<0.5	0.55	0.9
Cyanide	--------SPOT TEST NEGATIVE--------					

[a]All concentrations reported as mg/kg.

GLT432/90-5

Table 7
SUMMARY OF PBB, TRIS, CURENE-442, AND DIOXIN ANALYSIS OF SOIL AT CHEM-DYNE UNDER SAS 735E

Sample Location	Depth (Feet)	Compounds[a,b] Detected	Concentration (ug/kg)
TP-1-1	0-2	ND	--
TP-1-3	5-6	ND	--
TP-3-1	0-1	ND	--
TP-5-1	0.5 - 1.5	ND	--
TP-10-1	0.5 - 1.5	ND	--
TP-10-3	3.5 - 4.5	ND	--
TP-11-2	1.5 - 2.5	Tris	360
TP-13-1	0-1	Tris	200,000
TP-13-3	3 - 3.5	Tris	2,000
GS-1	Surface	Tris Curene-442	2,000 260
GS-3	Surface	ND	--

[a]ND denotes PBB, tris, or Curene-442 not detected at reported detection limits of 100 ug/kg for PBB and Curene-442 and 200 ug/kg for tris.
[b]2,3,7,8-TCDD (dioxin) was analyzed for but not detected at reported detection limits of 0.1 to 1.0 ug/kg.

GLT461/52

MEMORANDUM

TO: File

FROM: Brad J. Berggren/GLO

DATE: November 10, 1983

RE: Chem-Dyne Site Remedial Investigation
Final Soil Investigation - Test Pits
Onsite/Offsite
Subtask 3-4

JOB NO: W65310.C0

INTRODUCTION

A final soil investigation activity, involving test pit sampling and near surface soil grab sampling, was performed from August 23 through 29, 1983, at the Chem-Dyne site in Hamilton, Ohio. Sampling was performed onsite and offsite by personnel from CH2M HILL and Environment and Ecology, Inc. (E&E) after consultation with U.S. and Ohio EPA personnel. Excavation equipment and related decontamination facilities were provided by O.H. Materials. This work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 21.5M10.0.

PURPOSE

The purpose of the final soil investigation was to supplement the initial soil investigation with a program to more completely define the nature and extent, both vertically and horizontally, of the contamination of surface and subsurface soil onsite and offsite. The general scope of this investigation was determined by U.S. EPA personnel with recommendations from the engineer. Specific sample locations were reviewed with U.S. EPA and OEPA personnel prior to initiating the field work. The scheduling of this investigation was coordinated with completion of surface waste removal from the site by the Corps of Engineers and initiation of the Phase III Hydrogeologic Investigation.

SCOPE

The scope of the final soil investigation at the Chem-Dyne site included the following:

- Thirteen test pits, (11 onsite and 2 offsite).
- Seven surface soil grab samples.
- Forty-seven soil samples for analysis.
- One duplicate soil sample.
- Eleven special analytical services (SAS) samples.

Forty-seven samples, selected from the seventy-four samples taken, were analyzed for the inorganic and organic constituents included in the routine analytical packages of the U.S. EPA contract laboratories.

As requested by U.S. EPA after the soil sampling effort was complete, 11 (10 soils for analysis and 1 sample for matrix spike) samples were analyzed for dioxin, PBB, tris, and Curene-442 under the SAS program of the U.S. EPA Contract Laboratories. This addition to the analytical work was requested on September 7, 1983, and processed as SAS735E. The selection of the 10 soil samples for analysis was made by CH2M HILL with concurrence of Don Bruce/U.S. EPA OSC.

Samples collected during this investigation were analyzed by the following laboratories:

Routine Organic Analysis

- Mead Compu/Chem in Research Triangle Park, North Carolina 27709.

- Versar Laboratories, Inc., in Springfield, Virginia 22151.

Routine Inorganic Analysis

- Chemtech Consulting Group, Ltd., in New York, New York 10014.

- U.S. Testing Company, Inc., in Hobokin, New Jersey 07030.

SAS 735E Dioxin

- Acurex in Mountain View, California 94042.

SAS 735E Tris, PBB, and Curene-442

- IT Analytical (formerly West Coast Technical Service) in Cerritos, California 90701.

Original arrangements for laboratory space prior to initiation of the sampling called for a 2- to 3-week period during which all samples were to be shipped. The Sample Management Office of the U.S. EPA Contract Laboratories program modified the schedule for shipment of the soil

samples at the conclusion of the sampling effort. Scheduling difficulties within the U.S. EPA CLP program resulted in five soil sample shipments over the 5-week period from August 31 through September 30, 1983.

PERSONNEL

The sampling team included personnel from CH2M HILL, E&E, Inc., and O.H. Materials as follows:

CH2M HILL

Larry A. Holm, Project Manager/GLO (except August 25).
John Fleissner, Project Engineer/GLO (August 24 through 26 only).
Brad Berggren, Project Engineer/GLO

E&E, Inc.

Glen Millner

O.H. Materials

Steve Brigner (Backhoe operator)

SAMPLING PROCEDURE

TEST PIT AND GRAB SAMPLE LOCATIONS

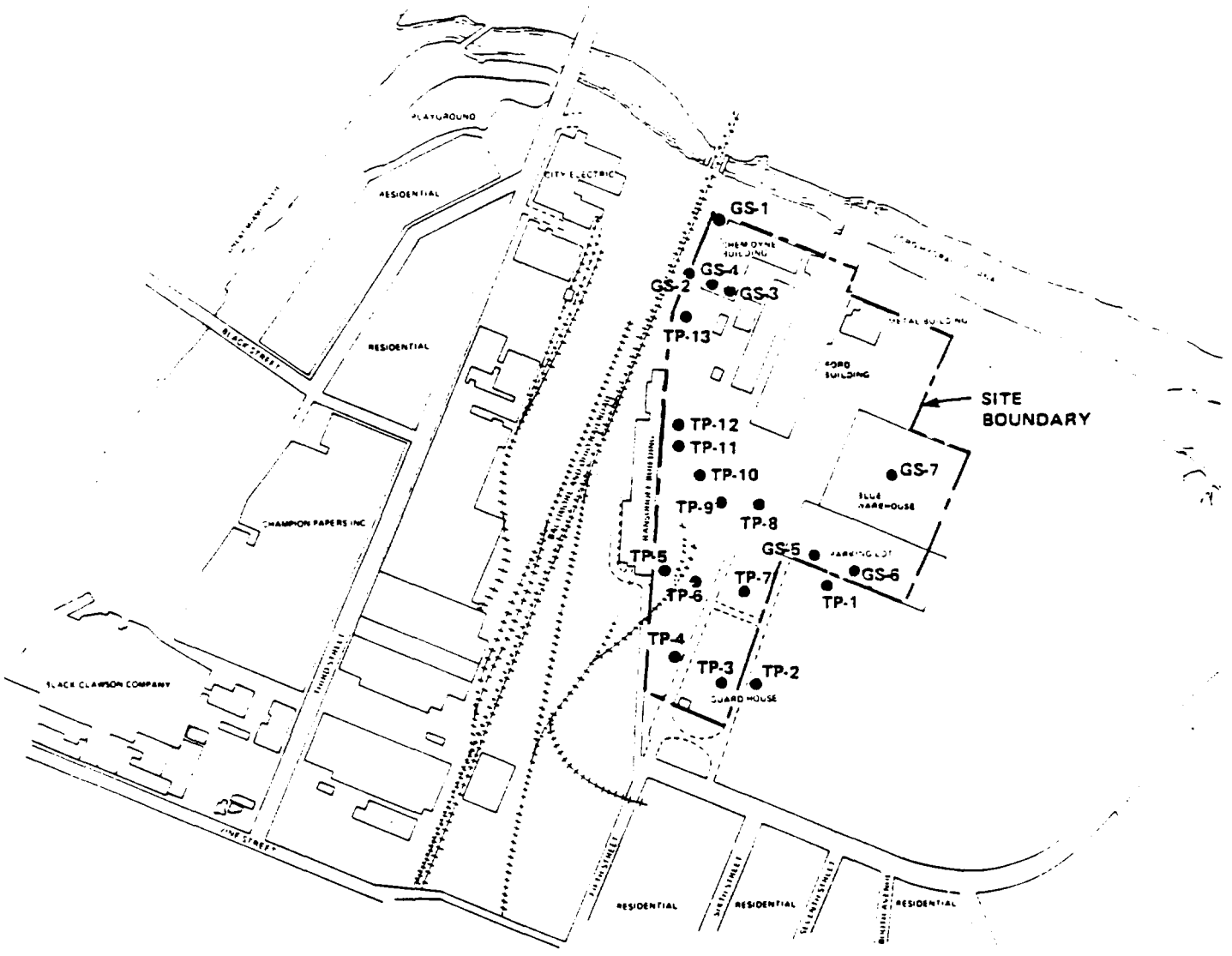
Test pit locations were positioned throughout the site, but concentrated on examining areas where the potential for contamination appeared greater. Aerial photographs of the site, available file information regarding drum storage and operations, and recommendations from U.S. and Ohio EPA personnel were used in determining these areas of greater potential contamination.

Soil and residue grab sample locations were determined by U.S. and Ohio EPA personnel with recommendations by the engineer. The grab samples were collected to obtain information regarding contamination in areas unsuitable for test pit sampling. These included confined onsite areas prohibiting excavation or the use of the backhoe and offsite areas where excavation permission could not be reasonably obtained.

Test pit and grab sample locations are shown in Figure 1.

SOIL SAMPLING EQUIPMENT

Test pits were excavated and backfilled with a Case Model 580C backhoe equipped with an 18-inch bucket. Soil



LEGEND

●	TEST PIT OR "GRAB" SAMPLE LOCATION
TP-1	TEST PIT NO. 1
GS-1	"GRAB" SAMPLE NO. 1

NOTE: More detailed descriptions of sampling locations are presented in the TM for subtask 3 - 4

N

0 1000

500

SCALE IN FEET

FIGURE 1
FINAL SOIL INVESTIGATION

samples were collected from the face of the test pit wall using a clean steel geologist pick. Soil grab samples were collected using clean stainless steel spoons.

SOIL SAMPLING

Test pits were excavated to depths generally ranging from 8 to 10 feet. Prior to sampling, a wall of the test pit was cleaned to expose the undisturbed material and allow differentiation of soil horizons for logging. Following horizon differentiation, four to six samples were collected per test pit. The sample depths were selected to allow determination of the nature and vertical extent of contamination, and in addition allow for characterization of as many soil horizons and materials as possible. Test pit logs, indicating sample locations, are included in Appendix A.

Backfilling of the test pits was accomplished by returning soil, previously segregated during excavation, in reverse of the excavation sequence. This procedure allowed for materials to be returned approximately to their original position and minimized vertical mixing.

Where possible, approximately 6 inches of overlying material were removed before collection of the surface grab" samples. In three cases, grab samples were taken directly from the surface of building floors. Grab samples GS-3 and GS-4 were taken directly from the floor of the Chem-Dyne building and sample GS-7 was taken from selected places on the floor of the blue warehouse.

DECONTAMINATION

Decontamination procedures included steps to avoid contamination of the sample and to minimize carryover of contamination from one test pit to another. The primary steps used to avoid or minimize contamination were as follows:

- Test pits were excavated in a sequence which progressed from areas least to most contaminated based on previous soil data and available information concerning past material handling and storage operations at the site.

- Decontamination of the backhoe. The backhoe was sandblasted prior to initiation of the sampling program. O.H. Materials provided a high-pressure water wash, which was used to decontaminate the backhoe and excavation bucket between each test pit.

- Decontamination of the geologist pick between collection of each soil sample.

- Decontamination of the stainless steel spoons prior to collection of grab samples.

Two solutions were used in sequence to decontaminate the geologist's pick. These solutions were trisodium phosphate (TSP) dissolved in city tap water and distilled water rinse. A solution of acetone and a distilled water (approximately 20 percent acetone) was inserted into the sequence, prior to the distilled water rinse, for decontamination of the stainless steel spoons.

The decontamination procedure for gloves used to handle equipment was washing in TSP solution followed by distilled water rinse. The spent decontamination solutions were disposed of by O.H. Materials at the Chem-Dyne site.

SAMPLE SELECTION

ROUTINE ANALYSIS STRATEGY

The requirements of the work plan necessitated selection of approximately three samples from each test pit for analysis of the inorganic and organic constituents included in the routine analytical packages by the U.S. EPA CLP. Sample selections were based on observations noted in the test pit logs and results of a rough headspace analysis of the samples in the field. The headspace analysis involved opening the sample container designated for inorganic analysis and obtaining an organic vapor measurement in the air space above the soil sample. The measurement was made using a HNU model 101 portable analyzer equipped with a 10.2 eV probe.

Samples selected for routine inorganic and organic analysis are shown in Table 1.

SAS STRATEGY

Due to a limitation on the number of samples to be analyzed using the SAS program of the U.S. EPA CLP, samples with a higher potential for yielding positive results were selected. The selection was based on available file information concerning materials handling and storage practices at the site and the U.S and Ohio EPA personnel recommendations.

Samples selected for SAS are summarized in Table 2.

Table 1
SAMPLES FROM FINAL SOIL INVESTIGATION SELECTED FOR ANALYSIS
CHEM-DYNE SITE
W65310.C0

Location Sample[a]	Depth (ft)	Traffic Report Number Inorganic	Traffic Report Number Organic	Lab Shipment Date Inorganic	Lab Shipment Date Organic
TP-1-1	0-2	MS0139	S2830	9/20/83	9/30/83
TP-1-3	5-6	MS0140	S2831	9/20/83	9/30/83
TP-2-2	1-2	MS0141	S2267	9/20/83	9/27/83
TP-2-4	4-4.5	MS0142	S2268	9/20/83	9/27/83
TP-2-5	7-8	MS0143	S2269	9/20/83	9/27/83
TP-3-3	1.5-2.5	MS0144	S2271	9/20/83	9/27/83
TP-3-4	4-5	MS0145	S2272	9/20/83	9/27/83
TP-3-5	6-7	MS0146	S2273	9/20/83	9/27/83
TP-4-2	2-2.5	MS0147	S2274	9/20/83	9/27/83
TP-4-3	3.5-4.5	MS0148	S2275	9/20/83	9/27/83
TP-4-5	6-7	MS0149	S2270	9/20/83	9/27/83
TP-4-6	7-8	MS0150	S2297	9/20/83	9/27/83
TP-5-1	0.5-1.5	ME0449	S2286	9/6/83	9/6/83
TP-5-3	4.5-5	ME0450	S2287	9/6/83	9/6/83
TP-5-5	0-0.5	ME0765	S2288	9/6/83	9/6/83
TP-6-1	0.5-1	ME0766	S2289	9/6/83	9/6/83
TP-6-3	2-3	ME0767	S2290	9/6/83	9/6/83
TP-6-4	5-6	ME0768	S2291	9/6/83	9/6/83
TP-7-1	0.5-1	ME0201	S2292	9/6/83	9/6/83
TP-7-2	1.5-2	ME0202	S2293	9/6/83	9/6/83
TP-7-3	3-3.5	ME0203	S2294	9/6/83	9/6/83
TP-7-5	6-7	ME0204	S2295	9/6/83	9/6/83
TP-8-2	0.5-1.5	MS0205	S2230	9/6/83	9/20/83
TP-8-3	1.5-2.5	MS0206	S2231	9/6/83	9/20/83
TP-8-6	5-5.5	MS0207	S2232	9/6/83	9/20/83
TP-8-7	8-8.5	MS0208	S2233	9/6/83	9/20/83
TP-9-2	1-1.5	MS0209	S2234	9/6/83	9/20/83
TP-9-3	3-3.5	MS0210	S2235	9/6/83	9/20/83
TP-9-5	7-8.5	MS0211	S2236	9/6/83	9/20/83
TP-10-1	0.5-1.5	ME0439	S2276	8/31/83	8/31/83
TP-10-2	2-3	ME0440	S2277	8/31/83	8/31/83
TP-10-3	3.5-4.5	ME0441	S2278	8/31/83	8/31/83
TP-10-4	5-6	ME0442	S2279	8/31/83	8/31/83
TP-11-1	0-1.5	ME0443	S2280	8/31/83	8/31/83
TP-11-2	1.5-2.5	ME0444	S2281	8/31/83	8/31/83
TP-11-4	5-6	ME0445	S2282	8/31/83	8/31/83
TP-12-1	0.5-1	MS0212	S2237	9/6/83	9/20/83
TP-12-3	4-5	MS0213	S2238	9/6/83	9/20/83
TP-13-2	1.5-2.5	ME0446	S2283	8/31/83	8/31/83
TP-13-3	3-3.5	ME0447	S2284	8/31/83	8/31/83
TP-13-4	5-5.5	ME0448	S2285	8/31/83	8/31/83
GS-1	Surface	MS0214	S2239	9/6/83	9/20/83
GS-2 (+ duplicate)	Surface	MS0215	S2824 (2825)	9/6/83	9/30/83 (9/30/83)
GS-3	Surface	MS0217	S2826	9/6/83	9/30/83
GS-4	Surface	MS0218	S2827	9/6/83	9/30/83
GS-5	Surface	MS0219	S2828	9/6/83	9/30/83
GS-6	Surface	MS0220	S2829	9/6/83	9/30/83

[a]Sample designation example, TP-3-1: refers to Test Pit 3, sample 1

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Table 2
SAMPLES SELECTED FROM FINAL SOIL
INVESTIGATION FOR SAS 735E
CHEM-DYNE SITE
765310.00

Sample Location	Depth, Feet	Dioxin[b] Traffic Report Number	Tris, PBB, Curene[c] Sample Number	Tag Number
TP-1-1	0-2	S2240	735-E1	5-110421
TP-1-3[a]	5-6	S2400	735-E11[a]	5-110431[a]
TP-3-1	0-1	S2241	735-E2	5-110422
TP-5-1	0.5-1.5	S2242	735-E3	5-110423
TP-10-1	0.5-1.5	S2243	735-E4	5-110424
TP-10-3	3.5-4.5	S2244	735-E5	5-110425
TP-11-2	1.5-2.5	S2245	735-E6	5-110426
TP-13-1	0-1	S2246	735-E7	5-110427
TP-13-3	3-3.5	S2247	735-E8	5-110428
GS-1	Surface	S2248	735-E9	5-110429
GS-3	Surface	S2249	735-E10	5-110430

[a]Soil sample TP-3-1 sent to laboratory for use as matrix site sample.
[b]Dioxin samples shipped for analysis on September 20, 1983.
[c]Samples for PBB, tris, and Curene-442 shipped for analysis on October 18, 1983.

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SAMPLING CHRONOLOGY

The following chronology summarizes the major activities and events of each day of final soil investigation work at Chem-Dyne from August 22 through August 29.

AUGUST 22, 1983, MONDAY

Team: Larry A. Holm, CH2M HILL
Brad J. Berggren, CH2M HILL
Glen Millner, E&E, Inc.

Sampling: None. Day used for site set up activities.

Comments: Meeting with Don Bruce (U.S. EPA) and Dave Stayer (Ohio EPA) to discuss sampling plan.

AUGUST 23, 1983, TUESDAY

Team: Same as Monday, August 22.

Sampling: Test pits 1 and 2 completed (offsite).

Comments: None.

AUGUST 24, 1983, WEDNESDAY

Team: Larry A. Holm, CH2M HILL
John T. Fleissner, CH2M HILL
Brad J. Berggren, CH2M HILL
Glen Millner, E&E, Inc.

Sampling: Test pits 3,4,5 and 6 completed (onsite).

Comments: Test pit work halted in afternoon to avoid conflicts with O.H. Material activities onsite.

AUGUST 25, 1983, THURSDAY

Team: John T. Fleissner, CH2M HILL
Brad J. Berggren, CH2M HILL
Glen Millner, E&E, Inc.

Sampling: Test pits 7,9, and 10 completed (onsite).

Comments: Test pit work halted in afternoon to avoid conflicts with O.H. Material activities onsite.

AUGUST 26, 1983, FRIDAY

Team: Larry A. Holm, CH2M HILL
John T. Fleissner, CH2M HILL
Brad J. Berggren, CH2M HILL
Glen Millner, E&E, Inc.

Sampling: Test pits 8,11, and 12 completed (onsite).

Comments: Test pit 13 postponed until Saturday to avoid conflicts with O.H. Material activities.

AUGUST 27, 1983, SATURDAY

Team: Larry A. Holm, CH2M HILL
Brad J. Berggren, CH2M HILL
Glen Millner, E&E, Inc.

Sampling: Test pit 13 completed (onsite). Grab samples (GS) 1, 2, 3, 4, 5 and 6 collected.

Comments: None.

AUGUST 30, 1983, TUESDAY

Team: Brad J. Berggren, CH2M HILL

Sampling: GS-7 collected.

Comments: This sample was requested by Don Bruce (U.S. EPA). It was a composite grab sample collected from three separate locations within the blue warehouse. However, due to an oversite this blue sample was not sent for analysis.

FIELD DATA SUMMARIES

The field data are presented on several tables which follow. These data are included without observations or evaluation. Data evaluation will be performed after all data are available under Task 5, Site Investigation Analysis in the final work plan.

The field data summaries include the following tables:

- Table 3 - Summary of Organic Analysis of Test Pit Soil
- Table 4 - Summary of Inorganic Analysis of Test Pit Soil
- Table 5 - Summary of Organic Analysis of Grab Samples
- Table 6 - Summary of Inorganic Analysis of Grab Samples
- Table 7 - Summary of SAS Analysis of Soil and Grab Samples

APPENDIX A

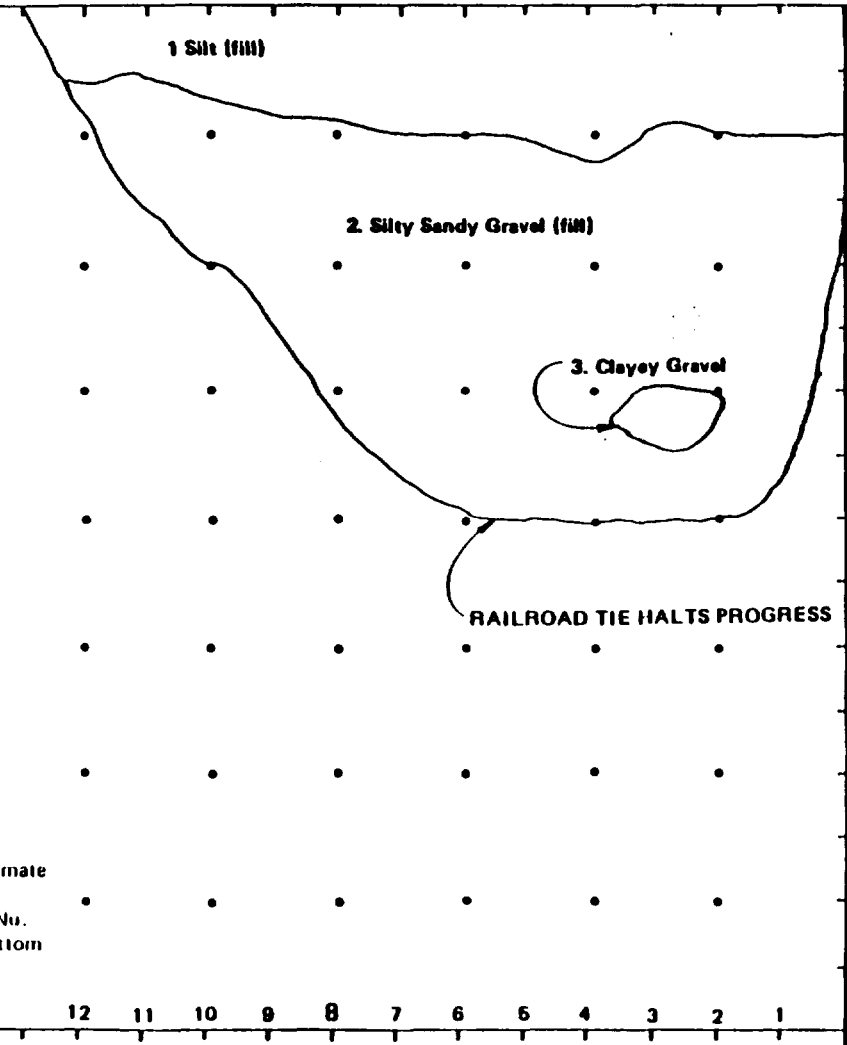
TEST PIT WALL LOGS

PROJECT NO.	TEST PIT NO.	
W65310.C0	1	SHEET 1 OF 1

TEST PIT WALL LOG

PROJECT CHEM-DYNE
LOCATION ≈200' S. OF BLUE W.H. & 200' E. OF "J" MAP OF W WALL OF PIT
ELEVATION 589.3 FT
CONTRACTOR O.H. MATERIALS
DATE EXCAVATED 8-23-83
WATER LEVEL AND DATE NO WATER
EXCAVATION METHOD CASE 580 C BACKHOLE
LOGGER BERGGREN
APPROXIMATE DIMENSIONS: LENGTH 10 FT WIDTH 3 FT DEPTH 8 FT REMARKS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
	1	X	TP-1-1	0
	2	X	TP-1-2	0
	3			
	4			
	5	X	TP-1-3	0
	6	X	TP-1-4	0
	7			
	8			
	9			
	10			
	11			



NOTES:
1. No water observed in test pit
2. Depth and sample intervals are approximate due to irregular ground surface.
3. No readings above background with HNu.
4. Excavation halted by railroad tie in bottom of pit.
5. 10:30 am.

COMMENTS

SOIL DESCRIPTIONS

1. **Silt (fill)**, nonplastic, some gravel; dark brown to black, friable, seams of gray ash.
2. **Silty Sandy Gravel (fill)**, Well graded, subrounded gravel, some cobbles. Light brown, moist, firm. Occassional brick and wood fragments.
3. **Clayey Gravel (fill)**, same as 2, except greater clay content in matrix.

PROJECT NO.	TEST PIT NO.	
W65310.CO	2	SHEET 1 OF 1

TEST PIT WALL LOG

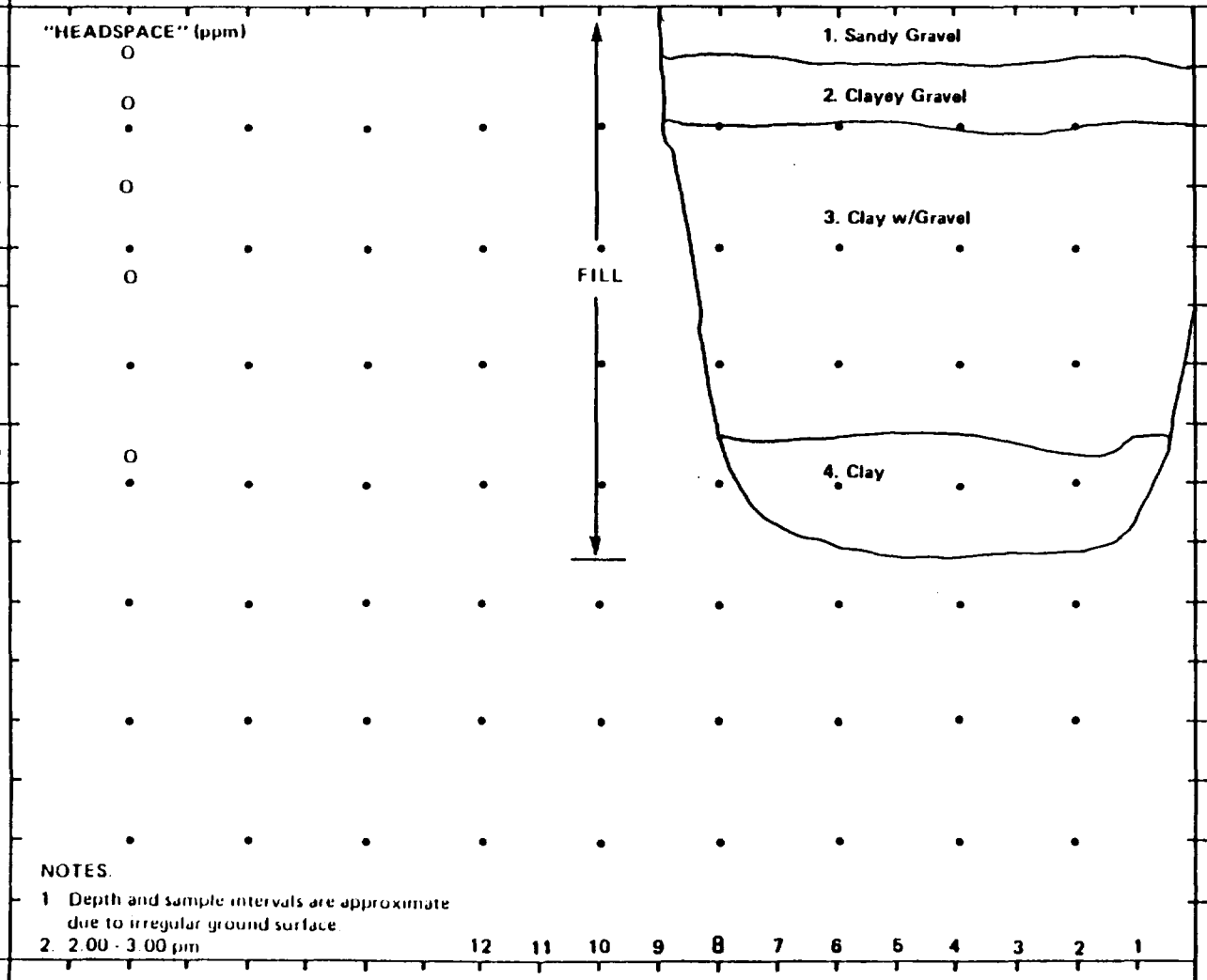
PROJECT CHEM-DYNE LOCATION 18' NORTH OF "E" MAP OF W WALL OF PIT

ELEVATION 590.3 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-23-83

WATER LEVEL AND DATE NOT ENCOUNTERED EXCAVATION METHOD BACKHOE CASE 580 C W/ 18" BUCKET LOGGER BERGGREN/HOLM

APPROXIMATE DIMENSIONS: LENGTH 9 FT WIDTH 2 FT DEPTH 8 FT REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER
1	X	TP-2-1
2	X	TP-2-2
3	X	TP-2-3
4	X	TP-2-4
5		
6		
7	X	TP-2-5
8		
9		
10		



NOTES:
1. Depth and sample intervals are approximate due to irregular ground surface.
2. 2:00 - 3:00 pm

COMMENTS

SOIL DESCRIPTIONS

1. **Sandy Gravel**, ark gray, loose, top soil.
2. **Clayey Gravel**, dark brown-gray, hard
3. **Clay**, with gravel, dark brown, hard Softer between 4 and 7 feet. "pockets" of gray clay with sand. Blocky structure.
4. **Clay**, gray, massive with channels of less dense material which is reddish-brown. Channelmaterial has blocky structure.

204

PROJECT NO.	TEST PIT NO.	
W65310.CO	3	SHEET 1 OF 1

TEST PIT WALL LOG

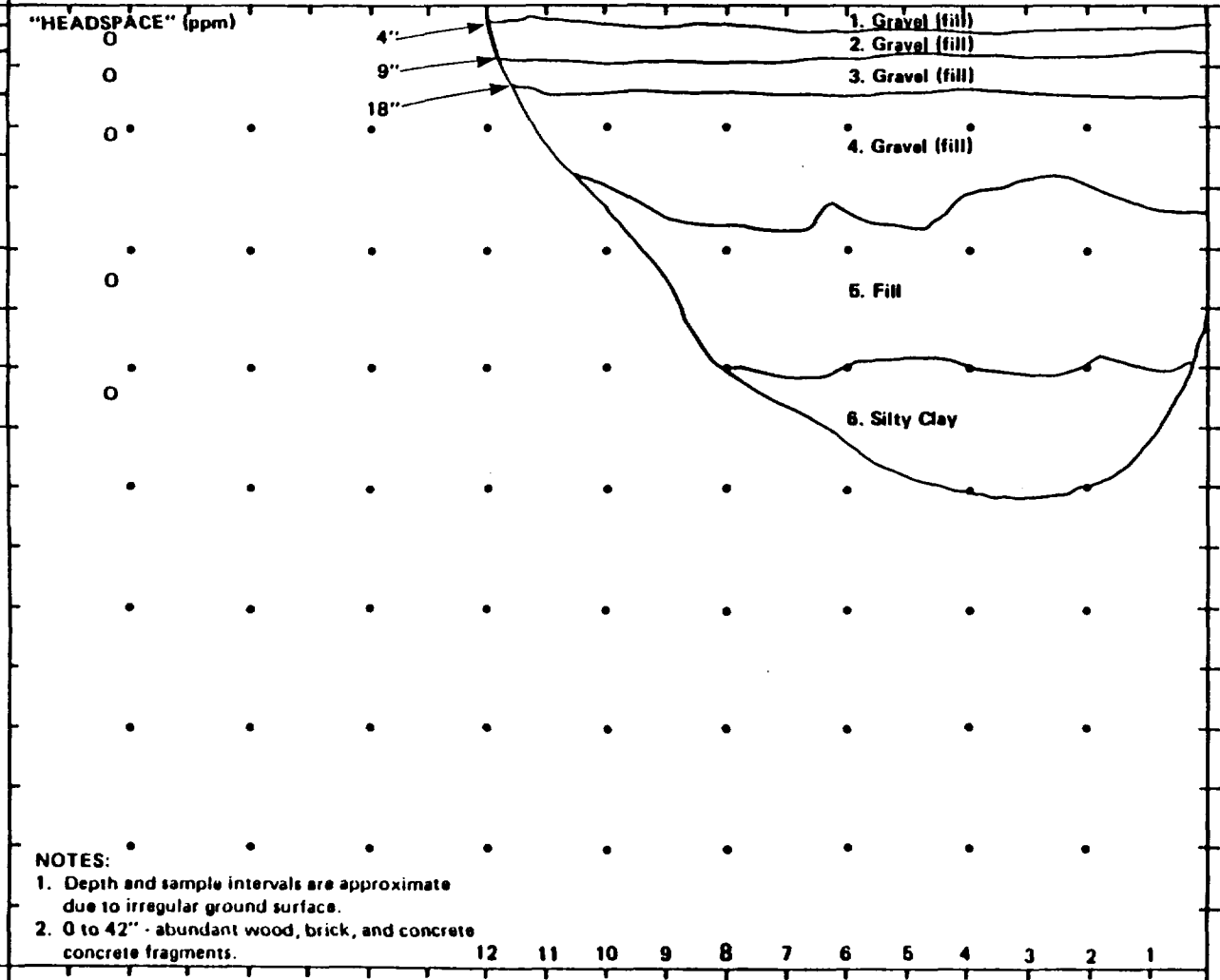
PROJECT CHEM - DYNE LOCATION "D" & "2" MAP OF W WALL OF PIT

ELEVATION 590.2 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-24-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE CASE 580 C W/ 18" BUCKET LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 12 FT WIDTH 2 1/2 FT DEPTH 8 FT REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
	X	TP-3-1	0
1	X	TP-3-2	0
2	X	TP-3-3	0
3			
4	X	TP-3-4	0
5			
6	X	TP-3-5	0
7			
8			
9			
10			



NOTES:
1. Depth and sample intervals are approximate due to irregular ground surface.
2. 0 to 42" - abundant wood, brick, and concrete concrete fragments.

COMMENTS

SOIL DESCRIPTIONS

1. Gravel (fill), with fines, brown. (GM).
2. Gravel (fill), same as above except, dark brown, firm.
3. Gravel (fill), same as 1.
4. Gravel (fill), with fines, dark brown, friable. (GM).
5. Fill, rubble, wood, brick, gravel, dark brown, loose.
6. Silty Clay, some gravel, dark brown to gray, moist. (CL).

205

PROJECT NO.	TEST PIT NO.	
W65310.CO	4	SHEET 1 OF 1

TEST PIT WALL LOG

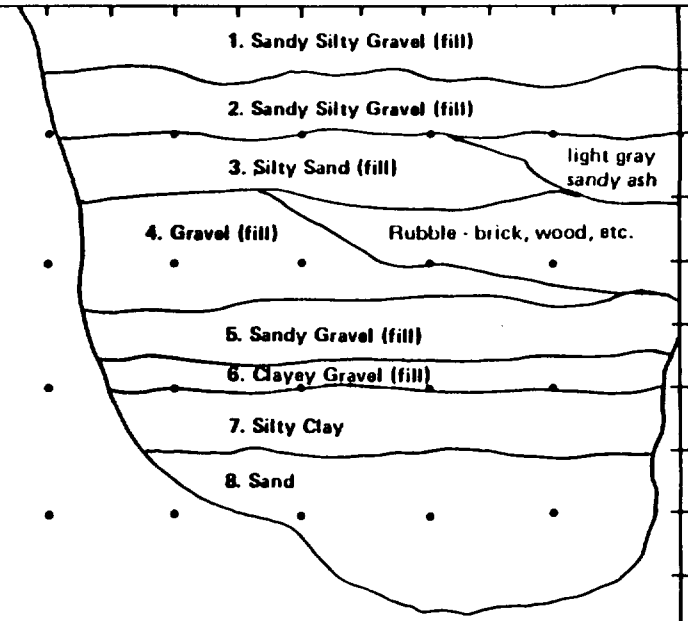
PROJECT CHEM - DYNE LOCATION APPROXIMATELY 80' EAST OF "D" MAP OF N WALL OF PIT

ELEVATION 590.6 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-24-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580 C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 10 FT WIDTH 3 FT DEPTH 9 FT REMARKS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
	1	X	TP-4-1	0
	2	X	TP-4-2	0
	3			
	4	X	TP-4-3	0
	5	X	TP-4-4	0
	6	X	TP-4-5	0
	7	X	TP-4-6	0
	8			



NOTES:
1. Depths and sample intervals due to irregular ground surf

12 11 10 9 8 7 6 5 4 3 2 1

LENGTH (FT)

COMMENTS

SOIL DESCRIPTIONS

1. **Sandy Silty Gravel (fill)**, light brown, (GM).
2. **Sandy Silty Gravel (fill)**, medium brown.
3. **Silty Sand (fill)**, black.
4. **Gravel (fill)**, with fines and rubble, dark brown.
5. **Sandy Gravel (fill)**, light brown to gray.
6. **Clayey Gravel (fill)**, dark brown.
7. **Silty Clay**, dark gray to black,
8. **Sand**, fine to medium, light brown, (SP-SW).

206

PROJECT NO.	TEST PIT NO.	
W65310.CO	5	SHEET 1 OF 1

TEST PIT WALL LOG

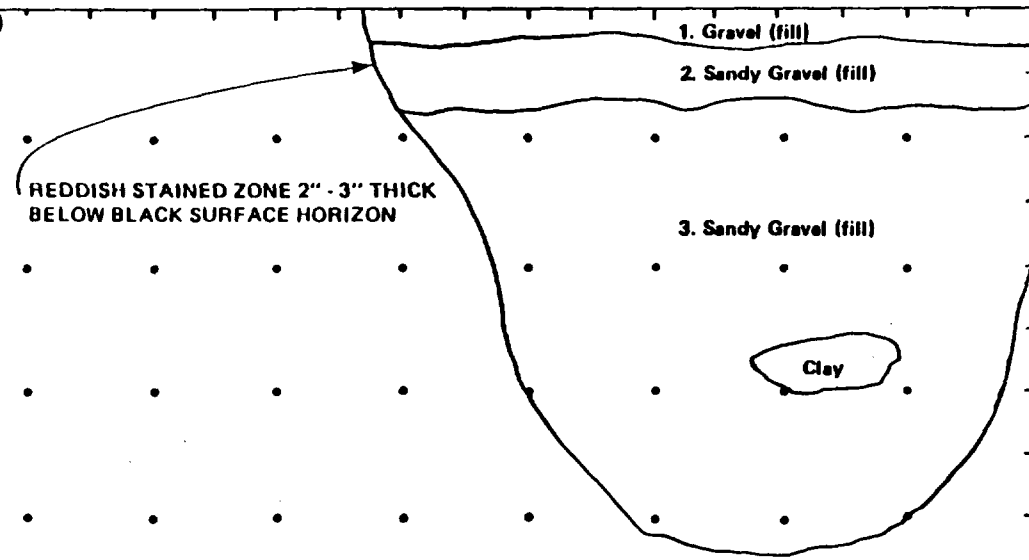
PROJECT CHEM-DYNE LOCATION 40' EAST & 15' NORTH OF "H" MAP OF W WALL OF PIT

ELEVATION 589.0 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-24-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580 C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 10 FT WIDTH 4 FT DEPTH 8½ ft REMARKS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
			TP-5-5	0.8
	1		TP-5-1	1.6
	2			
	3		TP-5-2	1.0
	4			
	5		TP-5-3	1.4
	6			
	7		TP-5-4	2.0
	8			
	9			
	10			



NOTES:
1. Depths and sample intervals are approximate due to irregular ground surface.
2. TP-5-5 sample collected from red-stained zone at approximately 7".

12 11 10 9 8 7 6 5 4 3 2 1

LENGTH (FT)

COMMENTS

SOIL DESCRIPTIONS

1. Gravel (fill), dark gray to black, friable.
2. Sandy Gravel (fill), medium brown, firm, greater gravel content than material above and below
3. Sandy Gravel (fill), light brown, friable, less than 5% cobbles, some small patches of brown clay.

PROJECT NO.	TEST PIT NO.	
W65310.CO	6	SHEET 1 OF 1

TEST PIT WALL LOG

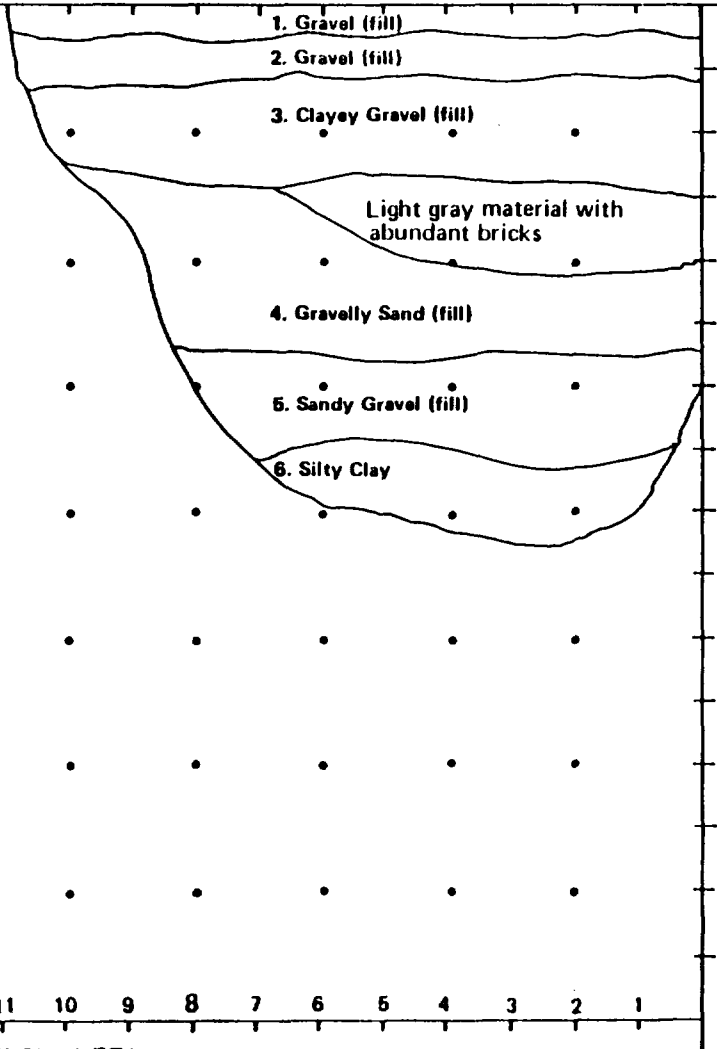
PROJECT CHEM-DYNE LOCATION 140' EAST OF "H" MAP OF W WALL OF PIT

ELEVATION 589.7 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-24-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580 C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 11 ft WIDTH 3 ft DEPTH 8½ ft REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
1	X	TP-6-1	0
2	X	TP-6-2	0.4
3	X	TP-6-3	2.2
4			
5	X	TP-6-4	14
6			
7	X	TP-6-5	1.0
8			
9			
10			



COMMENTS

SOIL DESCRIPTIONS

1. **Gravel (fill)**, dark gray to black, loose.
2. **Gravel (fill)**, with fines, reddish-brown, firm.
3. **Clayey Gravel (fill)**, top 6" very dark appears like tar or oil stained, remainder is dark brown.
4. **Gravelly Sand (fill)**, sandy fill with gravel, some brick fragments, light brown to medium gray.
5. **Sandy Gravel (fill)**, dark brown to black.
6. **Silty Clay**, nonplastic, light brown to gray.

PROJECT NO.	TEST PIT NO.	
W65310.CO	7	SHEET 1 OF 1

TEST PIT WALL LOG

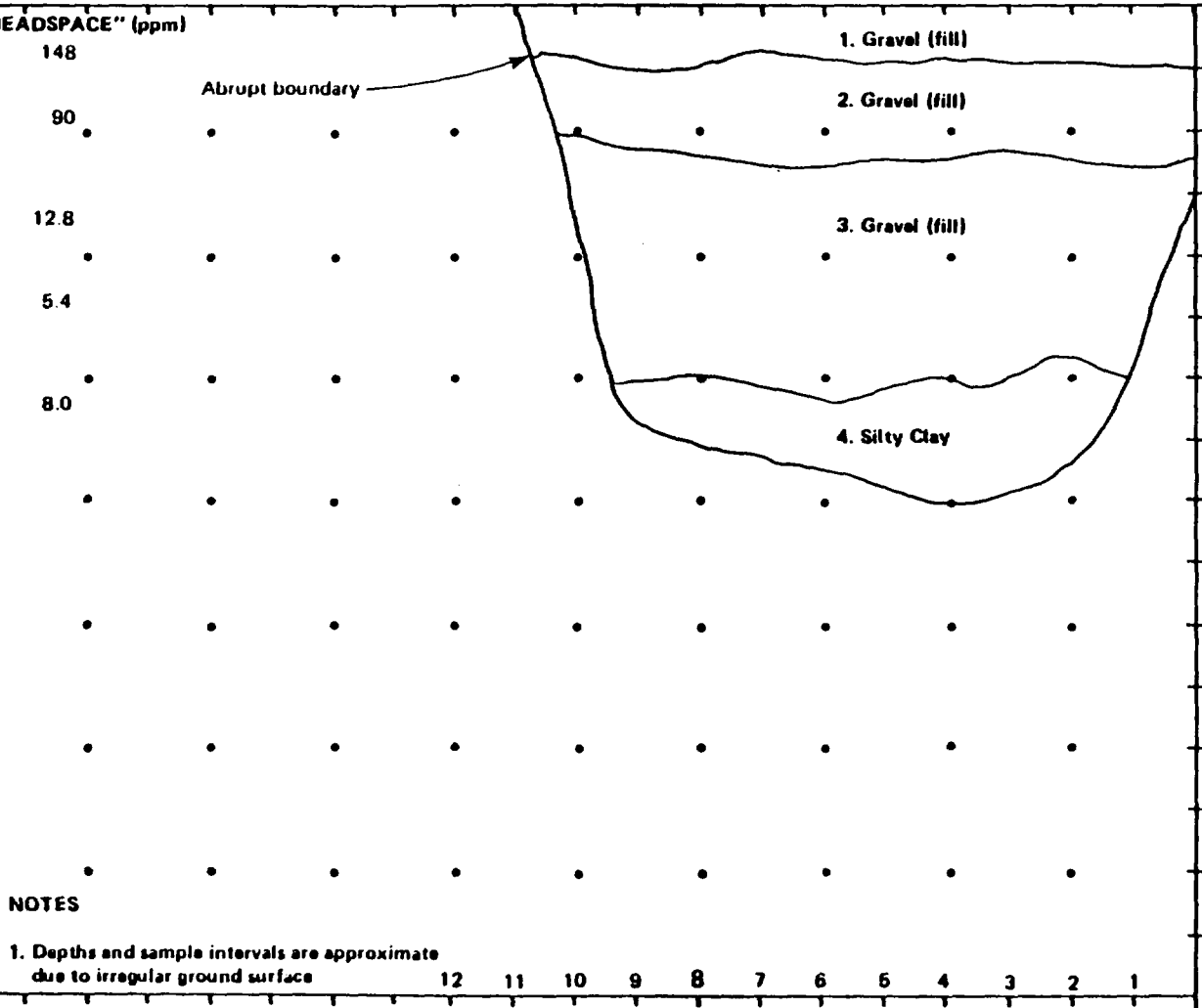
PROJECT CHEM-DYNE LOCATION APPROX 60' WEST OF "I" MAP OF W WALL OF PIT

ELEVATION 589.7 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-25-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580 C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 11 ft WIDTH 3 ft DEPTH 8 ft REMARKS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
	1	X	TP-7-1	148
	2	X	TP-7-2	90
	3	X	TP-7-3	12.8
	4			
	5	X	TP-7-4	5.4
	6	X	TP-7-5	8.0
	7			
	8			
	9			
	10			



NOTES

1. Depths and sample intervals are approximate due to irregular ground surface

COMMENTS

SOIL DESCRIPTIONS

Gravel (fill), with fines, cohesive matrix, black stained.

Gravel (fill), same as above, except medium to dark brown.

Gravel (fill), with fines, medium brown, loose, more sand than overlying material.

Silty Clay, nonplastic, dark brown, subangular blocky structure, abundant black stringers which appear to be charcoal or organic matter.

209

PROJECT NO.	TEST PIT NO.	
W65310.C0	8	SHEET 1 OF 1

TEST PIT WALL LOG

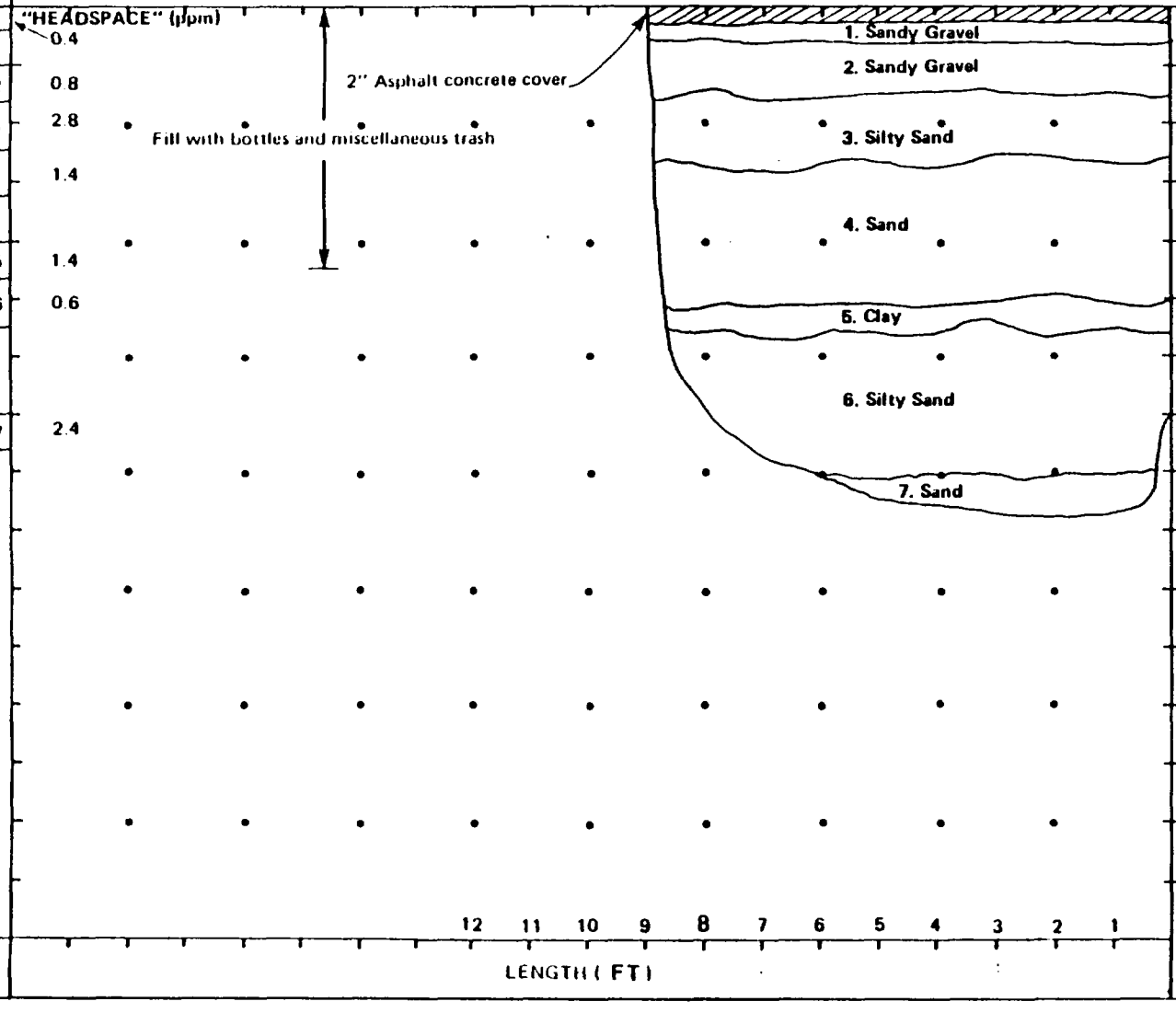
PROJECT CHEM-DYNE LOCATION "L"-"M" & "3"-"4" MAP OF W. WALL OF PIT

ELEVATION 589.5 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-26-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER L. HOLM

APPROXIMATE DIMENSIONS: LENGTH 9 ft WIDTH 3 ft DEPTH 8½ ft REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
	X	TP-8-1	0.4
1	X	TP-8-2	0.8
2	X	TP-8-3	2.8
3	X	TP-8-4	1.4
4	X	TP-8-5	1.4
5	X	TP-8-6	0.6
6			
7	X	TP-8-7	2.4
8			
9			
10			



COMMENTS

SOIL DESCRIPTIONS

1. **Sandy Gravel (fill), brown**
2. **Sandy Gravel (fill), black**
3. **Silty Sandy (fill), medium sand,**
4. **Sand (fill), medium to coarse sand, some silt, dark brown to black.**
5. **Clay, gray with dark gray mottles. Discontinuous through pit.**
6. **Silty Sandy, fine sand, very silty, brown.**
7. **Sand, medium to fine sand, very few fines, brown.**

210

PROJECT NO.	TEST PIT NO.	
W65310.C0	9	SHEET 1 OF 1

TEST PIT WALL LOG

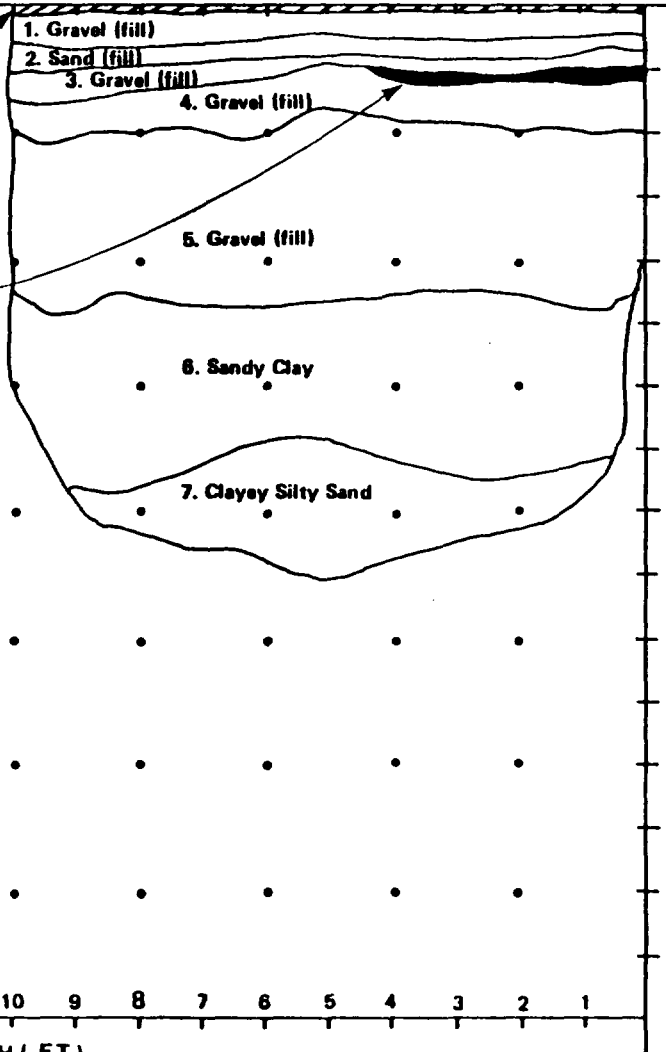
PROJECT CHEM-DYNE LOCATION 200' EAST OF "K" MAP OF W WALL OF PIT

ELEVATION 589.9 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-25-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 10 ft WIDTH 3 ft DEPTH 9 ft REMARKS

SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
X	TP-9-1	0.4
X	TP-9-2	6.4
X	TP-9-3	2.8
X	TP-9-4	1.2
X	TP-9-5	1.2



COMMENTS

SOIL DESCRIPTIONS

1. **Gravel (fill)**, dark brown, loose.
2. **Sand (fill)**, medium gray, ashy appearance.
3. **Gravel (fill)**, with fines, cohesive, medium brown.
4. **Gravel (fill)**, dark brown to black stained.
5. **Gravel (fill)**, medium brown.
6. **Sandy Clay**, nonplastic, brown.
7. **Clayey Silty Sand**, light brown.

PROJECT NO.	TEST PIT NO.
W65310.C0	10 SHEET 1 OF 1

TEST PIT WALL LOG

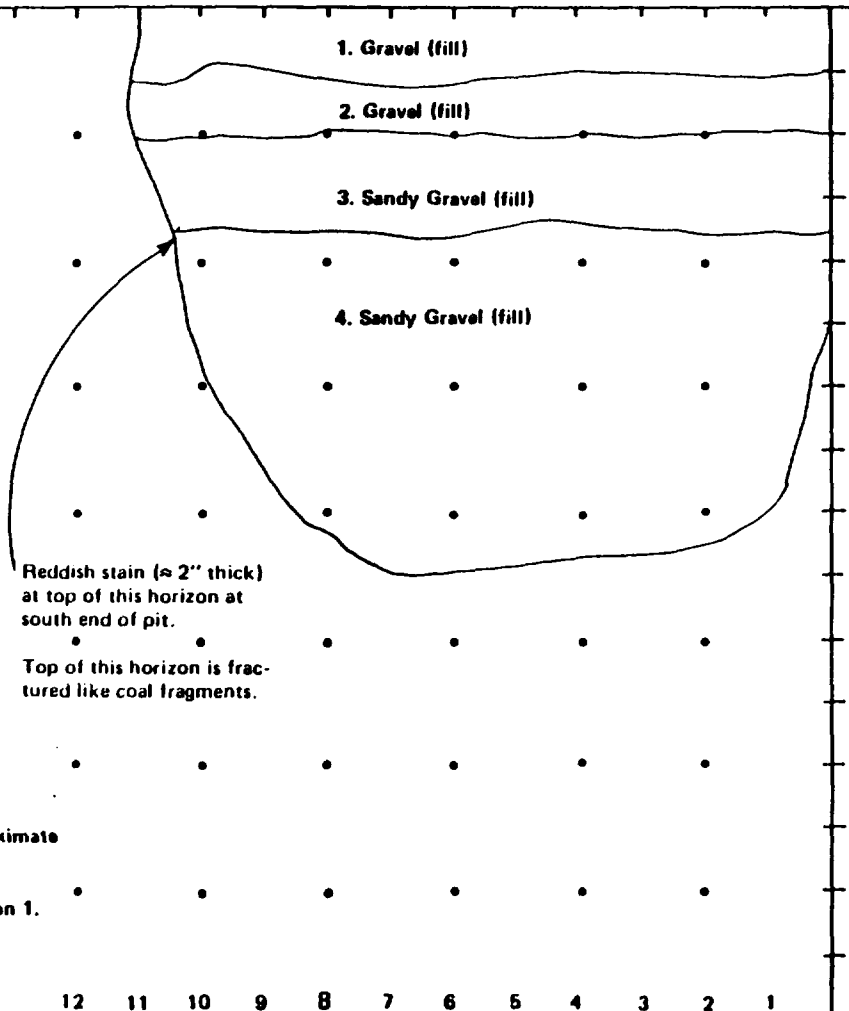
PROJECT CHEM-DYNE LOCATION 100' EAST OF "L" MAP OF W WALL OF PIT

ELEVATION 589.0 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-25-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 11 ft WIDTH 3 ft DEPTH 8½ ft REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
1	X	TP-10-1	174
2	X	TP-10-2	88
3			
4	X	TP-10-3	200
5	X	TP-10-4	122
6			
7	X	TP-10-5	42
8			
9			
10			



COMMENTS

SOIL DESCRIPTIONS

1. Gravel (fill), some fines, black stained.
2. Gravel (fill), with fines cohesive, dark brown to black.
3. Sandy Gravel (fill), brown, loose.
4. Sandy Gravel (fill), dark brown.

NOTES

1. Depths and sample intervals are approximate due to irregular ground surface
2. HNu readings up to 50 ppm for Horizon 1. in the pit
3. HNu readings of air quality in pit are between 10 and 20 ppm

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PROJECT NO.	TEST PIT NO.	
W65310.C0	11	SHEET 1 OF 1

TEST PIT WALL LOG

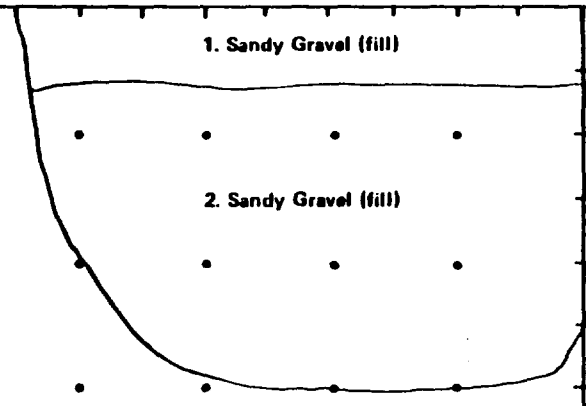
PROJECT CHEM-DYNE LOCATION "N"-"O" 30' EAST OF FENCE MAP OF W WALL OF PIT

ELEVATION 588.0 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-26-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER L. HOLM

APPROXIMATE DIMENSIONS: LENGTH 9 ft WIDTH 4 ft DEPTH 6 ft REMARKS

DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
1	X	TP-11-1	92
2	X	TP-11-2	142
3			
4	X	TP-11-3	8
5			
6	X	TP-11-4	56
7			
8			
9			
10			



NOTES

1. Depths and sample intervals are approximate due to irregular ground surface
2. Test pit walls required bracing and shoring
3. Bottom of pit is light brown Sandy Gravel

12 11 10 9 8 7 6 5 4 3 2 1

LENGTH (FT)

COMMENTS

SOIL DESCRIPTIONS

1. Sandy Gravel (fill), dark brown to black, loose.
2. Sandy Gravel (fill), coarse gravel with coarse sand, dark brown.

PROJECT NO.	TEST PIT NO.	
W65310.C0	12	SHEET 1 OF 1

TEST PIT WALL LOG

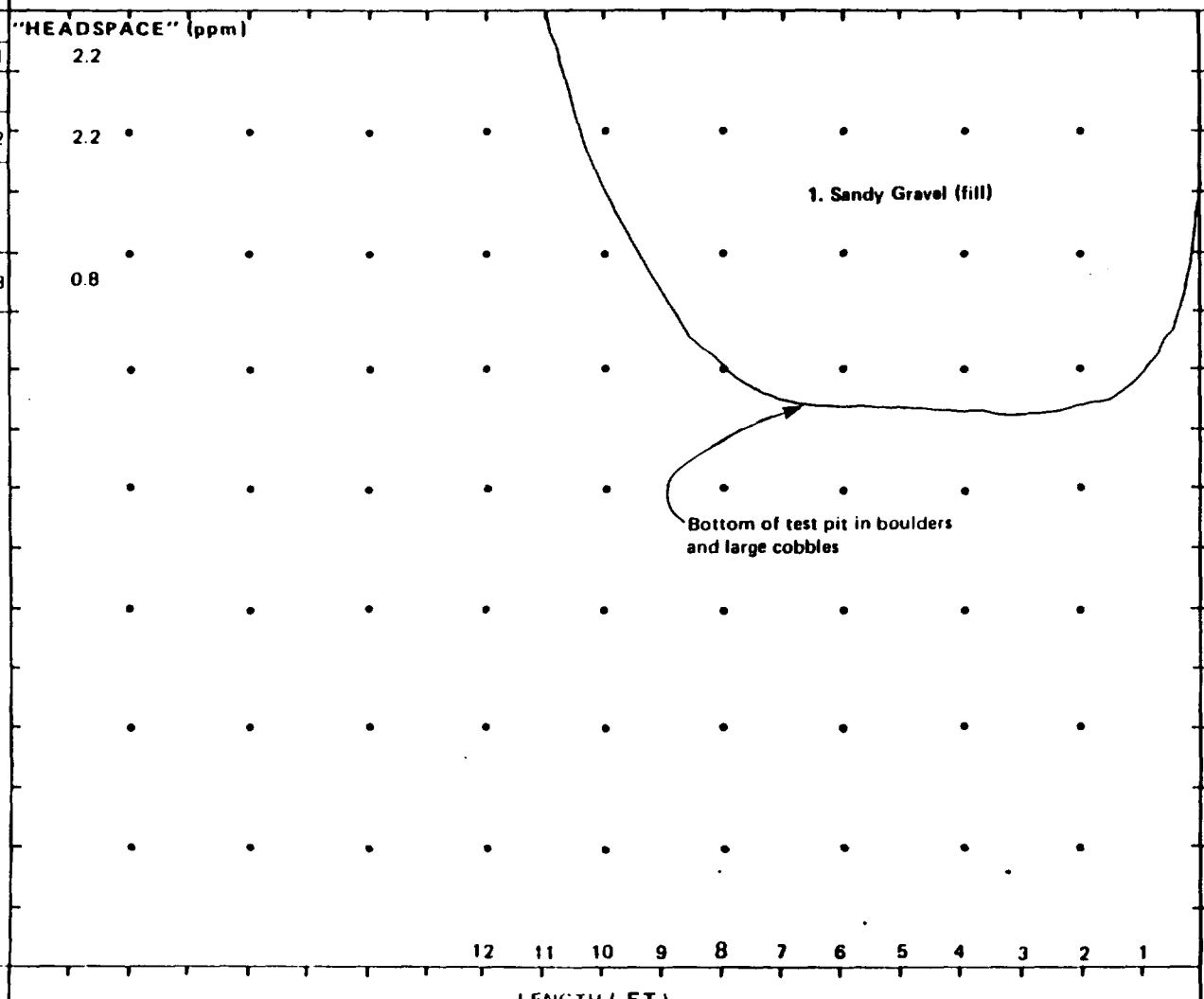
PROJECT CHEM-DYNE LOCATION "0"-"P" 25' WEST OF FENCE MAP OF W WALL OF PIT

ELEVATION 588.8 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-26-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER L. HOLM

APPROXIMATE DIMENSIONS: LENGTH 11 ft WIDTH 3 ft DEPTH 6½ ft REMARKS

SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
X	TP-12-1	2.2
X	TP-12-2	2.2
X	TP-12-3	0.8



COMMENTS

SOIL DESCRIPTIONS

1. **Sandy Gravel (fill),** cobbles to 9" in diameter

PROJECT NO.	TEST PIT NO.	
W65310.C0	13	SHEET 1 OF 1

TEST PIT WALL LOG

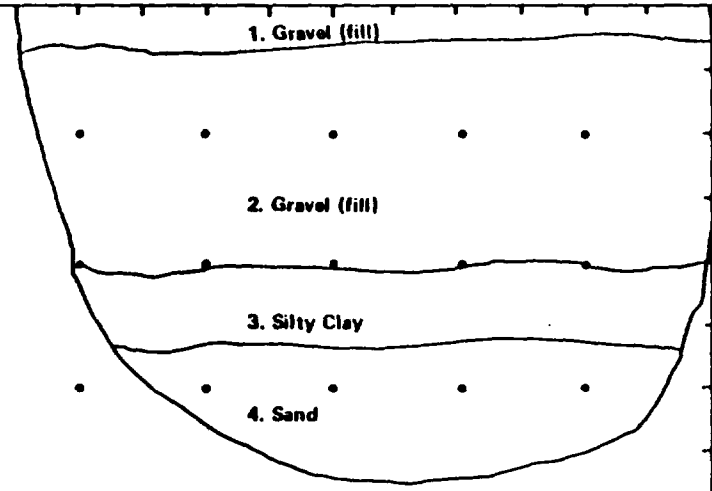
PROJECT CHEM-DYNE LOCATION 25' EAST OF "U" MAP OF W WALL OF PIT

ELEVATION 588.8 FT CONTRACTOR O.H. MATERIALS DATE EXCAVATED 8-27-83

WATER LEVEL AND DATE NONE ENCOUNTERED EXCAVATION METHOD BACKHOE, CASE 580C LOGGER B. BERGGREN

APPROXIMATE DIMENSIONS: LENGTH 11 ft WIDTH 2½ ft DEPTH 7 ft REMARKS

ELEVATION	DEPTH BELOW SURFACE (FT)	SAMPLE INTERVAL	SAMPLE TYPE AND NUMBER	"HEADSPACE" (ppm)
		X	TP-13-1	26
	1			
	2	X	TP-13-2	26
	3	X	TP-13-3	34
	4			
	5	X	TP-13-4	22
	6			
	7			
	8			
	9			
	10			



12 11 10 9 8 7 6 5 4 3 2 1

LENGTH (FT)

NOTES

1. Depths and sample intervals are approximate due to irregular ground surface
2. Stability problems in sand at bottom of pit, walls cave in easily
3. HNu readings in pit – a) top 6" at 15 ppm, b) ambient aier in pit at 5 ppm

COMMENTS

SOIL DESCRIPTIONS

1. **Gravel (fill)**, dark brown to black, loose.
2. **Gravel (fill)**, dark brown to black, loose, highly variable in texture, pockets of cinder material.
3. **Silty Clay**, medium brown, moist, nonplastic
4. **Sand**, medium grained, medium brown, some silt and clay.

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APPENDIX B

FINAL SOIL INVESTIGATION

PHOTOGRAPHIC LOG

FINAL SOIL INVESTIGATION
Photographic Log
Chem-Dyne Site
W65310.C0

PHOTO 1: View of western wall of Test Pit No. 1 [8-23-83].

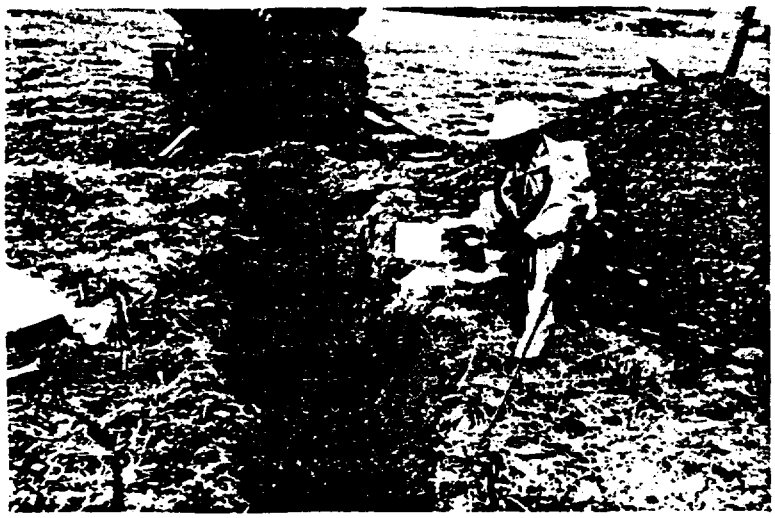

PHOTO 2: Same as Photo 1 [8-23-83].

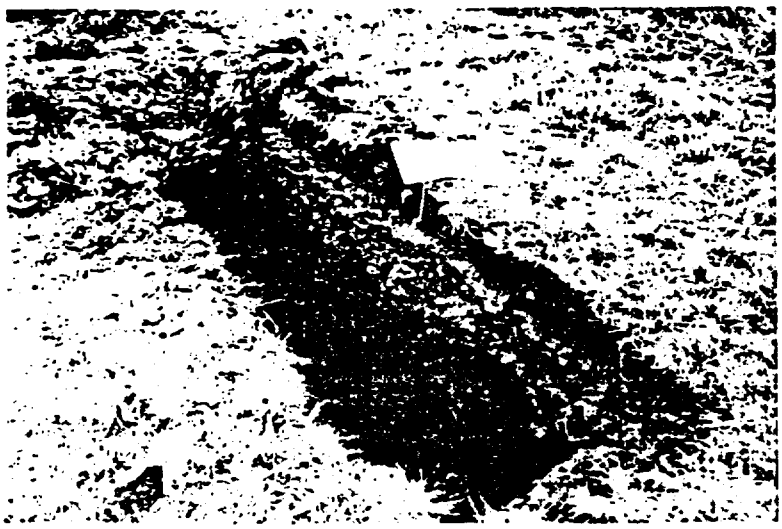

PHOTO 3: View of western wall of Test Pit No. 2 [8-24-83].

PHOTO 4: Same as Photo 3 [8-23-83].

PHOTO 5: View of backhoe operation at Test Pit No. 3 [8-24-83].

PHOTO 6: View of western wall of Test Pit No. 3 [8-24-83].

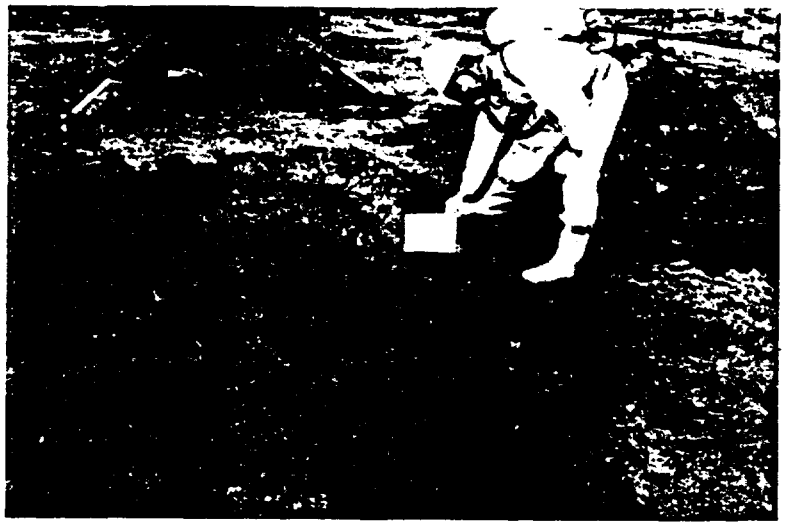

PHOTO 7: Same as Photo 6 [8-24-83].

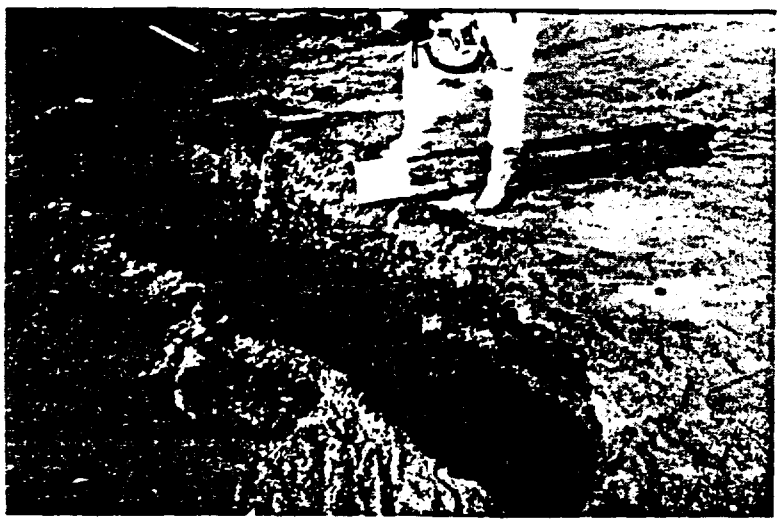

PHOTO 8: View of western wall of Test Pit No. 4 [8-24-83].

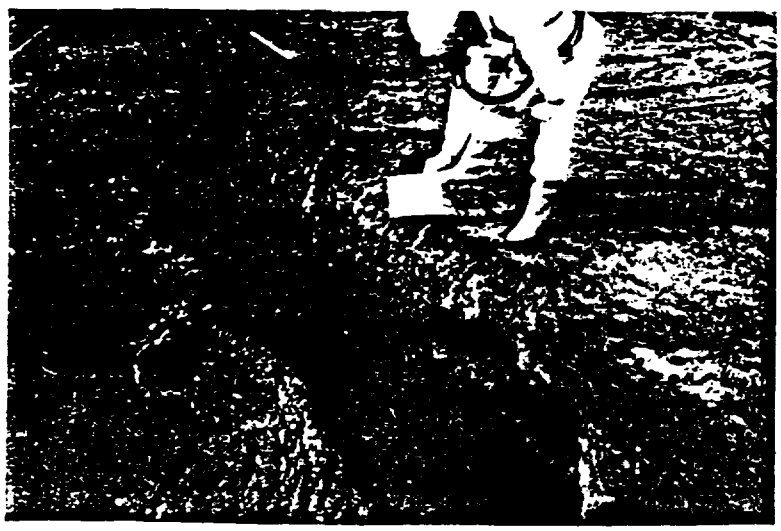

PHOTO 9: Same as Photo 8 [8-24-83].

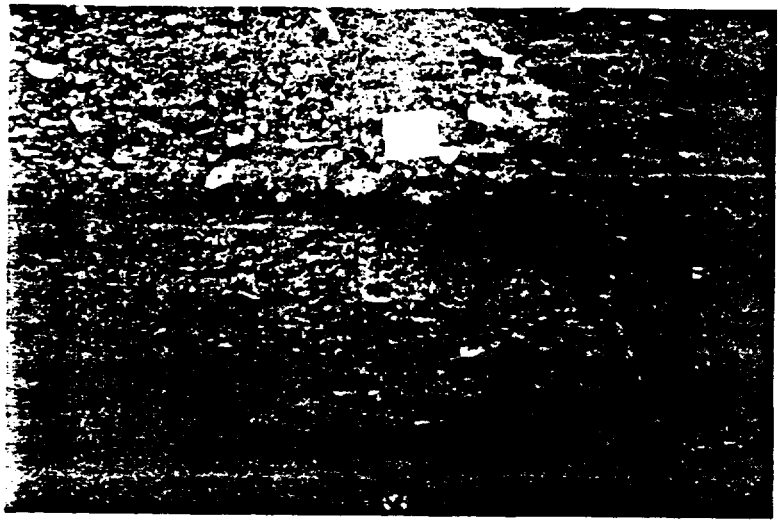

PHOTO 10: View of western wall of Test Pit No. 5 [8-24-83].

PHOTO 11: Same as Photo 10 [8-24-83].

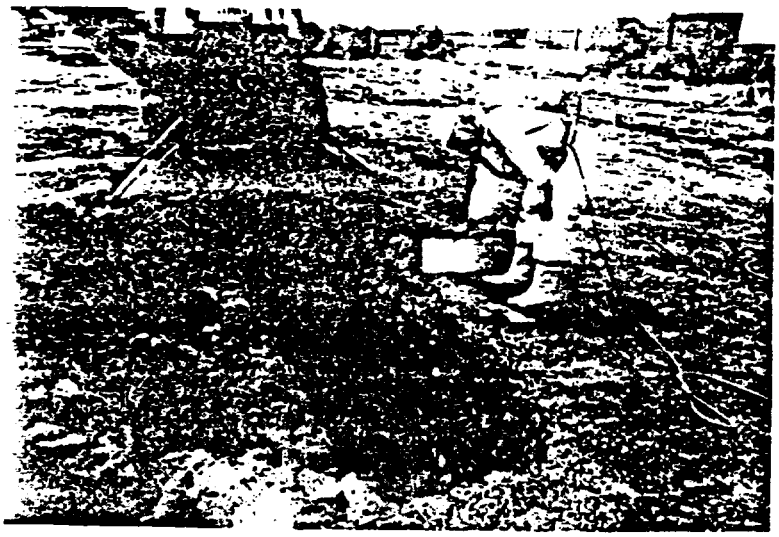

PHOTO 12: View of western wall of Test Pit No. 6 [8-24-83].

PHOTO 13: Same as Photo 12 [8-24-83].

PHOTO 14: View of western wall of Test Pit No. 9 [8-25-83].

PHOTO 15: Same as Photo 14 [8-25-83].

PHOTO 16: Same as Photo 14 [8-25-83].

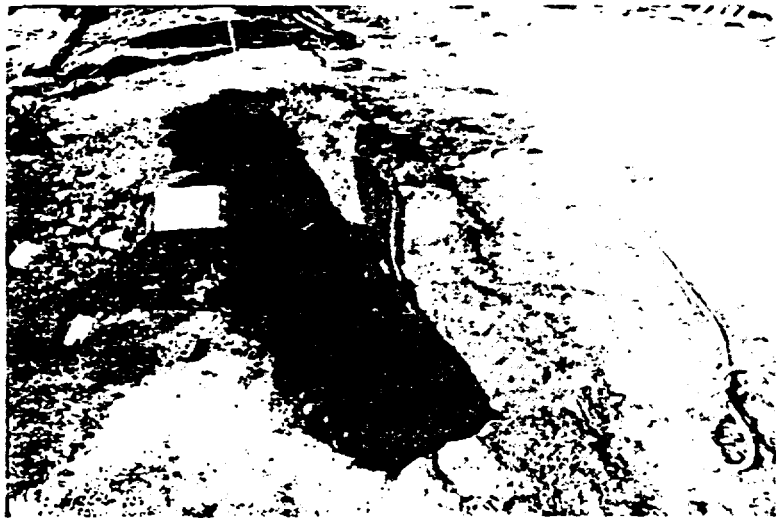

PHOTO 17: View of western wall of Test Pit No. 10 [8-25-83].

PHOTO 18: Same as Photo 17 [8-25-83].

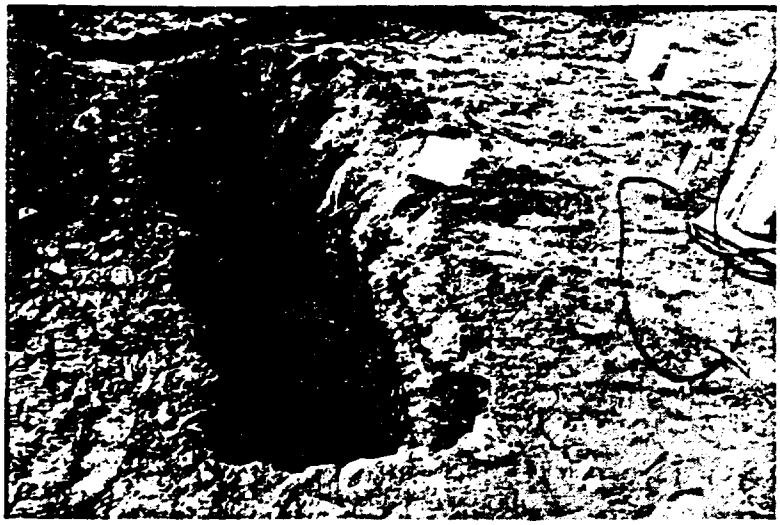

PHOTO 19: View of western wall of Test Pit No. 7 [8-25-83].

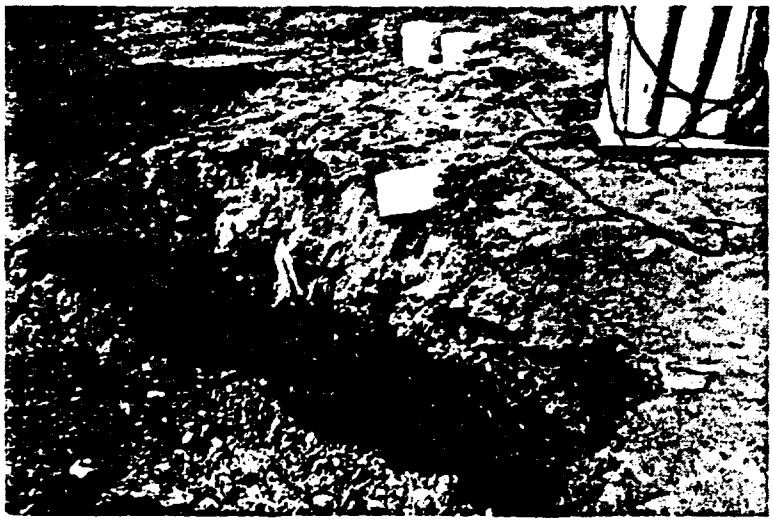

PHOTO 20: Same as Photo 19 [8-25-83].

PHOTO 21: View of western wall of Test Pit No. 8 [8-26-83].

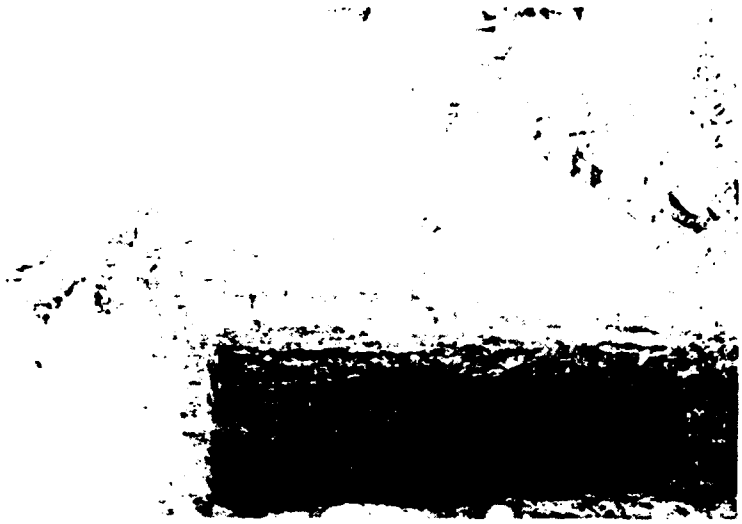

PHOTO 22: Same as Photo 21 [8-26-83].

PHOTO 23: View of Test Pit No. 3 setting [8-26-83].

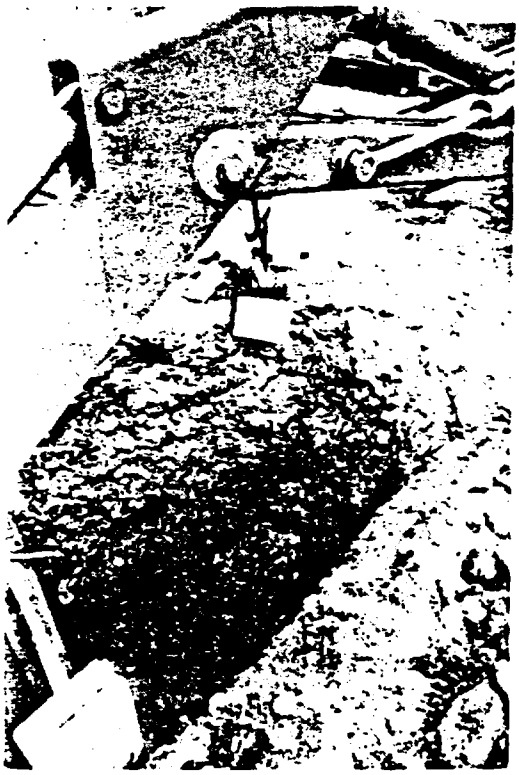

PHOTO 24: View of southwestern wall of Test Pit No. 11 [8-26-83].

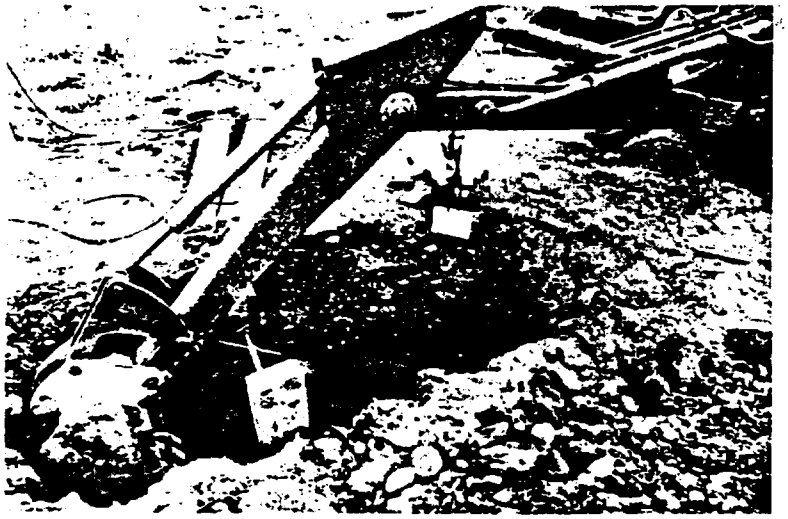

PHOTO 25: Same as Photo 24 [8-26-83].

PHOTO 26: Same as Photo 24 [8-26-83].

PHOTO 27: View of western wall of Test Pit No. 12 [8-26-83].

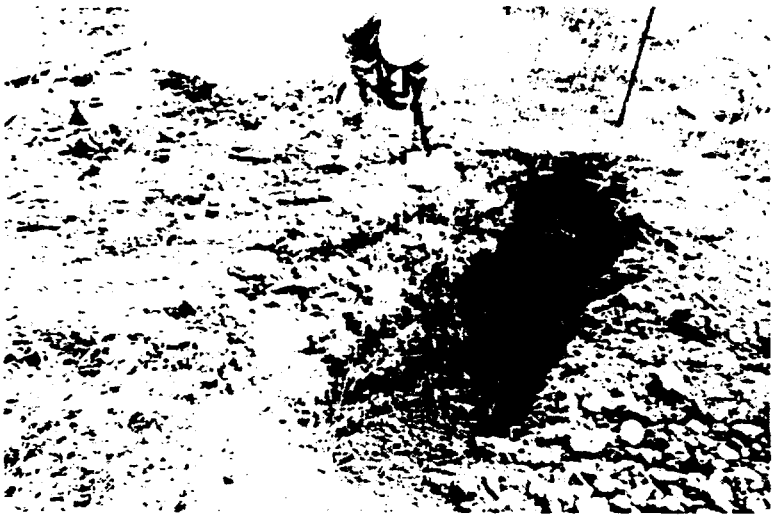

PHOTO 28: Same as Photo 27 [8-26-83].

PHOTO 29: View of western wall of Test Pit No. 13 [8-27-83].

PHOTO 30: Same as Photo 29 [8-27-83].

PHOTO 31: View of Test Pit No. 13 setting [8-27-83].

PHOTO 32: Same as Photo 31 [8-27-83].

PHOTO 33: Collection of grab sample GS-1 west of Chem-dyne Building [8-27-83].

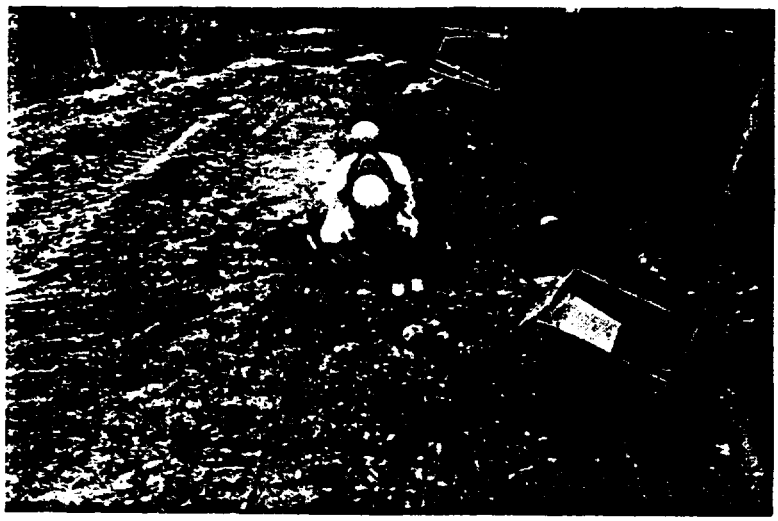

PHOTO 34: Collecton of grab sample GS-2 west of Chem-Dyne Building [8-27-83].

PHOTO 35: Location of grab sample GS-3 inside Chem-Dyne Building [8-27-83].

PHOTO 36: Same as Photo 35 [8-27-83].

PHOTO 37: Location of grab sample GS-4 inside Chem-Dyne Building [8-27-83].

PHOTO 38: View to the west across the Baylor parking lot [8-27-83].

PHOTO 39: Measurement of volatile organics from "pot hole" in Baylor parking lot (also location of GS-5). HNu reading up to 50 ppm in the hole [8-27-83].

PHOTO 40: View of western wall of Test Pit No. 13 [8-27-83].

APPENDIX C

TENTATIVELY IDENTIFIED COMPOUNDS

Table 7
TENTATIVELY IDENTIFIED COMPOUNDS IN TEST PIT
SOIL SAMPLES FROM CHEM-DYNE

Sample Number	CAS Number	Compound Name	Percent Purity	Percent Fit	Estimated Concentration (ug/kg)
TP-01-01	501-52-0	benzenepropanoic acid	87.7		700
TP-01-03		none found			
TP-02-02	108-88-3	benzene, methyl-	96.7		320
TP-02-04		none found			
TP-02-05	108-88-3	benzene, methyl-	97.2		640
TP-03-03	108-88-3	benzene, methyl-	97.0		660
TP-03-03	719-22-2	2,5-cyclohexadiene-1,4-dione,2,6-bis(1,1-dimethylethyl)-	84.1		470
TP-03-04	149-73-5	methane, trimethoxy-	89.8		4.4
TP-03-05	85-44-9	1,3-isobenzofurandione	97.1		1,000
TP-04-02	3073-66-3	cyclohexane,1,1,3-trimethyl-	91.9		2,300
TP-04-02	111-76-2	ethanol,2-butoxy-	89.0		2,000
TP-04-02	629-50-5	tridecane	89.9		470
TP-04-02	91-57-6	naphthalene,2-methyl-	84.5		950
TP-04-02	629-59-4	tetradecane	87.2		870
TP-04-02	569-41-5	naphthalene,1,8-dimethyl-	87.3		1,500
TP-04-02	18344-37-1	heptadecane,2,6,10,14-tetramethyl-	87.0		830
TP-04-02	629-62-9	pentadecane	86.8		720
TP-04-02	544-76-3	hexadecane	84.5		1,300

SHELL/GLT461/47
FILE/GLT461/350

Sample Number	CAS Number	Compound Name	Percent Purity	Percent Fit	Estimated Concentration (ug/kg)
TP-04-02	1921-70-6	pentadecane,2,6,10,14-tetramethyl-	81.5		4,700
TP-04-02	593-45-3	octadecane	85.7		3,500
TP-04-02	629-99-2	pentacosane	85.5		3,300
TP-04-02	112-95-8	eicosane	86.6		2,200
TP-04-02	629-94-7	heneicosane	86.1		3,200
TP-04-02	638-67-5	tricosane	86.1		2,800
TP-04-02	629-99-2	pentacosane	80.2		2,200
TP-04-02	629-99-2	pentacosane	81.0		1,600
TP-04-03	149-73-5	methane, trimethoxy-	88.2		1.9
TP-04-05	367-12-4	phenol,2-fluoro-	87.8		600
TP-04-05	88-99-3	1,2-benzenedicarboxylic acid	96.0		770
TP-04-06	149-73-5	methane,trimethoxy-	89.5		7.4
TP-04-06	542-18-7	cyclohexane,chloro-	92.7		170
TP-04-06	822-87-7	cyclohexanone,2-chloro-	92.3		170
TP-05-01		2,6-bis(1,1-dimethyl ethyl)-1,4-dione-2,5-cyclohexadiene	67.9	94.8	2.6
TP-05-01		Hexane	886	94.3	5.4
TP-05-03		2,6-bis(1,1-dimethyl ethyl)1,4-dione-2,5-cyclohexadiene	68.0	92.9	1.0
TP-05-05		2,6-bis(1,1-dimethyl ethyhl)1,4-dione-2,5-cyclohexadiene	66.7	94.7	4.5
TP-05-05		triphenyl phosphene oxide	81.6	87.0	1.0
TP-05-05		2-propen-1-ol	36.6	84.2	2.0

Sample Number	CAS Number	Compound Name	Percent Purity	Percent Fit	Estimated Concentration (ug/kg)
TP-05-05		bis(2-ethylhexyl)ester deconoic acid	61.8	78.1	1.0
TP-05-05		1,4-dioxane	98.1	98.3	10
TP-05-05		1-butene	44.9	89.2	15
TP-06-01		1-methyl-4-(1-methyl ethenyl)cyclohexane	80.3	91.4	1.0
TP-06-01		heptamethyl novane	70.0	75.0	1.0
TP-06-01		methyl cycloheptane	49.5	83.1	1.0
TP-06-01		hexadecanoic acid	65.2	80.8	1.0
TP-06-01		tetracontane, trimethyl	65.1	77.2	2.0
TP-06-03		1-fluoro-4-methoxy benzene			1.0
TP-06-03		2,6-nonadienal			1.0
TP-06-04		C10-alkane	88.5	95.0	3,400
TP-06-04		C11-alkane	85.1	93.4	2,000
TP-06-04		C13-alkane	78.8	92.4	3,200
TP-06-04		C14-alkane	77.7	92.6	2,000
TP-06-04		dimethyl naphthalene	83.9	99.4	1,900
TP-06-04		C21-alkane	85.1	93.8	3,600
TP-06-04		C18-alkane	85.9	93.3	3,200
TP-06-04		C16-alkane	85.6	93.8	1,800
TP-06-04		C13-alkane	86.8	95.4	2,000
TP-06-04		C16-alkane	89.4	98.0	7,200

SHELL/GLT461/47
FILE/GLT461/350

Sample Number	CAS Number	Compound Name	Percent Purity	Percent Fit	Estimated Concentration (ug/kg)
TP-06-04		C18-alkane	86.9	95.6	3,000
TP-06-04		C18-alkane	84.8	95.6	3,200
TP-06-04		C36-alkane	88.3	97.1	3,100
TP-06-04		C36-alkane	83.1	95.5	2,800
TP-06-04		C36-alkane	86.6	96.8	2,800
TP-06-04		C36-alkane	84.3	95.2	3,000
TP-06-04		C36-alkane	79.1	91.2	2,900
TP-06-04		C36-alkane	84.5	95.0	2,800
TP-06-04		C36-alkane	75.9	89.3	2,700
TP-06-04		C36-alkane	77.9	95.2	2,500
TP-07-01		1-methyl-4-(1-methylethenyl)cyclohexene	79.7	90.6	920,000
TP-07-01		1,a4-trimethyl-3 cyclohexene-1-methanol	74.2	93.2	180,000
TP-07-01		2-methyl-5(1-methylethnyl)2-cyclohexen-1-one	70.8	96.3	630,000
TP-07-01		1,1'-oxybis benzene	82.6	93.9	900,000
TP-07-01		2,5-diphenylfuran	64.7	91.0	49,000
TP-07-01		dodecanoic acid	42.1	76.4	140,000
TP-07-01		2-phenoxy-1,1'biphenyl	74.3	87.1	830,000
TP-07-01		4-phenoxy-1,1'-biphenyl	80.5	89.6	760,000
TP-07-01		1,terpheny 1-2'-ol	81.1	95.8	200,000
TP-07-01		hexamethyl tetracosa hexene	66.0	80.2	840,000

Sample Number	CAS Number	Compound Name	Percent Purity	Percent Fit	Estimated Concentration (ug/kg)
TP-07-02		1-methyl-5-(1-methyl ethenyl)-(R)-cyclohexene	79.4	92.1	2,300,000
TP-07-02		2-(1-methylpropyl)-cyclopentanone	46.5	79.5	120,000
TP-07-02		2-methyl-5-(1-methyl ethenyl)2-cyclohexene-ione	70.1	96.2	660,000
TP-07-02		2,6-nonadienal	60.6	83.3	97,000
TP-07-02		hexadecanoic acid	65.6	79.1	220,000
TP-07-02		trimethylmethylestor dodecattienoic acid	64.6	80.1	
TP-07-03		none found			
TP-07-05		none found			

Table 5
TENTATIVELY IDENTIFIED COMPOUNDS IN TEST PIT SOIL SAMPLES
COLLECTED FROM CHEM-DYNE (ANALYZED BY MEAD)

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-08-02	127-18-4	Ethene, tetrachloro-	93.3	210
TP-08-02	3073-66-3	Cyclohexane, 1,1,3-trimethyl-	88.6	27
TP-08-02	95-63-6	Benzene, 1,2,4-trimethyl-	61.6	28
TP-08-02	5989-27-5	Cyclohexene, 1-methyl-4-(1-methylethenyl)-,(R)-	78.9	48
TP-08-02	13475-78-0	Heptane, 5-ethyl-2-methyl-	85.3	18
TP-08-02	91-57-6	Naphthalene, 2-methyl-	89.0	26
TP-08-02	629-59-4	Tetradecane	80.1	40
TP-08-02	569-41-5	Naphthalene, 1,8-dimethyl-	91.0	84
TP-08-02	18344-37-1	Heptadecane, 2,6,10,14-tetramethyl-	82.1	45
TP-08-02	18344-37-1	Heptadecane, 2,6,10,14-tetramethyl-	80.2	35
TP-08-02	593-45-3	Octadecane	70.3	76
TP-08-02	2245-38-7	Naphthalene, 1,6,7-trimethyl-	84.6	48
TP-08-02	1921-70-6	Pentadecane, 2,6,10,14-tetramethyl-	77.4	150
TP-08-02	593-45-3	Octadecane	78.0	51
TP-08-02	112-95-8	Eicosane	81.8	65
TP-08-02	112-95-8	Eicosane	79.5	44
TP-08-02	629-99-2	Pentacosane	65.0	63

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-08-02	629-99-2	Pentacosane	79.6	52
TP-08-02	630-06-8	Hexatriacontane	78.1	54
TP-08-02	630-06-8	Hexatriacontane	76.0	55
TP-08-03	127-18-4	Ethene, tetrachloro-	92.6	320
TP-08-06	127-18-4	Ethene, tetrachloro-	94.5	300
TP-08-07	127-18-4	Ethene, tetrachloro-	93.4	450
TP-08-07	286-20-4	7-oxabicyclo/4.1.0/heptane	80.8	11
TP-08-07	823-69-8	Bicyclo/4.1.0/heptane, 7,7-dichloro-	77.0	95
TP-09-02	110-83-8	Cyclohexene	95.3	480
TP-09-02	79-01-6	Ethene, trichloro-	92.2	38
TP-09-02	127-18-4	Ethene, tetrachloro-	91.7	330
TP-09-02	91-57-6	Naphthalene, 2-methyl-	92.4	31
TP-09-02	55045-13-1	Tetradecane, 6,9-dimethyl-	71.9	37
TP-09-02	573-98-8	Naphthalene, 1,2-dimethyl-	92.5	63
TP-09-02	18344-37-1	Heptadecane, 2,6,10,14-tetramethyl-	85.6	37
TP-09-02	7045-71-8	Undecane, 2-methyl-	63.6	68
TP-09-02	6332-28-1	Diphenethylamine, hydrochloride	45.8	170
TP-09-02	593-45-3	Octadecane	83.9	33
TP-09-02	1921-70-6	Pentadecane, 2,6,10,14-tetramethyl-	79.6	64

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13
FILE/GLT442/100

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-09-02	593-45-3	Octadecane	83.1	41
TP-09-02	593-45-3	Octadecane	86.1	41
TP-09-02	593-45-3	Octadecane	82.2	33
TP-09-02	112-95-8	Eicosane	82.2	47
TP-09-02	112-95-8	Eicosane	81.2	70
TP-09-02	629-99-2	Pentacosane	81.5	54
TP-09-02	629-99-2	Pentacosane	80.5	55
TP-09-02	629-99-2	Pentacosane	78.0	56
TP-09-02	630-06-0	Hexatriacontane	78.0	43
TP-09-03	127-18-4	Ethene, tetrachloro	94.1	480
TP-09-03	938-85-2	(Compound name unreadable on lab report copy)	87.6	16
TP-09-05	127-18-4	Ethene, tetrachloro-	93.8	230
TP-09-05	30.0	2-butanol		19
TP-10-01		none found		
TP-10-02	127-18-4	Ethene, tetrachloro-	93.6	130
TP-10-02	108-90-7	Benzene, chloro-	88.5	55
TP-10-02	2381-21-7	Pyrene, 1-methyl-	86.4	17
TP-10-02	2381-21-7	Pyrene, 1-methyl-	79.7	10
TP-10-02	2381-21-7	Pyrene, 1-methyl-	52.9	13

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-10-02	205-82-3	Benzo/j/Fluoranthene	93.2	29
TP-10-03	127-18-4	Ethene, tetrachloro-	94.1	26
TP-10-03	108-90-7	Benzene, chloro-	90.5	21
TP-10-04	79-01-6	Ethene, trichloro-	92.8	41
TP-10-04	624-92-0	Disulfide, dimethyl	95.1	31
TP-10-04	544-25-2	1,3,5-cycloheptatriene	94.6	27
TP-10-04	127-18-4	Ethene, tetrachloro-	95.4	24
TP-10-04	127-18-4	Ethene, tetrachloro-	92.9	300
TP-10-04	67-68-5	Methane, sulfonylbis-	97.3	140
TP-10-04	108-90-7	Benzene, chloro-	83.9	690
TP-10-04	67-71-0	Methane, sulfonylbis-	94.3	28
TP-10-04	3658-80-8	Trisulfide, dimethyl	95.7	16
TP-10-04	719-22-2	2,5-cyclohexadiene-1,4-dione, 2,6-bis(1,1-dimethylethyl)	73.5	48
TP-10-04	4130-42-1	Phenol, 2,6-bis(1,1-dimethylethyl)-4-ethyl-	63.3	23
TP-10-04	33649-17-1	Propanoicacid, 2-methyl-,(decahydro-6A-hydroxy-9A-methyl)	38.3	33
TP-10-04	5535-51-3	Benzene, 1-chloro-4-(ethenylsulfonyl)-	49.2	31
TP-10-04	791-28-6	Phosphineoxide, triphenyl-	79.8	94
TP-11-01	127-18-4	Ethene, tetrachloro-	93.4	20
TP-11-01	91-57-6	Naphthalene, 2-methyl-	90.5	46

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13
FILE/GLT442/100

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-11-01	575-37-1	Naphthalene, 1,7-dimethyl-	94.5	36
TP-11-01	573-98-8	Naphthalene, 1,2-dimethyl-	91.6	74
TP-11-01	112-31-2	Decanal	62.0	39
TP-11-01	17851-53-5	1,2-benzenedicarboxylicacid, butyl 2-methylpropylester	56.1	35
TP-11-02	127-18-4	Ethene, tetrachloro-	94.4	36
TP-11-02	91-57-6	Naphthalene, 2-methyl-	91.7	32
TP-11-02	575-37-1	Naphthalene, 1,7-dimethyl-	95.7	19
TP-11-02	573-98-8	Naphthalene, 1,2-dimethyl-	92.3	35
TP-11-04	79-01-6	Ethene, trichloro-	93.1	27
TP-11-04	544-25-2	1,3,5-cycloheptatriene or toluene	95.7	39
TP-11-04	108-88-3	Benzene, methyl-	95.1	390
TP-11-04	127-18-4	Ethene, tetrachloro-	93.2	360
TP-11-04	108-90-7	Benzene, chloro-	90.7	19
TP-11-04	100-41-4	Benzene, ethyl-	94.1	140
TP-11-04	108-38-3	Benzene, 1,3-dimethyl-	92.6	100
TP-11-04	108-38-3	Benzene, 1,3-dimethyl-	91.2	34
TP-11-04	104-76-7	1-hexanol, 2-ethyl-	89.3	65
TP-11-04	103-24-2	Nonanedioicacid, bis(2-ethylhexyl)ester	63.4	69
TP-11-04	791-28-6	Phosphineoxide, triphenyl-	83.5	37

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13
FI [illegible]

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-11-04	29961-54-5	Hexadecadienoicacid, methylester	48.9	130
TP-11-04	629-82-3	Octane, 1,1'-oxybis-	56.8	4900
TP-11-04	629-92-3	Octane, 1,1'-oxybis-	59.0	100
TP-11-04	765-27-5	1-eicosyne	52.7	110
TP-11-04	103-20-8	4-undecanol, 7-ethyl-2-methyl-	42.5	35
TP-11-04	765-27-5	1-eicosyne	52.6	140
TP-11-04	21061-10-9	8,11,14-eicosatrienoicacid, methylester, (Z,Z,Z)-	45.1	65
TP-11-04	55976-09-5	Naphthalene, 1,2,3,4,4A,5,6,8A-Octahydro-4A,8-dimethy	40.9	27
TP-11-04	56259-16-6	Cyclopropanemethanol, alpha, 2-bis(1-methylethyl)-	50.7	18
TP-12-01	127-18-4	Ethene, tetrachloro-	97.6	200
TP-12-01	108-90-7	Benzene, chloro-	95.7	20
TP-12-01	823-69-8	Bicyclo/4.1.0/Heptane, 7,7-dichloro-	80.3	16
TP-12-01	1120-25-8	9-hexadecenoicacid, methylester, (Z)-	71.0	21
TP-12-01	791-28-6	Phosphineoxide, triphenyl-	87.8	16
TP-12-03	108-88-3	Benzene, methyl-	98.8	17
TP-12-03	127-18-4	Ethene, tetrachloro-	93.0	210
TP-12-03	29538-77-0	Cyclohexanol, 4-chloro-, trans-	71.2	31
TP-13-02	127-18-4	Ethene, tetrachloro-	93.9	24
TP-13-02	5363-63-3	Pentane, 1-(ethenyloxy)-	40.4	13

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13
FILE/GLT442/100

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-13-02	791-28-6	Phosphineoxide, triphenyl-	89.0	35
TP-13-03	79-01-6	Ethene, trichloro-	82.2	48
TP-13-03	462-95-3	Ethane, 1,1'-/methylebis(oxy)/bis-	41.8	28
TP-13-03	79-00-5	Ethane, 1,1,2-trichloro-	93.0	100
TP-13-03	127-18-4	Ethene, tetrachloro-	92.9	560
TP-13-03	76-13-1	Ethane, 1,1,2-trichloro-1,2,2,-trifluoro-	56.7	55
TP-13-03	108-90-7	Benzene, chloro-	92.7	32
TP-13-03	13676-58-9	1-butene, 1,4-dichloro-	75.3	51
TP-13-03	76-06-2	Methane, trichloronitro-	62.8	300
TP-13-03	96-18-4	Propane, 1,2,3-trichloro-	81.3	42
TP-13-03	7342-38-3	Stannane, chlorotris(2-methylpropyl)-	70.7	60
TP-13-03	19549-83-8	3-heptanone, 2-6-dimethyl-	45.5	750
TP-13-03	791-28-6	Phosphineoxide, triphenyl-	72.8	3100
TP-13-04	108-88-3	Benzene, methyl-	95.5	13
TP-13-04	76-13-1	Ethane, 1,1,2-trichloro-1,2,2-trifluoro-	47.3	80
TP-13-04	127-18-4	Ethene, tetrachloro-	95.7	540
TP-13-04	76-13-1	Ethane, 1,1,2-trichloro-1,2,2-trifluoro-	67.3	13
TP-13-04	108-90-7	Benzene, chloro-	95.9	14
TP-13-04	76-06-2	Methane, trichloronitro-	59.8	340

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

Sample Number	CAS Number	Compound Name*	Percent Purity	Estimated Concentration (ug/extract)
TP-13-04	354-58-5	Ethane, 1,1,1-trichloro-2,2,2-trifluoro-	64.3	20
TP-13-04	2233-00-3	1-Propene, 3,3,3-trichloro-	81.6	12
TP-13-04	6064-90-0	Heneicosanoicacid, methylester	77.4	15
TP-13-04	870-85-9	2-Butenoicacid, 3-(methylamino)-,ethylester	44.9	28

*Tetrachloroethene tentatively identified in each of three reagent blank samples.

SHELL/GLT442/13
FILE/GLT442/100

Table 6
TENTATIVELY IDENTIFIED COMPOUNDS IN TEST PIT SOIL SAMPLES
COLLECTED FROM CHEM-DYNE (VERSAR INC. ANALYSIS)

Sample Number	CAS Number	Compound Name*	Percent Fit	Estimated Concentration (ug/kg)
GS-01-01	96-18-4	propane, 1,2,3-trichloro-	96.6	300
GS-01-01	13676-58-9	1-butene, 1,4-dichloro-	90.1	200
TP-08-02	109-99-9	furan, tetrahydro-	75	10
TP-08-03	109-99-9	furan, tetrahydro-	94	10
TP-08-06	109-99-9	furan, tetrahydro-	94.7	10
TP-08-07	109-99-9	furan, tetrahydro-	95.4	10
TP-08-07	108-94-1	cyclohexanone	91.0	10
TP-09-02	109-99-9	furan, tetrahydro-	96.7	50
TP-09-02	112-072-5	cyclopentanone, 2-methyl-	73	10
TP-09-03	109-99-9	furan, tetrahydro-	96.2	20
TP-09-03	108941	cyclohexanone	91.4	10
TP-09-05	109-99-9	furan, tetrahydro-	96.2	40
TP-09-05	2233-00-3	1-propane, 3,3,3-trichloro-	93.5	10
TP-10-01	109-99-9	furan, tetrahydro-	96	20
TP-10-01	75-65-0	2-propanol, 2-methyl	98	100
TP-10-01	108-94-1	cyclohexanone	97.1	40
TP-10-01	13676-58-9	1-butene, 1,4-dichloro-	96.6	1,000

*Tetrahydrafuran tentatively identified in field blank sample.

Sample Number	CAS Number	Compound Name*	Percent Fit	Estimated Concentration (ug/kg)
TP-10-01	108-86-1	benzene, bromo-	98.1	500
TP-10-01	95-49-8	benzene, 1-chloro-2-methyl	99.8	2,000
TP-10-02	109-99-9	furan, tetrahydro-	98.7	20
TP-10-02	75-65-0	2-propanol, 2-methyl	98.1	30
TP-10-02	108-94-1	cyclohexanone	96.5	10
TP-10-03	75-65-0	2-propanol, 2-methyl	98.4	40
TP-10-03	624-92-0	dimethyl, disulfide	98.8	60
TP-10-03	95-49-8	benzene, 1-chloro-2-methyl	96.8	50
TP-10-04	109-99-9	furan, tetrahydro-	97.0	10
TP-10-04	75-65-0	2-propanol, 2-methyl	98.4	20
TP-10-04	624-92-0	disulfide, dimethyl	94.5	50
TP-10-04	108-94-1	cyclohexanone	92.3	10
TP-11-01	109-99-9	furan, tetrahydro-	93.5	20
TP-11-01	16747-50-5	cyclopentane, 1-ethyl-1-methyl-	95.4	400
TP-11-01	1678-97-3	cyclohexane, 1,2,3-trimethyl	95.1	400
TP-11-02	622-96-8	benzene, 1-ethyl-1-methyl	98.6	400
TP-11-04	109-99-9	furan, tetrahydro-	98.0	20
TP-11-04	75-65-0	2-propanol, 2-methyl	97.2	200
TP-11-04	598-96-9	2-pentene, 3,4,4-trimethyl	95.9	100

*Tetrahydrafuran tentatively identified in field blank sample.

SHELL/GLT464/3
FILE/GLT464/100

Sample Number	CAS Number	Compound Name*	Percent Fit	Estimated Concentration (ug/kg)
TP-11-04	123-05-7	hexanol, 2-ethyl	98.6	400
TP-11-04	104-76-7	1-hexanol, 2-ethyl	99.5	2,000
TP-12-01	0000109999	furan, tetrahydro-	83	20
TP-12-03	109-99-9	furan, tetrahydro-	93.3	10
TP-13-0	55887-82-6	cyclobutane, 1,3-dichloro	97.3	400
TP-13-02	55887-82-6	cyclobutane, 1,3-dichloro	90.5	30
TP-13-02	630-20-6	ethane, 1,1,1,2-tetrachloro	99.9	40
TP-13-02	76-13-1	ethane, 1,1,2-trichloro-1,2,2-trifluoro	81.4	100
TP-13-02	76-13-1	ethane, 1,1,2-trichloro-1,2,2-trifluoro	96.2	10
TP-13-02	76-14-2	ethane, 1,2-dichloro-1,1,2,2-tetrafluoro	94.3	70
TP-13-02	67-72-1	hexachloroethane	98.8	70
TP-13-02	13676-58-9	1-butene, 1,4-dichloro	91.3	60
TP-13-02	97-99-4	2-furanmethanol, tetrahydro	93.9	40
TP-13-02	108-41-8	benzene, 1-chloro-3-methyl	97.6	50
TP-13-03	109-99-9	furan, tetrahydro	97.8	20
TP-13-03	764-41-0	2-butene, 1,4-dichloro	89.6	200
TP-13-03	96-18-4	propane, 1,2,3-trichloro	491	2,000
TP-13-03	67-72-1	ethane, hexachloro	98.4	1,000
TP-13-03	13676-58-9	1-butene, 1,4-dichloro	95.7	1,000

*Tetrahydrafuran tentatively identified in field blank sample.

Sample Number	CAS Number	Compound Name*	Percent Fit	Estimated Concentration (ug/kg)
TP-13-03	56-23-5	unknown	92.7	400
TP-13-04	0000109999	furan, tetrahydro	97.5	20
TP-13-04	21400-25-9	1-propene, 1,1,2-trichloro	90.8	400
TP-13-04	67-72-1	ethane, hexachloro	99.9	2,000
TP-13-04	13676-58-9	1-butene, 1,4-dichloro	90.2	300

*Tetrahydrafuran tentatively identified in field blank sample.

SHELL/GLT464/3
FILE/GLT464/100

Table 8

TENTATIVELY IDENTIFIED COMPOUNDS IN GRAB SOIL SAMPLES FROM FINAL SOIL INVESTIGATION AT CHEM-DYNE

Sample Number	CAS Number	Compound Name	Percent Purity	Estimated Concentration (ug/kg)
GS-01	127-18-4	Ethene, tetrachloro-	95.0	58
GS-01	96-18-4	Propane, 1,2,3-trichloro-	33.6	18
GS-01	17759-88-5	Propane, 2-bromo-1,2-dichloro-	64.2	110
GS-01	17759-88-5	Propane, 2-bromo-1,2-dichloro-	44.5	95
GS-01	1120-21-4	Undecane	79.2	24
GS-01	18344-37-1	Heptadecane, 2,6,10,14-tetramethyl-	76.6	25
GS-02	791-28-6	Phosphineoxide, triphenyl-	81.3	9,700
GS-02	544-25-2	1,3,5-cycloheptatriene	95.3	1,800
GS-02	108-90-7	Benzene, chloro-	94.0	5,800
GS-02	630-20-6	Ethane, 1,1,1,2-tetrachloro-	89.2	13
GS-02	791-28-6	Phosphineoxide, triphenyl-	87.2	3,600
GS-02	544-25-2	Toluene	95.3	2,500
GS-02	108-90-7	Benzene, chloro-	94.3	6,500
GS-02	108-38-3	Benzene, 1,3-dimethyl- (or isomer)	92.8	4,000
GS-02	100-41-4	Benzene, ethyl- (or xylene)	91.9	4,000
GS-02		Pentachlorobenzene		1,600
GS-03	57-55-6	1,2-propanediol	93.7	550,000
GS-03	544-25-2	1,3,5-cycloheptatriene	93.4	160,000

Sample Number	CAS Number	Compound Name	Percent Purity	Estimated Concentration (ug/kg)
GS-03	127-18-4	Ethene, tetrachloro-	92.3	3,100,000
GS-03	111-76-2	Ethanol, 2-butoxy-	94.8	72,000
GS-03	111-90-0	Ethanol, 2-(2-ethoxyethoxy)-	91.6	1,500,000
GS-03	124-19-6	Nonanal	82.6	350,000
GS-03	544-76-3	Hexadecane	87.6	230,000
GS-03	118-58-1	Benzoicacid, 2-hydroxy-, phenylmethylester	84.7	43,000
GS-04	124-18-5	Decane	84.1	8,200
GS-04	1120-21-4	Undecane	82.5	24,000
GS-05	99-89-8	Phenol, 4-(1-methylethyl)-	81.5	3,300
GS-05	95-16-9	Benzothiazole	87.9	4,100
GS-05	92-52-4	1,1'-biphenyl	88.2	1,500
GS-05	101-84-8	Benzene, 1,1'-oxybis-	87.9	2,300
GS-05	115-86-6	Phosphoric acid, triphenylester	83.3	16,000
GS-06	108-38-3	Benzene, 1,3-dimethyl-	92.1	120
GS-06	1120-21-4	Undecane	85.0	1,300
GS-06	115-86-6	Phosphoric acid, triphenylester	83.7	15,000

MEMORANDUM

TO: File

FROM: Randal K. Weltzin/GLO

DATE: January 10, 1984

RE: Chem-Dyne Site Remedial Investigation
Survey and Mapping
Subtask 3-6

JOB NO: W65310.C0

INTRODUCTION

Survey and mapping services were performed as part of the Chem-Dyne site investigation work from November 14, 1983, to December 21, 1983, at the Chem-Dyne site in Hamilton, Ohio. Arrangement for these services and onsite field coordination was provided by CH2M HILL to assist the subcontractor, GRW Engineers of Lexington, Kentucky, who performed these services. This work was performed as part of EPA's work assignment No. 21.5M10.0, Subtask 3-6.

PURPOSE

The purpose of the surveying and mapping effort was to determine horizontal coordinates and elevations of all groundwater monitoring wells and test pits, to obtain current aerial photography and to generate current topographic information about the site. The topographic information represents site conditions after completion of waste removal work by O.H. Materials during 1983. Since site topography will remain unchanged, this topographic data will be the basis for evaluations of potential remedial actions.

SCOPE

The scope of work for the surveying and mapping effort included:

- Obtaining horizontal coordinates and elevations on 37 monitoring wells and 13 test pits both on and offsite (Figure 1).
- Obtaining current aerial photography suitable for preparing a topographic map at a scale of 1" = 50'

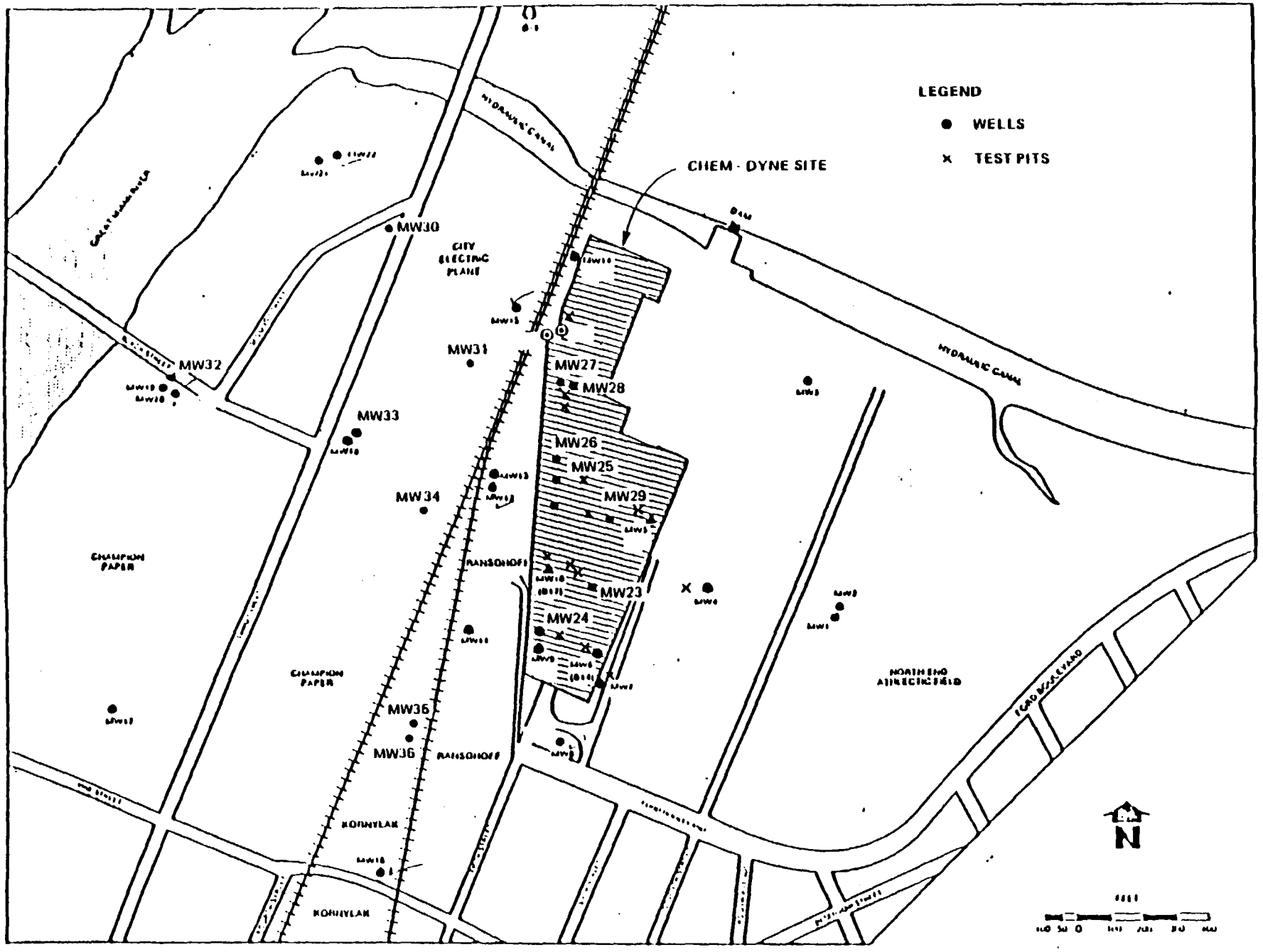

FIGURE 1
LOCATIONS OF MONITORING WELLS
AND TEST PITS TO BE SURVEYED

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and suitable for preparing a photo enlargement at a scale of 1" = 100'.

- Obtaining the necessary photo control to map the site.
- Preparing a topographic map of the site on mylar at a scale of 1' = 50' with a 1' contour interval.
- Reducing the topographic map to a scale of 1" = 100' and final drafting of the mapping on a single 22" x 34" sheet.

PERSONNEL

The following personnel/firms were involved in completing the survey and mapping assignment:

CH2M HILL

Randy Weltzin - Coordination and Technical Review
Brad Berggren - Onsite Field Services

GRW ENGINEERS

Supplied field crew and mapping personnel.

LIST OF DELIVERABLES

The list of deliverables requested from the subcontractor included:

- Original survey field notes, drawings, and computations.
- Original aerial negatives, two sets of 9" x 9" contact prints.
- Photo enlargement at 1" = 100' at 4-mil mylar film (Figure 2).
- Original map manuscript.
- Final drafted map at 1" = 100' on 4-mil mylar film (Figure 3). Also attached are copies of the final drafted map at 1" = 50' (Figures 6-1 and 6-2).
- Tabulation of x, y, and z coordinates on all wells and test pits (Tables 1 and 2).
- One blue line print of the final map to be submitted for field check, review and comments prior to submittal of the final map.

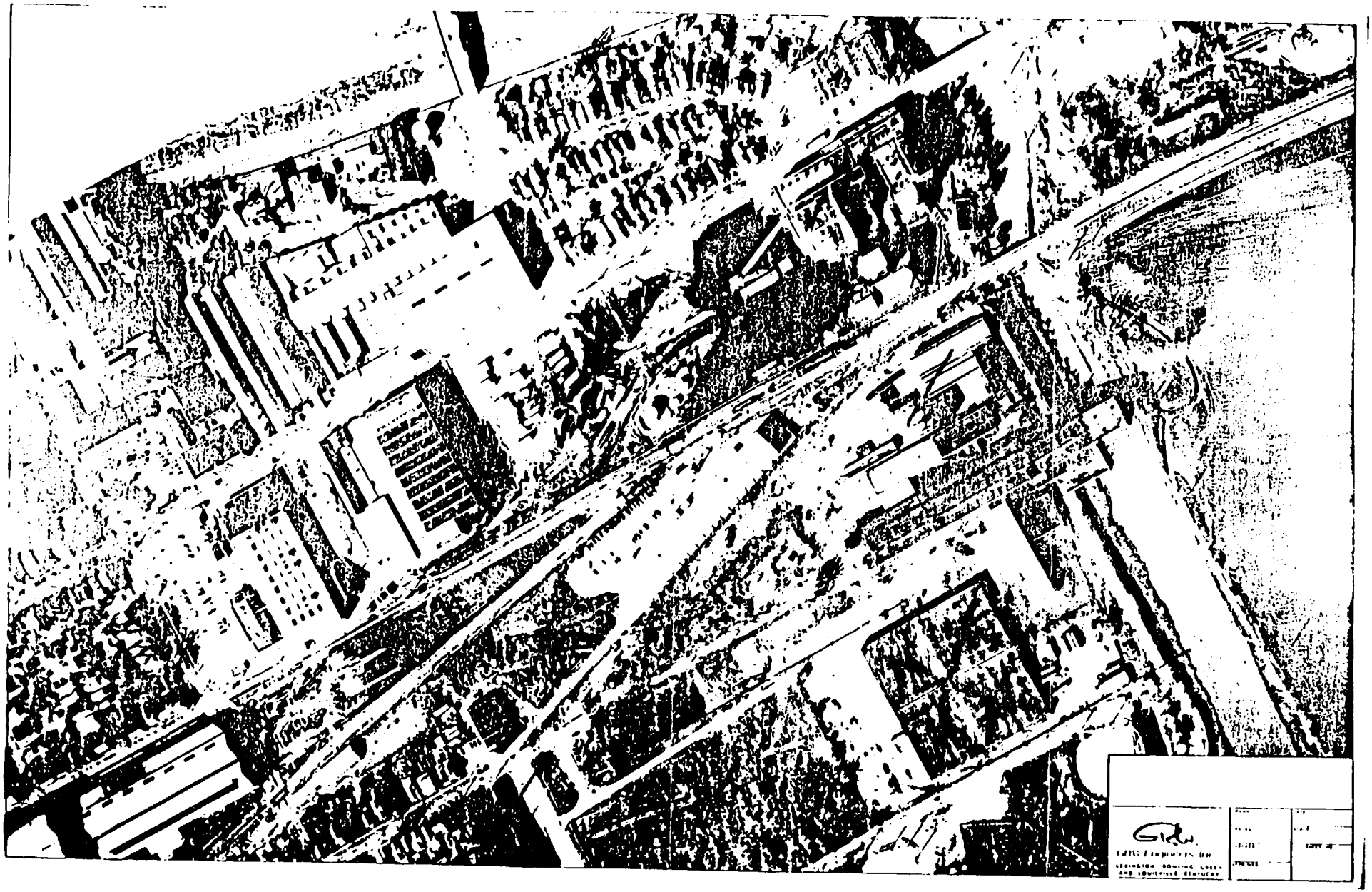

FIGURE 2

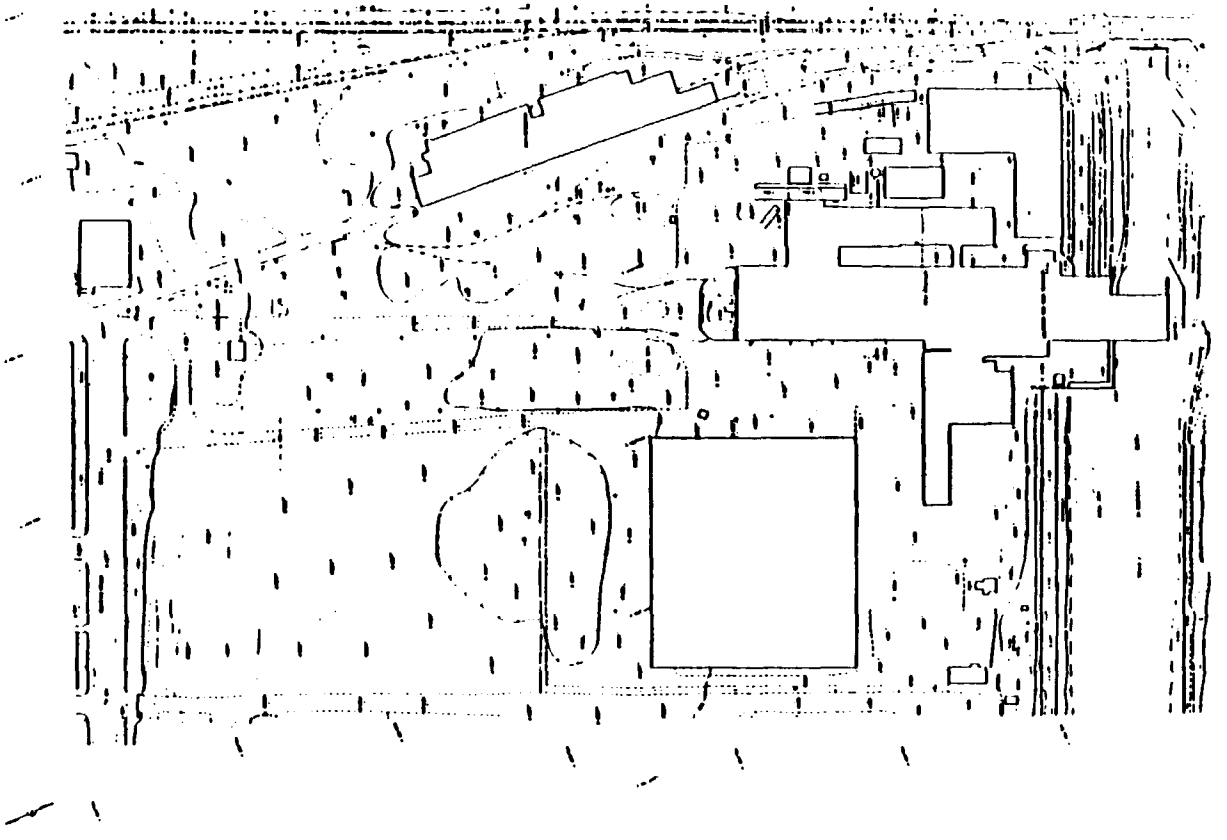

FIGURE 3

LEGEND

DISMANTLED RAILROAD
POWER POLE
LIGHT POLE
LOCATED OBJECT (SMALL POLE, ETC.)
CATCH BASIN
WALL
ROAD SIGN
MONITOR WELL
MONITOR WELL w/ HORIZONTAL CONTROL
TEST PIT
HORIZONTAL CONTROL
VERTICAL CONTROL

GRAPHIC SCALE
0 100 200

DATE OF PHOTOGRAPHY NOV 31 1983

PROJECT NO. 90010

GRW Engineers Inc.
LEXINGTON DOWNING GREEN AND LOUISVILLE KENTUCKY

CHEM - DYNE SITE
HAMILTON, OHIO

DESCRIPTION | DATE | BY
REVISIONS

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Table 1
HORIZONTAL COORDINATES AND ELEVATIONS FOR
MONITORING WELLS AND TEST WELL

Monitoring Wells	Horizontal Coordinates East	Horizontal Coordinates North	Elevation (Top of Casing)
MW-1	1420775	519036	591.12
MW-2	1420792	519065	591.52
MW-3	1420627	519709	591.14
MW-4	1420329	519064	592.89
MW-5	1420174	519283	591.62
MW-6	1420058	518962	592.19
MW-7	1420060	518896	593.30
MW-8	1419863	518595	597.91
MW-9	1419794	518853	592.83
MW-10	1419817	519155	591.58
MW-11	1419561	518935	598.36
MW-12	1419641	519392	593.18
MW-13	1419652	519427	593.20
MW-14	1419897	520035	594.39
MW-15	1419734	519932	595.56
MW-16	1419324	518180	594.82
MW-17	1418495	518684	597.32
MW-18	1419187	519470	594.65
MW-19	1418705	519652	591.42
MW-20	1418684	519659	592.02
MW-21	1419148	520369	598.06
MW-22	1419183	520394	597.57
MW-23	1420066	519115	590.32
MW-24	1419821	518940	591.32
MW-25	1419862	519388	591.25
MW-26	1419875	519396	590.52
MW-27	1419870	519607	590.71
MW-28	1419883	519582	591.56
MW-29	1420026	519289	590.85
MW-30	1419271	520130	592.77
MW-31	1419510	519635	594.07
MW-32	1418674	519662	592.52
MW-33	1419202	519522	595.29
MW-34	1419414	519283	596.25
MW-35	1419446	518837	595.76
MW-36	1419435	518789	594.73
Test Well			
TW	1419866	519335	591.72

MW = Monitoring Well
TW = Test Well

GLT432/106.1

Table 2

HORIZONTAL COORDINATES AND ELEVATIONS FOR TEST PITS

Test Pit	Horizontal Coordinates East	Horizontal Coordinates North	Elevation (ground)
TP-1	1420294	519084	589.3
TP-2	1420046	518873	590.3
TP-3	1419970	518864	590.2
TP-4	1419860	518932	590.6
TP-5	1419855	519171	589.0
TP-6	1419932	519122	589.7
TP-7	1420037	519087	589.7
TP-8	1420074	519296	589.5
TP-9	1419966	519274	589.9
TP-10	1419895	519333	589.0
TP-11	1419857	519482	588.0
TP-12	1419848	519546	588.8
TP-13	1419871	519854	588.8

GLT432/106.2

- Breakdown of all time and materials charges.

PROCEDURES

FIELD ACTIVITIES

With the assistance of Brad Berggren of CH2M HILL, the field crew from GRW Engineers identified the monitoring wells and test pits. A numbering system had previously been developed for the wells and test pits as part of the drilling program which Brad had been involved in. Pre-marking was accomplished by placing strips of material in the shape of a "cross" or a "V" over the well casings and in the geometric center of the test pits for the purpose of identifying these locations on the aerial photography.

A level circuit was run with GRW personnel remaining offsite and Brad Berggren performing as the rodman onsite to obtain elevations on the casings of the monitoring wells and ground surface elevations at the test pits. The remainder of the ground survey activities were performed by the GRW field crew for the purpose of obtaining the control necessary to map the site.

AERIAL PHOTOGRAPHY

The aerial photography obtained consisted of two flight lines at different altitudes (Figure 4). Flight line 1 (Photo scale at 1" = 285'±) was for the purpose of preparing a 1" = 50' scale topographic map and flight line 2 (photo scale at 1" = 500'±) was for the purpose of preparing a 1" = 100' scale enlargement of the entire site.

MAPPING

Mapping of approximately 40 acres (Figure 5) was prepared at a scale of 1" = 50' with a 1-foot contour interval. Mapping was accomplished by using photogrammetric methods and standard stereoplotting techniques. The final drafting was accomplished by using the method of scribing.

Horizontal coordinates of monitoring wells located inside of the mapping limits were obtained by plotting the well or test pit position onto the map manuscript and scaling the coordinates from the grid system established. Coordinates on those wells and test pits outside of the mapping limits were obtained by aerotriangulation techniques (Tables 1 and 2).

CHRONOLOGY OF EVENTS

November 14, 1983	Task Order issued to GRW Engineers for survey and mapping services.

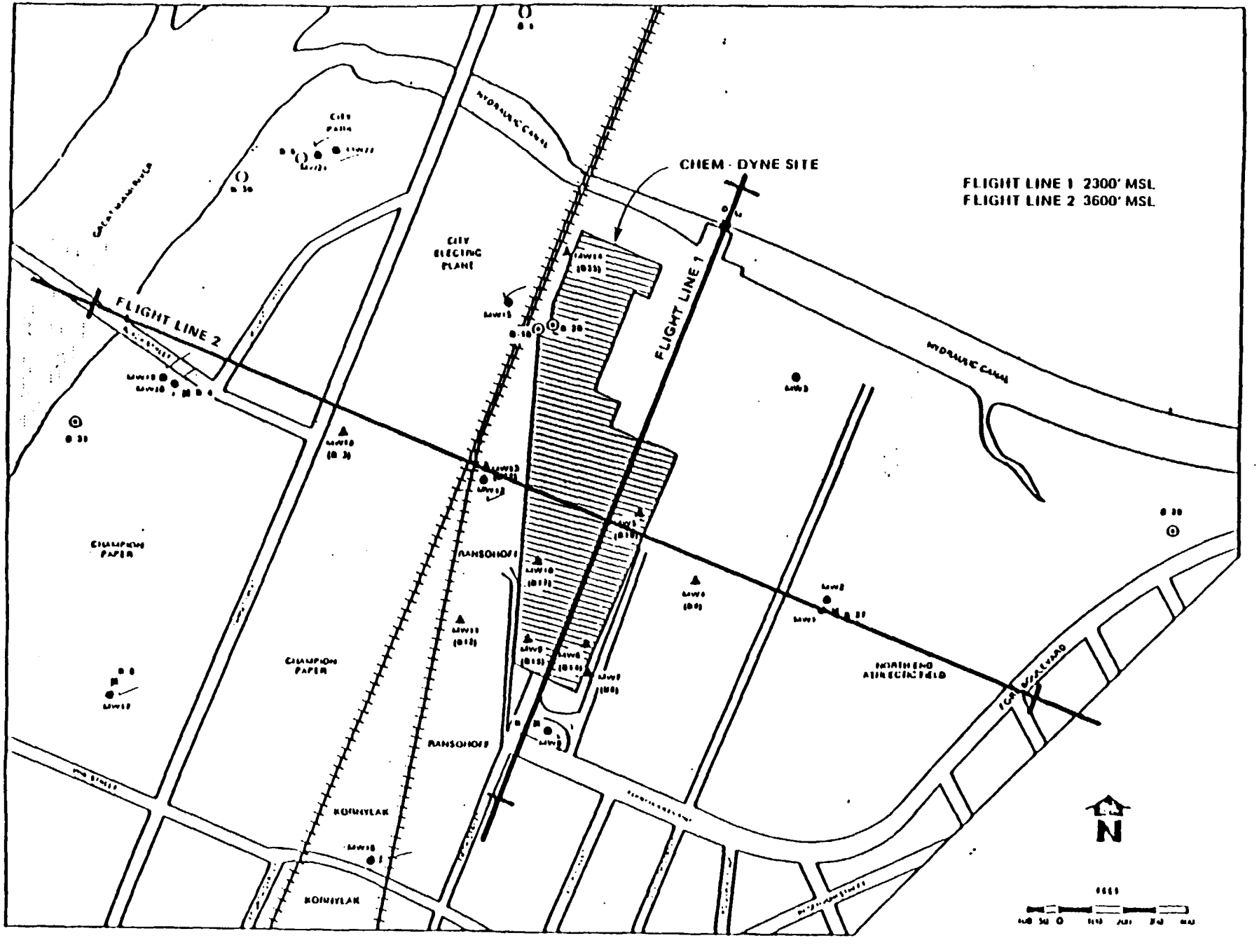

FIGURE 4
FLIGHT PLAN

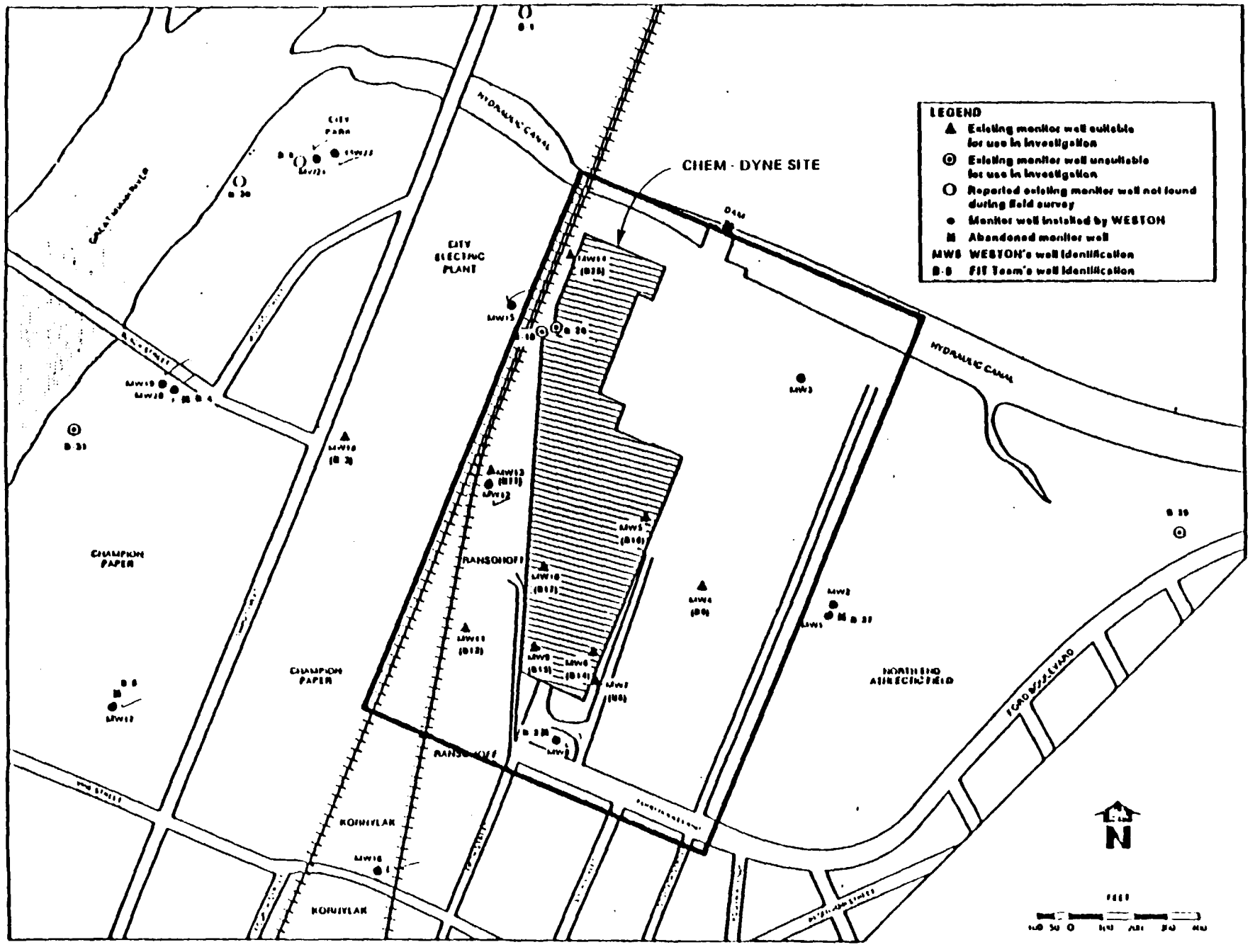

FIGURE 5
MAPPING LIMITS

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November 17 & 18, 1983	Brad Berggren and GRW Engineers were at the site placing panels on well casings on and offsite. Crew also obtained elevations on well casings and test pits.
November 21, 1983	Aerial photography was obtained. Two flight lines were flown at a photo scale of 1" = 300' for mapping and one flight line was flown at a photo scale of 1" = 800' for the preparation of a photo enlargement.
November 21-23, 1983	GRW surveyors completed photo control surveys.
December 1, 1983	Two sets of contact prints were received by CH2M HILL from GRW Engineers.
December 15, 1983	Two blue line prints of 1" = 50' scale topo mapping received by CH2M HILL.
December 21, 1983	Final mylars (2) of the drafted topo map were received along with a tabulation of horizontal coordinates for 37 wells and 13 test pits (Table 1).

GLT432/68

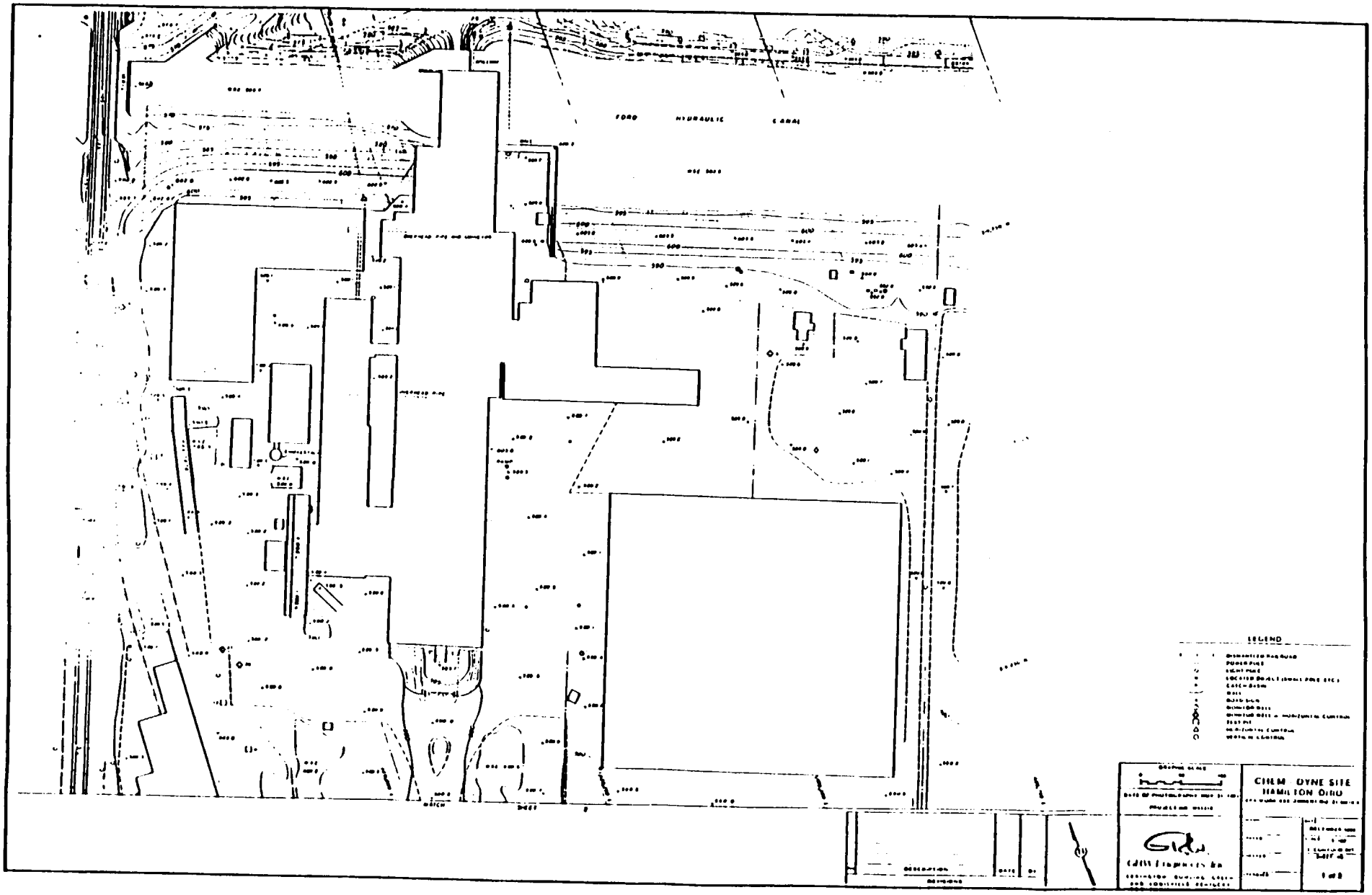


FIGURE 6 1

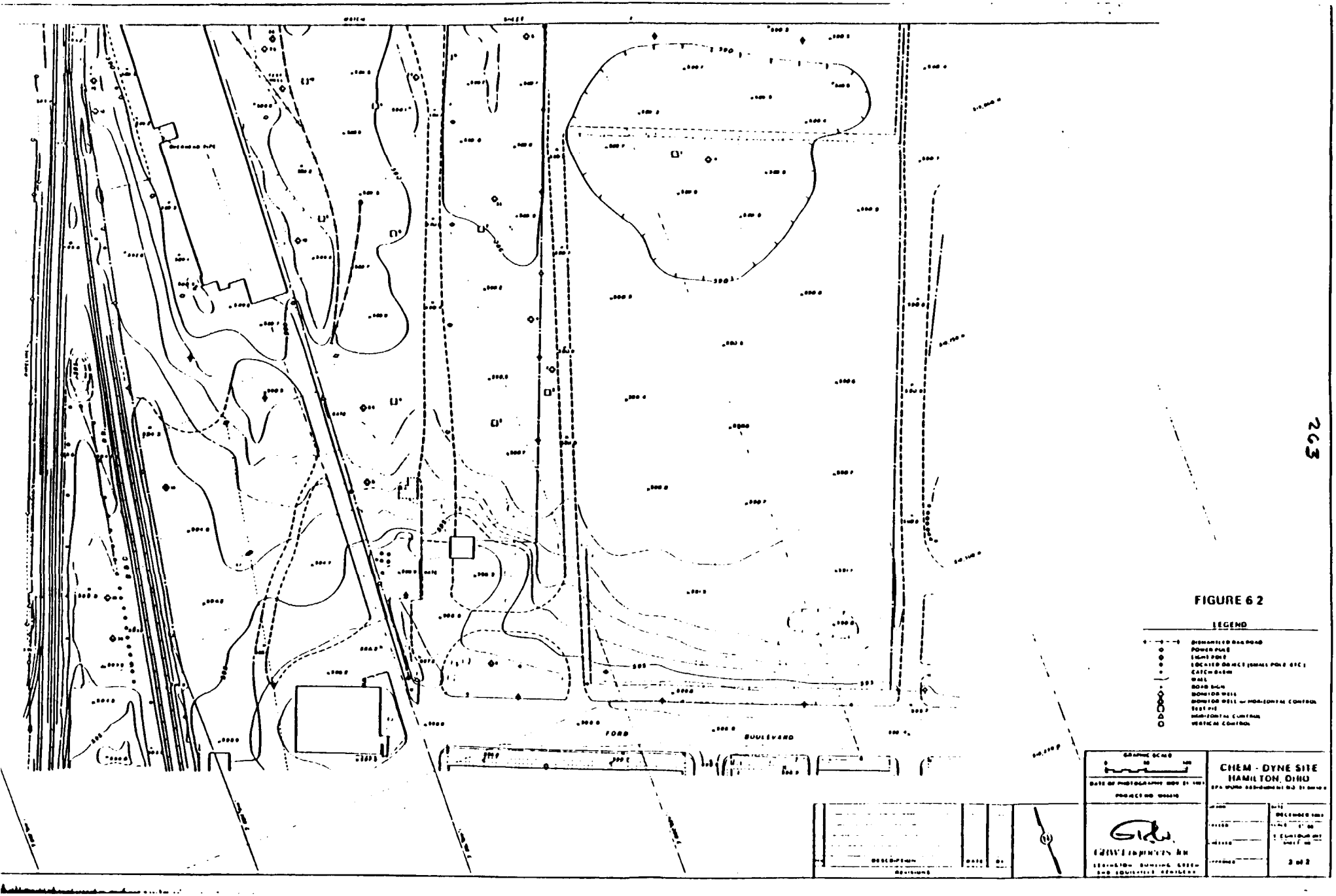


FIGURE 6 2
LEGEND
FORD
BOULEVARD
CHEM - DYNE SITE
HAMILTON, OHIO

APPENDIX

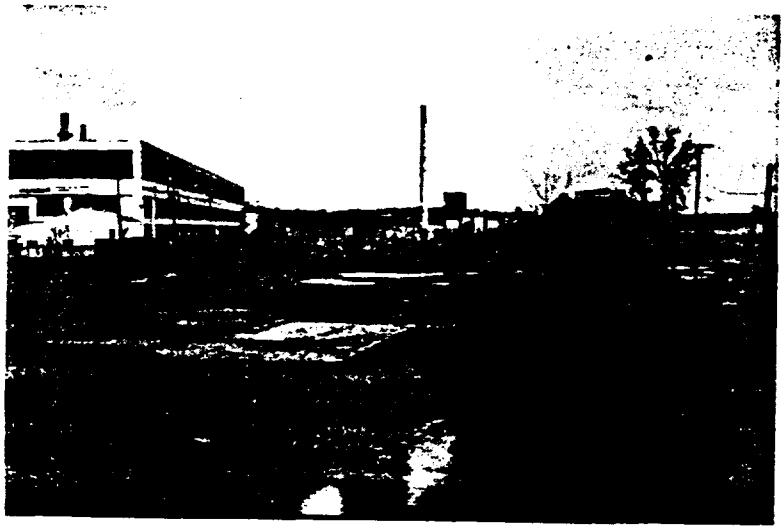
SURVEY AND MAPPING

Photograhic Log

GLT460/25-2

SURVEY TASK
Photographic Log
Chem-Dyne Site
W65310.C0

Photos 1 through 4: This is a panoramic view of the site following completion of the onsite waste removal. The photos are taken from the southern entrance and pan from northwest to north and finally northeast [11-17-83].



- Butler County Recorders Office
  Hamilton, Ohio

- The Miami Conservancy District
  Dayton, Ohio

Physical inspection (reconnaissance) of facilities at the site included the following:

- Onsite surface structures and appurtenances including below-grade floors and tunnels.

- Buried utilities on and adjacent to the site

- The blue warehouse

PERSONNEL

Larry A. Holm, Project Manager/GLO (Physical Inspection)
John T. Fleissner, Project Engineer/GLO (Physical Inspection)
Lauri J. Gorton, Project Engineer/GLO (Existing File Review)
Brad J. Berggren, Project Engineer/GLO (Physical Inspection)

Assistance was provided by Mr. R. Butz, Hamilton City Engineer and Mr. P. Plummer of The Miami Conservancy District.

PROCEDURES AND ACTIVITIES

Records at the City of Hamilton's municipal office were examined on October 3, 1983. The city engineer's office was able to provide copies of the following documents:

- Map of existing sewers for the Chem-Dyne site (Figure 1).
- City of Hamilton as-built drawing #142, showing the plan and profile of an 8-inch sewer construction of cast iron pipe (Figure 2).

While direct access to the city Building Department's files was not permitted, the city engineer did assign a staff person to check those files for pertinent data. This resulted only in the retrieval of one rough sketch of what was apparently the blue warehouse.

The City Utility Department was the most valuable source of data on the site construction history. In addition to maps of utility locations, the Department has copies of plan documents for the construction of the old Henry Ford Tractor

MEMORANDUM

TO: File

FROM: Lauri J. Gorton
Brad J. Berggren/GLO
John T. Fleissner/GLO

DATE: January 12, 1984

JOB NO: W65310.C0

RE: Chem-Dyne Site Remedial Investigation
Facilities Inventory
Subtask 3-7

INTRODUCTION

Existing facilities at the Chem-Dyne site in Hamilton, Ohio were inventoried during October 1983 to obtain and record data necessary for evaluation during the feasibility study. The facilities inventory included surface structures, appurtenances, and buried utilities on and adjacent to the site. On October 3 and 4, 1983, existing files were examined for documentation relative to the location and general structure of facilities of the site. Physical inspection (reconnaissance) of the facilities was performed from October 22 through 24, 1983 by a separate field team. This inventory work was performed in partial satisfaction of Contract No. 68-01-6692, Work Assignment No. 21.5M10.0.

PURPOSE

The inventory was performed to obtain and record data, such as a chronology of site development, construction methods and materials, and locations of existing facilities, necessary for evaluation during the feasibility study. Where possible, physical inspectin (reconnaissance) of the facilities was conducted to obtain photographs and to visually determine the general structural integrity and degree of contamination of the facilities.

SCOPE

Available existing files were reviewed and, in some cases, photocopied from the following sources:

- City of Hamilton Municipal Offices
  Hamilton, Ohio, specifically the City Engineer's office and the Utilities Department

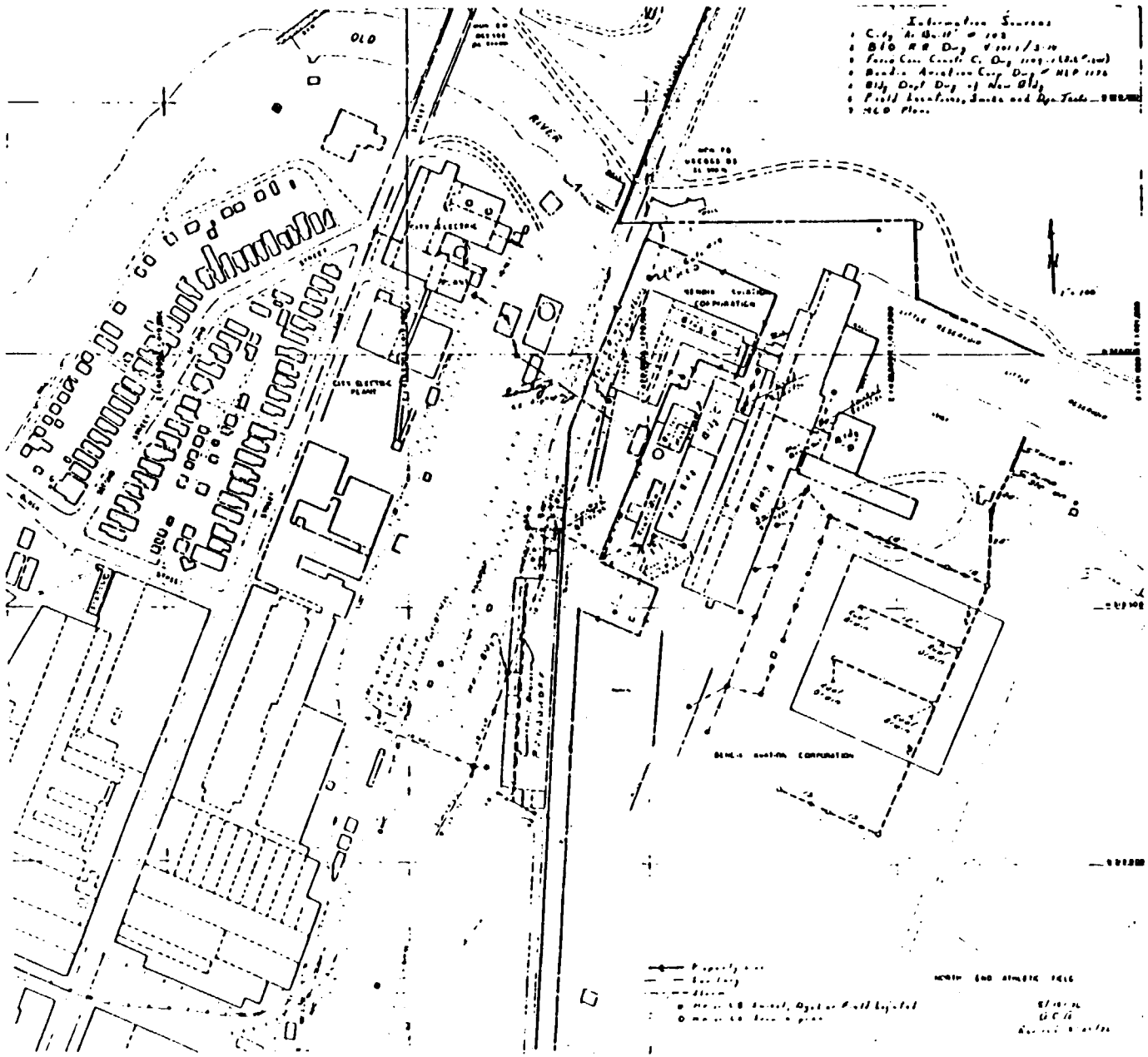


FIGURE 1
MAP OF EXISTING SEWERS
CHEM DYNE

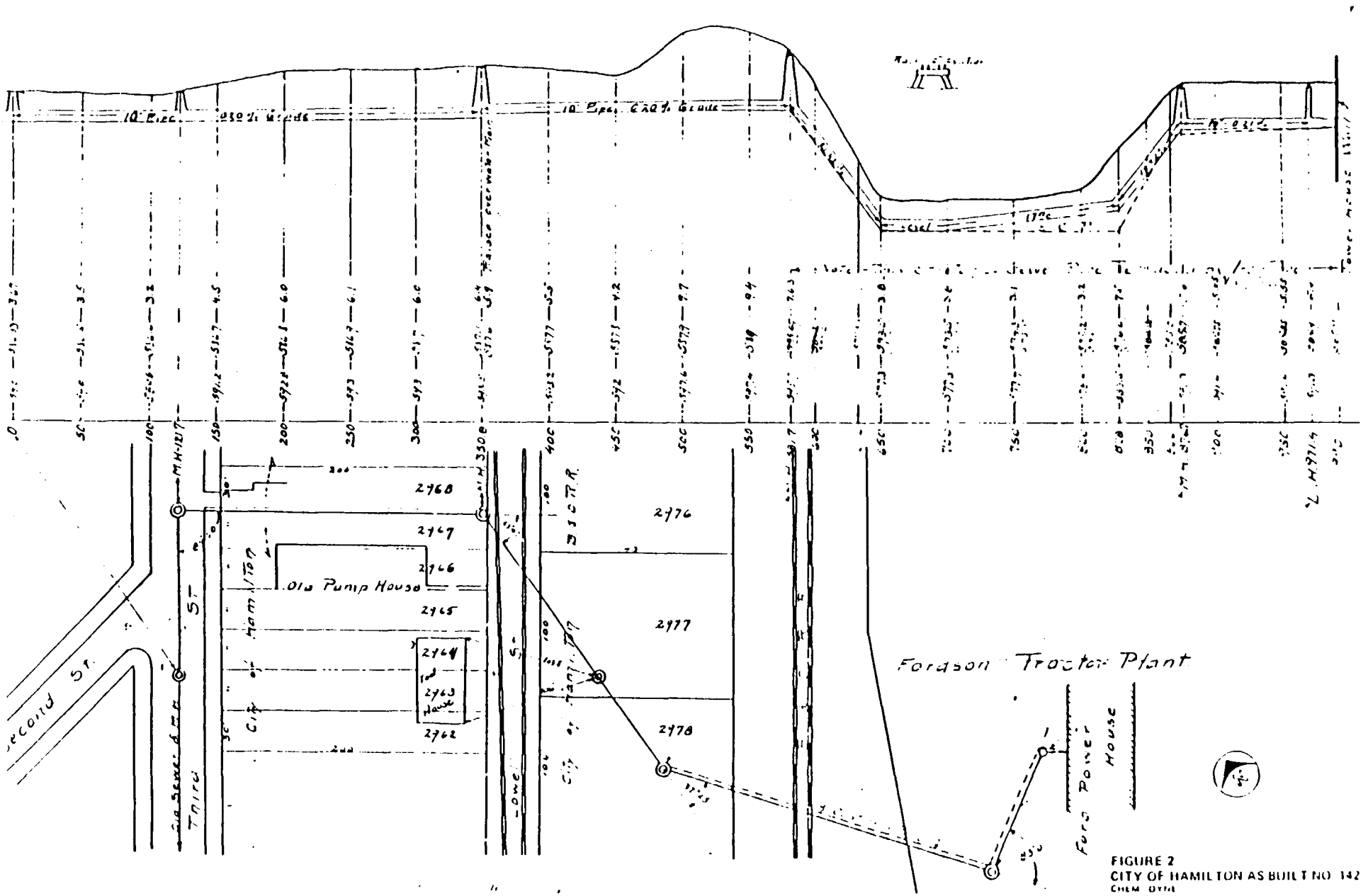


FIGURE 2
CITY OF HAMILTON AS BUILT NO. 142
CHEM DYNE

Plant. While these Ford Tractor Plant drawings were the most complete and detailed data found, the drawings in most cases indicate proposed facilities with no record of the actual "as-built" construction. Partial copies of the following were furnished by the Utility Department:

- Map of water lines to site (Figure 3).
- Ford and Son Tractor Plant plan drawing; plan and section of Building "B" (Chem Dyne Building).
- Sheet index No. 52940 titled, "Ford Motor Company and/or Hamilton and Rossville Hydraulic Co."; site plan, surveyed 3-17-33.
- Plan drawing from set titled, "Tractor Buildings for Henry Ford and Son," dated 9-23-19; plot plan.
- Plan drawing titled, "Plot Plan," from set listed above, dated 8-15-19.
- Plan drawing titled, "Ford Motor Co., Hamilton, Ohio Plant," dated 9-21-48; site plan.

Because the Ford Company plan drawings were old full and half size bluelines and the largest copy produced by available equipment was 11" by 14", only partial copies of the plans could be obtained. The Utility Department continues to retain these plan drawings and files and they may be examined there at any time.

To obtain existing property survey information, the Butler County Recorders Office was also contacted. They had one survey on file done by Louis W. Graf & Associates, Cincinnati, Ohio, dated October 1963, and revised on July 22, 1967. Because this document offered little additional information and was not readily reproducable (being a full size blueline), a copy was not obtained. It is possible that copies may be obtained by contacting Graf & Associates in Cincinnati.

Finally, on the afternoon of the October 3, photographs were taken from the southern, eastern and western edges of the Chem-Dyne site (see Appendix A). Because of the remote location, only building exteriors were photographed. Through a conversation with one of the Corps of Engineer's men it was mentioned that a 90-foot portion of the interior of Building "B" (See Figure 4) was removed following a recent fire.

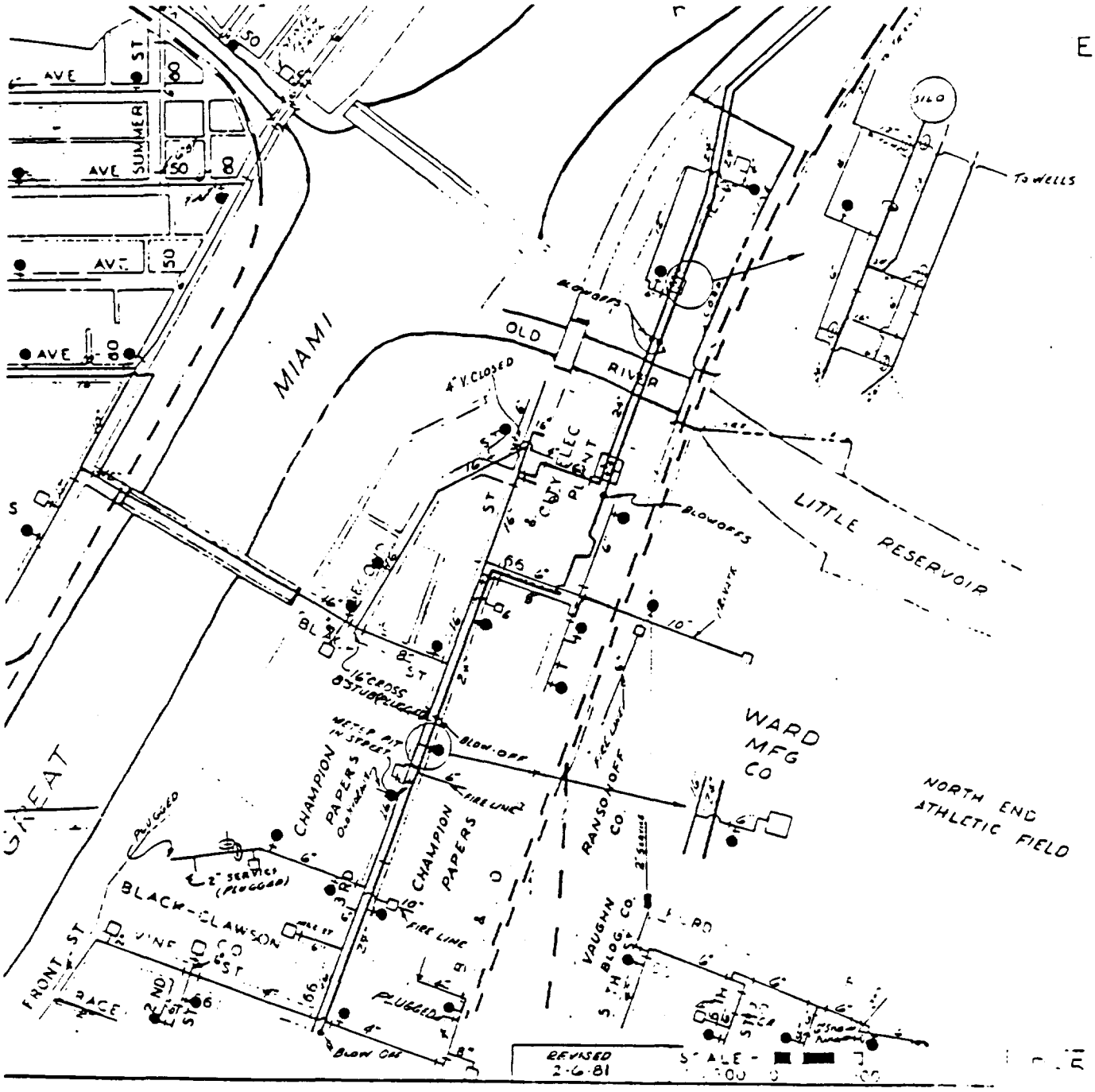


FIGURE 3
MAP OF EXISTING WATER LINES
CHEM-DYNE

NOTES

1) THIS MAP IS A COMPOSITE MAP INDICATING THE APPROXIMATE LOCATION OF EXISTING STRUCTURES AND UTILITIES

2) ALL LOCATIONS SHOULD BE FIELD VERIFIED

3) THE FOLLOWING DRAWINGS WERE USED TO MAKE UP THIS MAP

A) SANITARY SEWER

CITY OF HAMILTON AS BUILT NO 142
CITY OF HAMILTON SEWER LOCATION

B) STORM SEWERS CITY OF HAMILTON SEWER LOCATION

C) WATER CITY OF HAMILTON UTILITY DRAWING D 6

D) GAS PLAN OF HENRY FORD TRACTOR PLANT

E) TELEPHONE MCD DRAWING "PLAN TO ACCOMPANY AGREEMENT WITH HAMILTON & HOSSVILLE HYDRAULIC CO FOR LAYING OF TELEPHONE CONDUIT"

F) TUNNEL LOCATION DRAWING TITLED "FORD MOTOR CO AND/OR HOSSVILLE HYDRAULIC CO" SURVEYED MARCH 17, 1933

4) THE 4" GAS LINE MAY OR MAY NOT EXIST IF IT WAS INSTALLED IT HAS BEEN ABANDONED

5) ALL LOCATIONS HAVE BEEN SCALED FROM EXISTING DRAWING NOTED ABOVE

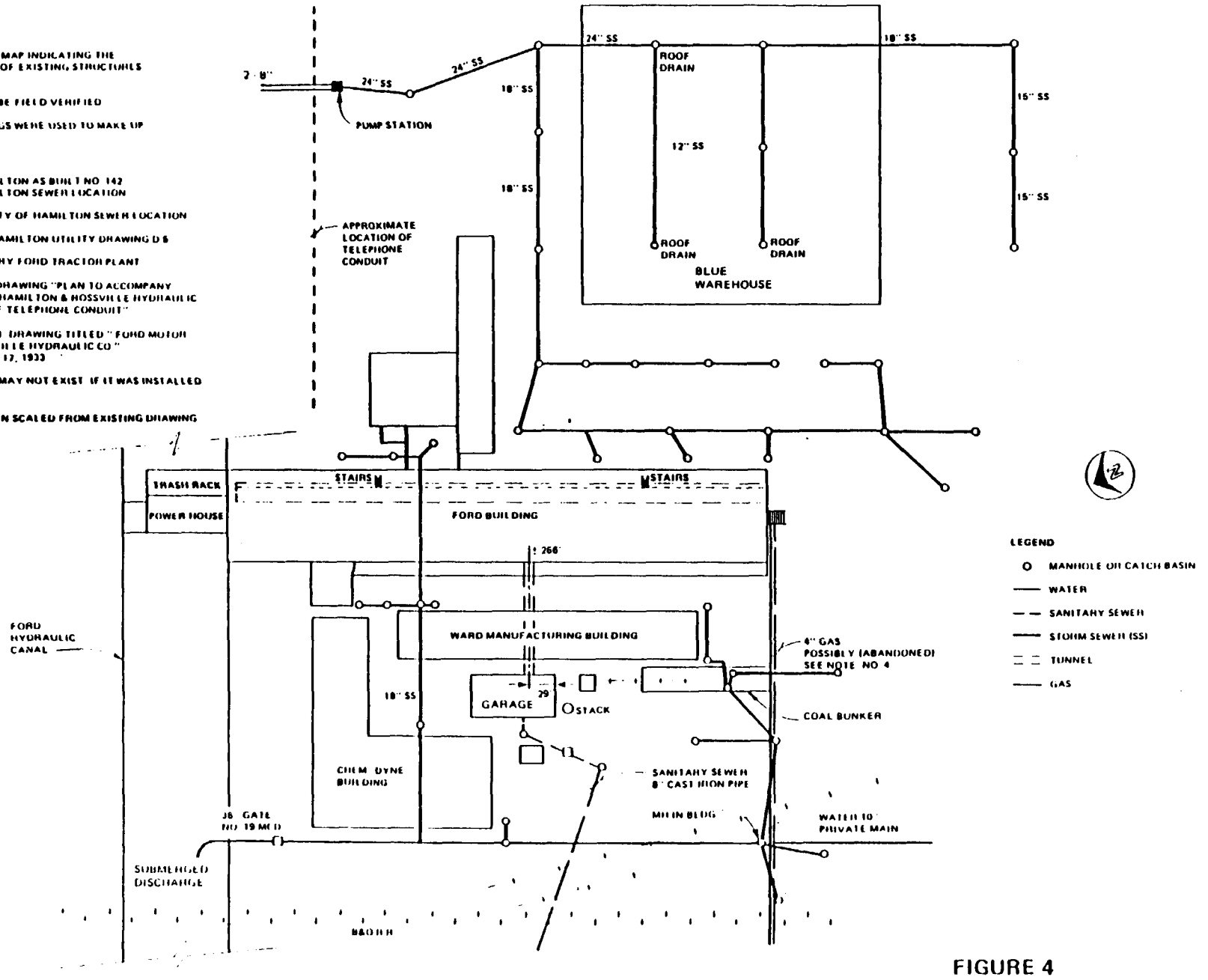


FIGURE 4
COMPOSITE UTILITY MAP
CHEM - DYNE RI

On October 4, microfilmed records were examined at The Miami Conservancy District (MCD). Because of the Conservancy District's interest in the adjacent canal the majority of data available concerned the hydroelectric plant and retaining wall construction. Copies of documents obtained are:

- Proposed electric service to MCD lands
- Gas service on MCD lands

The MCD also had several books of old photographs on file. Some of the photographs showed the construction of the Ford Tractor Plant, the type of construction used and various stages of completion. The pictures were illustrative but provided no quantitative data.

Information from these sources were reviewed and the various documents were compared to see if data corresponded. A location map (Figure 4) was developed based on a composite of all available data. This map was used by field personnel during the physical inspection (reconnaissance).

SUMMARY

The following is a description of facilities based on the review of available files:

- Gas Utility. Per city of Hamilton Utility Department, there is no city gas on the site. If a 4-inch gas line shown on old Ford Company plan drawings was ever installed (Figure 4), it has since been abandoned and may be still in place.

- Electric Utility. Above ground service only, visible upon field investigation.

- Water Utility. 10-inch water line entering site from west (See Figure 3)

- Sanitary Sewer. 8-inch cast iron pipe entering site from west (See Figures 1 and 2)

- Storm Sewers (See Figure 1) Several lines summarized as follows:
  - Approximately 500 feet of 36-inch diameter
  - Approximately 1,100 feet of 18-inch diameter
  - Miscellaneous short sections

- Telephone Service. MCD drawings indicate service at the northern end of the site. No other information was available.

- Building "A" - Ford Building. (Figure 4)
  - 2-story, 602' (north-south) x 100' (east-west)
  - Reinforced concrete foundation with steel superstructure
  - Two heating tunnels indicated beneath building

- Building "B" - Chem Dyne Building. (Figure 4)
  - Approximately 22,000 square feet
  - Concrete foundation, steel superstructure
  - Fire in easterly portion of building, partially gutter

- Building "C" - Boiler Building. (Figure 4)
  - 91' (north-south) x 44.5' (east-west)
  - Connected to Building "A" by heating tunnel

The photographic log, attached as Appendix B, summarizes the physical inspection (reconnaissance) of the facilities at the Chem-Dyne site. Results of the facilities inventory will be included and discussed in the final remedial investigation report.

GLT460/3

APPENDIX A

PHOTO LOG

Chem-Dyne Site Remedial Investigation
Facilitory Inventory
Subtask 3-7

The following photographs were taken by Lauri Gorton/CH2M HILL on October 4, 1983. All photography was done from outside the site fence.

GLT460/13

PHOTO 1: Viewing north showing the O.H. Materials' trailers in foreground and Ford Building in background.

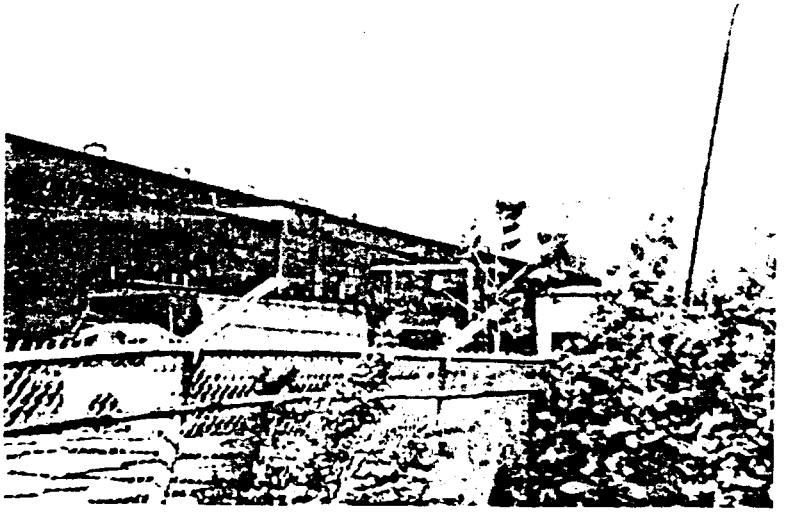


PHOTO 2: Viewing northeast showing east side of Ford Building.

PHOTO 3: Similar to Photo 2.

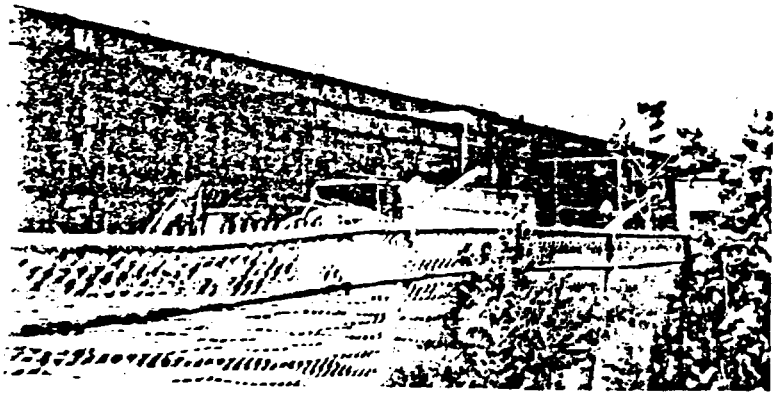


PHOTO 4: Viewing northeast showing south face of Ford Building.

PHOTO 5: Viewing east showing the west face of Ford Building and the hydroelectric spillway at left.

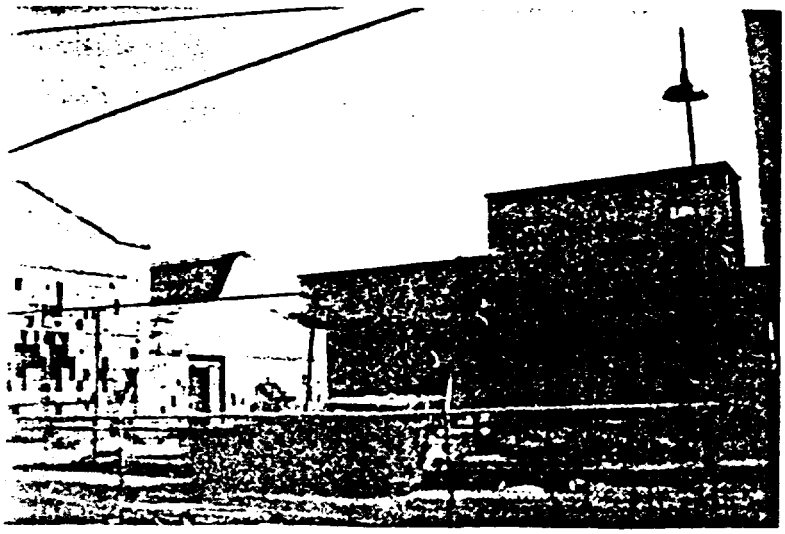


PHOTO 6: Viewing northeast showing "loading dock" area of the Chem-Dyne facility.

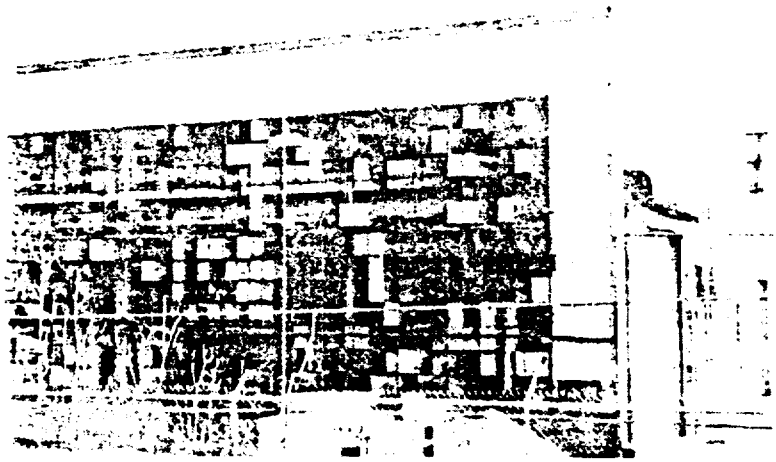


PHOTO 7: Viewing east northeast showing the west wall of the Chem-Dyne Building.

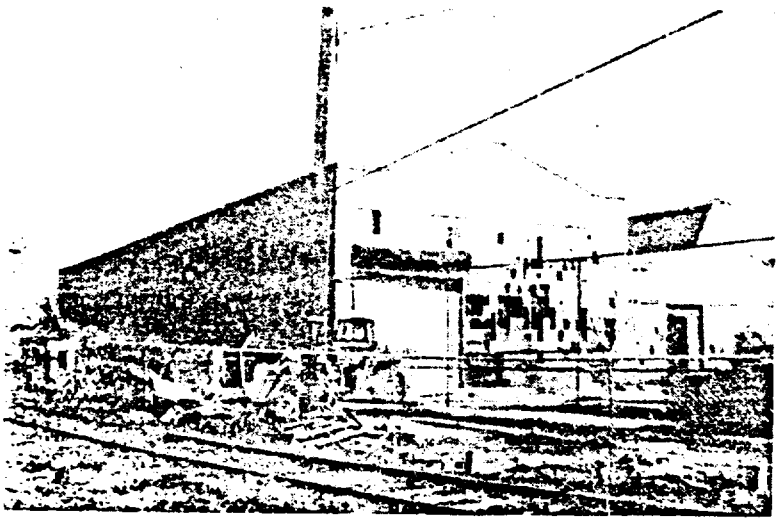


PHOTO 8: Viewing northeas showing the south face of Chem-Dyne Building and the "loading dock" area.

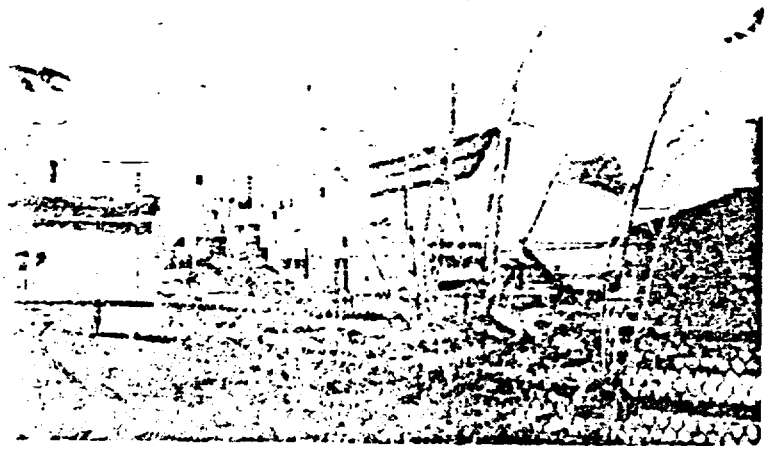


PHOTO 9: Viewing north showing south face of Chem-Dyne Building.

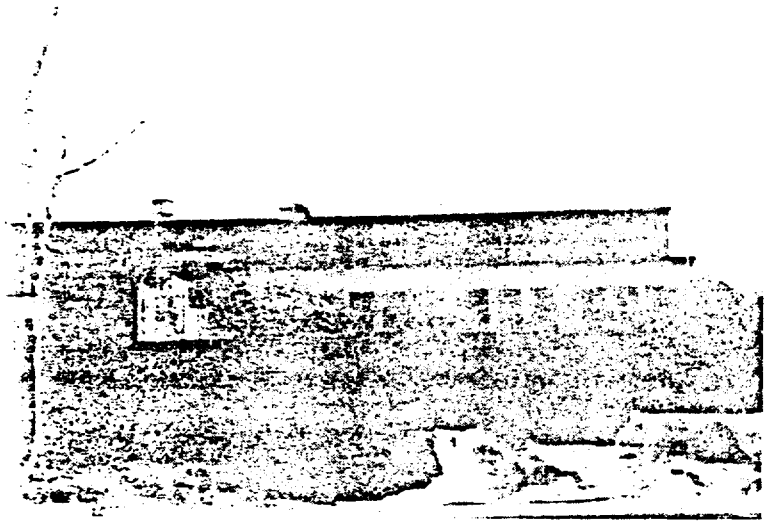


PHOTO 10: Viewing east showing coal bunker and Ford Building beyond.

PHOTO 11: Viewing northeast showing lower portion of smokestack and boiler building.

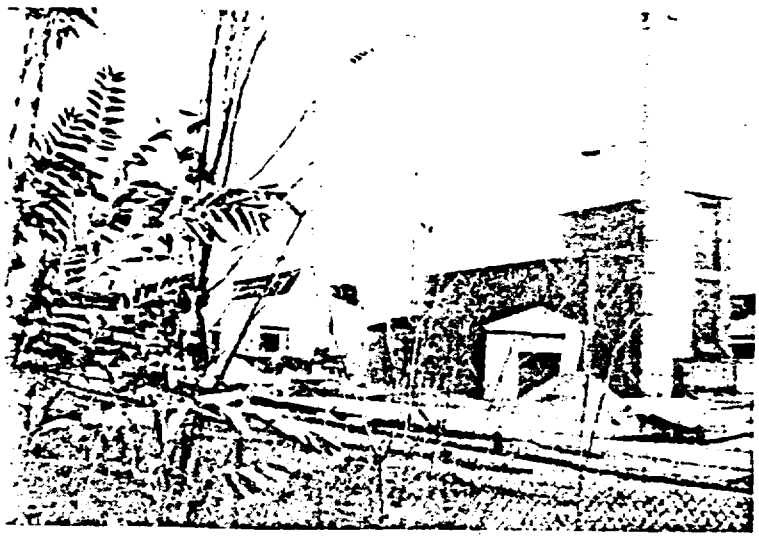


PHOTO 12: Similar to Photo 11 showing more of the loading dock area in the foreground.

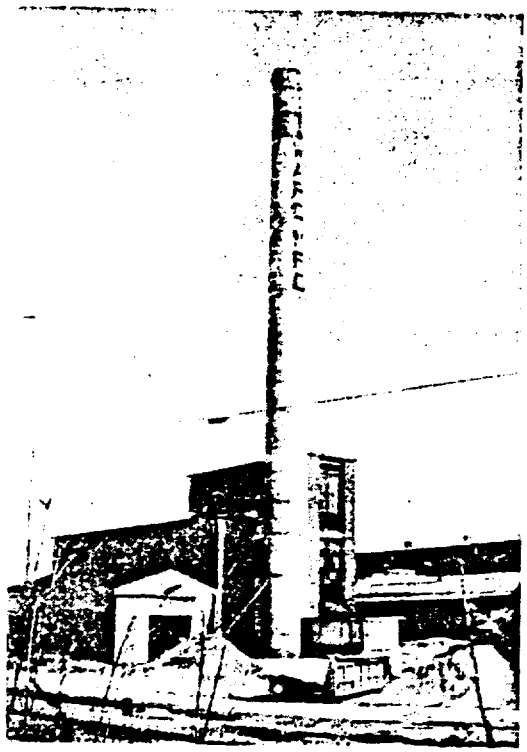
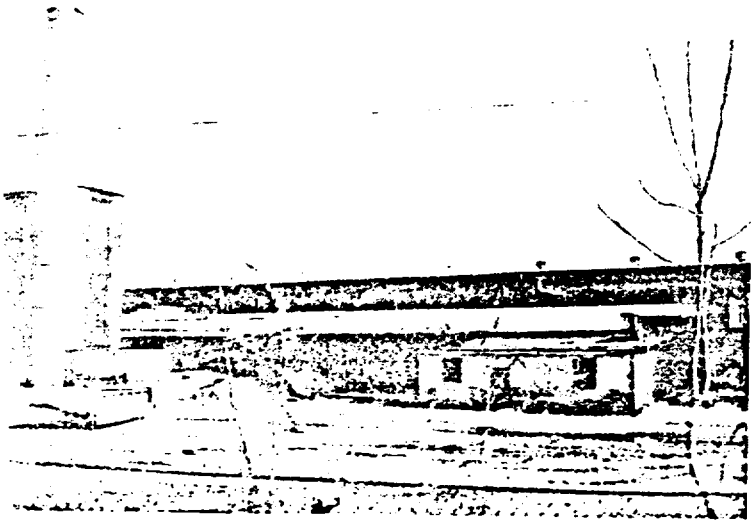
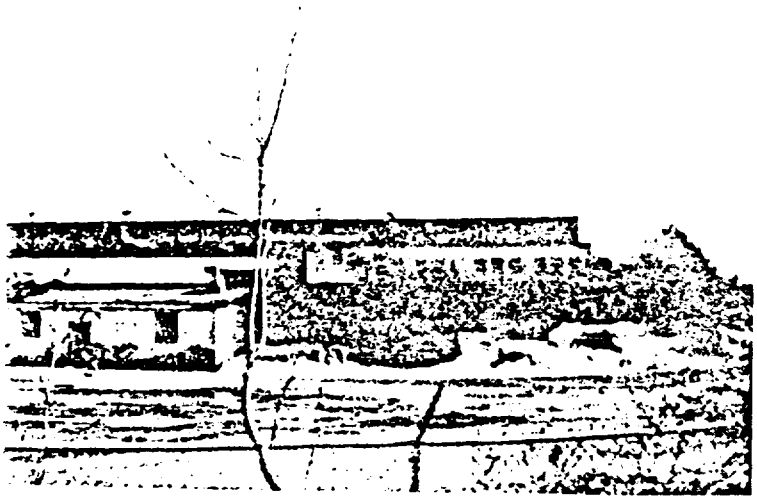


PHOTO 13: Similar to Photo 11 showing boiler building and the complete smoke stack.





PHOTOS 14 and 15: Viewing Northeast showing the old Ward Manufacturing Building with the Ford Building beyond.

PHOTO 16: Viewing north similar to Photo 1 view from the site gate on the south side.

APPENDIX B

PHOTO LOG

Chem-Dyne Site Remedial Investigation
Physical Inspection (Reconnaissance)
October 22-24, 1983

Team Members: L. Holm, J. Fleissner, B. Berggren

Background HNu reading: 0.2-0.3 ppm

GLT460/30

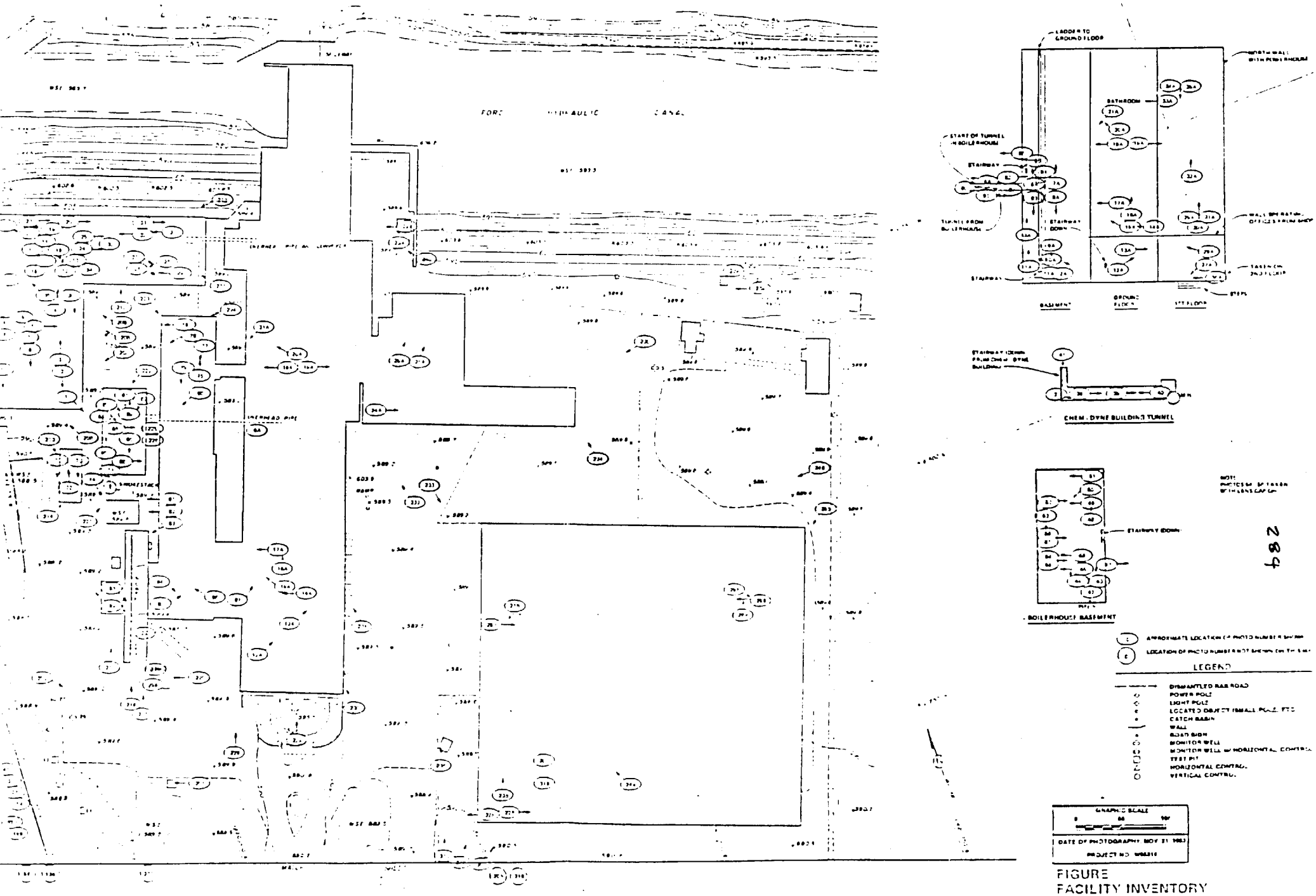


FIGURE
FACILITY INVENTORY
PHOTO LOCATION MAP SUBTASK 3-7
CHEM DYNE SITE

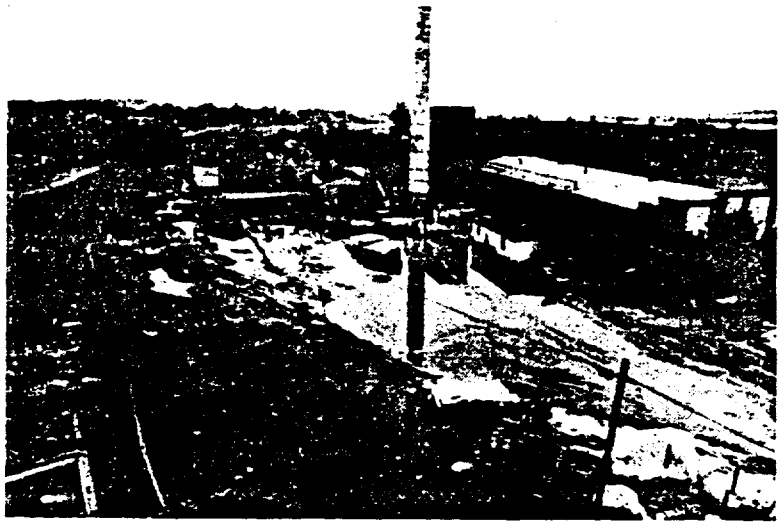
284

FACILITY INVENTORY

CHEM-DYNE OFFSITE

Friday, October 21, 1983

Team Members: Larry A. Holm, John T. Fleissner, Brad J. Berggren



Photos 1B, 2B, 2B, and 4B: Taken from northeastern corner of the Ransohoff building roof. The photos are a pan of the site from the north to the south [10-21-83].

Photo 2B: (See Photo 1)[10-21-83].

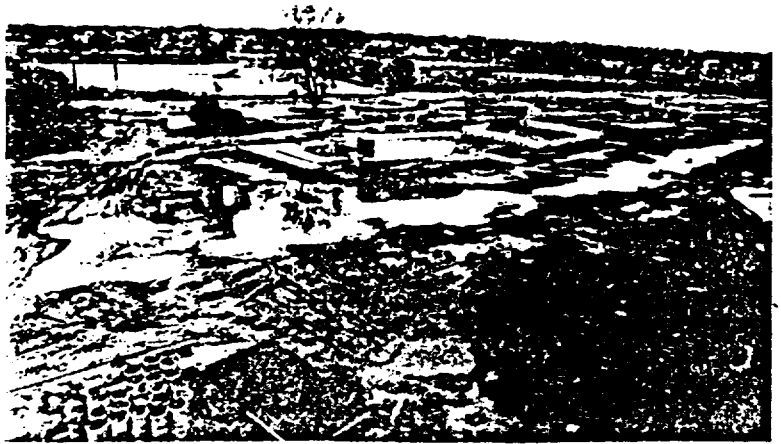


Photo 3B: (See Photo 1)[10-21-83].

Photo 4B: (See Photo 1) [10-21-83].

Photo 5B: Taken from the east central portion of the Ransohoff building roof. The view is toward the north and shows the onsite structures at the northern end of the site [10-21-83].

Photos 6B, 7B, 8B, 9B, 10B: Taken from the southeastern corner of the Ransohoff building roof, showing the structures and activities outside and adjacent to the southern boundary of the site. The photos pan from the north to the south [10-21-83].

Photo 7B: (See Photo 6) [10-21-83].

Photo 8B: (See Photo 6) [10-21-83].

Photo 9B: (See Photo 6) [10-21-83].

Photo 10B: (See Photo 6) [10-21-83].

Photo 11B: Taken from the same location as Photos 6 through 10. Shows the structures and activity at the northern end of the site and the area of the test well [10-21-83].

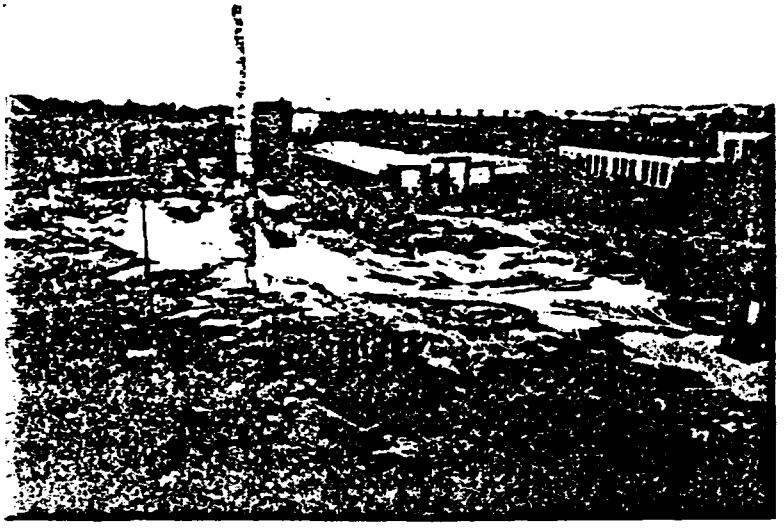


Photo 12B: Taken from the east central portion of the Ransohoff building roof. View looks toward the north and shows the structures and cleanup activities in that portion of the site [10-21-83].

Photo 13B: Taken from the same location as Photo 12, looking toward the southeast and shows the test well and pool construction for the pump test [10-21-83].

Photo 14B: Taken from the north end of the Ransohoff building roof, looking toward the north [10-21-83].

Photo 15B: Taken from the same location as Photo 14. View is toward the west and shows the close proximity of the Hamilton City power plant to the site [10-21-83].

Photo 16B: Shows a catch basin located approximately 35 feet southwest of the northwest corner of the Ransohoff building. HNu readings in the drain were less than 1.0 ppm [10-21-83].

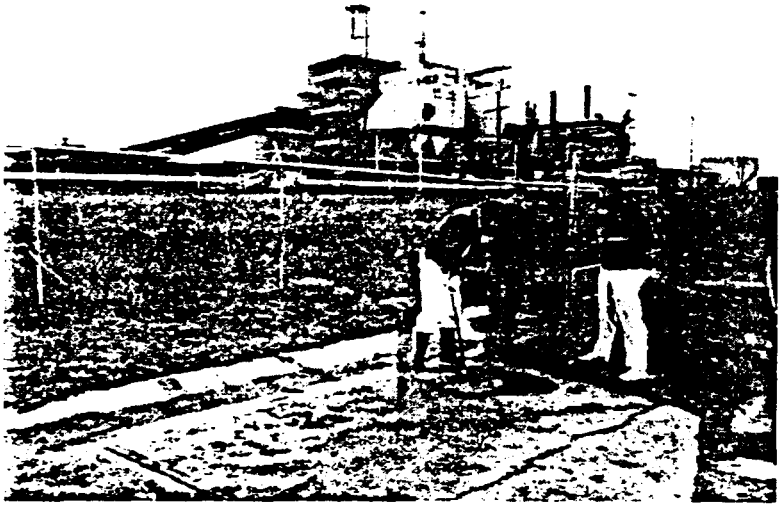


Photo 17B: Looks northwest at a metering vault located approximately 40 feet northwest of the northwest corner of the Ransohoff building. HNu readings in the vault were less than 1.0 ppm and the same as background readings [10-21-83].

Photo 18B: Looks north at a catch basin, which is approximately 8 feet northwest of the vault shown in Photo 17. The inlet is from the south and the outlet flows toward the manhole located north of the Ransohoff building. HNu readings in the basin are less than 1.0 ppm [10-21-83].

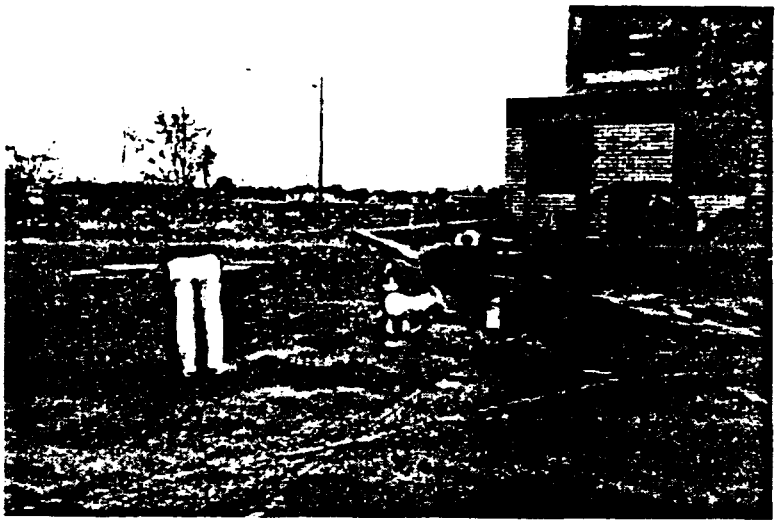


Photo 19B: Looks to the southeast toward a manhole located approximately 40 feet north of the Ransohoff building. HNu readings were 2.5 ppm in the manhole [10-21-83].

The following photos were taken in and around the blue warehouse which is located along the eastern site boundary.

Photos 20B and 21B: Looks north and shows the drum rings on the blue warehouse parking lot. The rings shown are approximately 30 feet north of catch basin 38 [10-21-83].

Photo 21B: (See Photo 20)[10-21-83].

Photos 22B and 23B: Taken from the southwest interior corner of the blue warehouse. Photo 22 views toward the east and Photo 23 views toward the north [10-21-83].

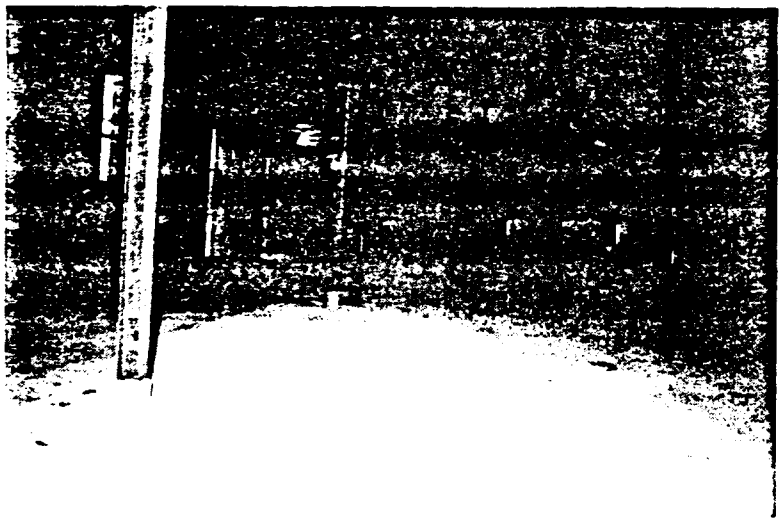


Photo 23B: (See Photo 22) [10-21-83].

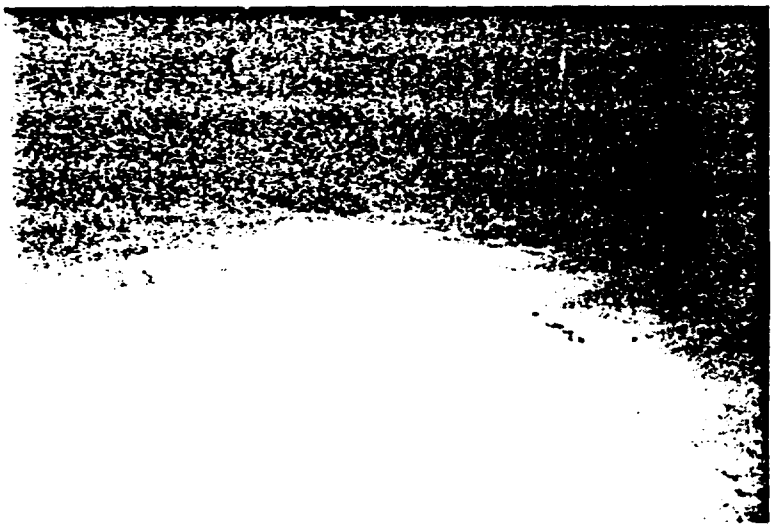
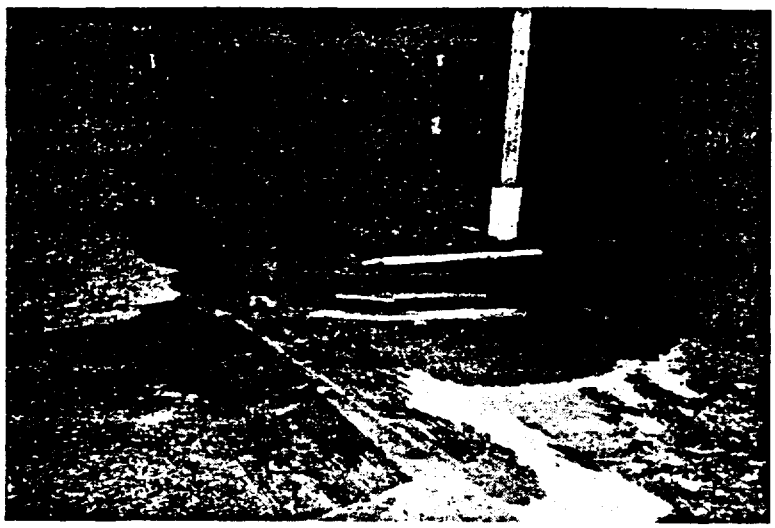


Photo 24B: Taken in south-central portion of the blue warehouse. Shows an ashy material on the floor. [10-21-83].



Photos 25B and 26B: Shows a catch basin located in the northeast corner of the blue warehouse. [10-21-83].

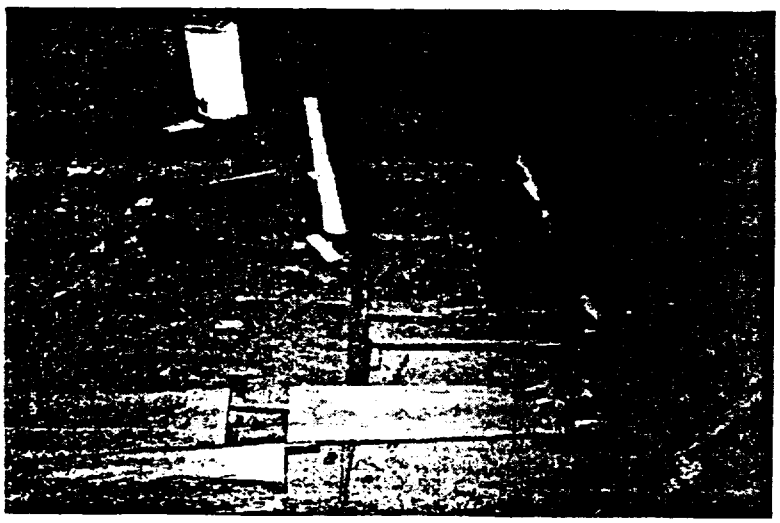
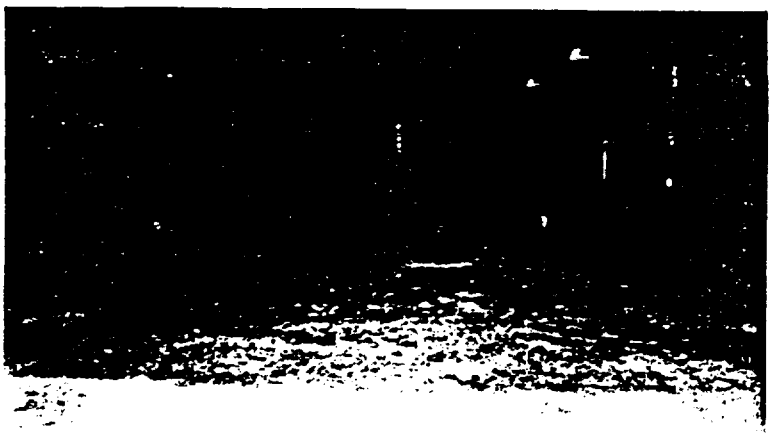


Photo 26B: (See Photo 25) [10-21-83].



Photos 27B and 28B: Shows a rectangular area in the western portion of the blue warehouse, that appears to be stripped of asphalt floor cover. [10-21-83]

Photo 28B: (See Photo 27B on preceding page) [10-21-83].

Photo 29B: Taken of the catch basin shown in Photos 25 and 26. HNu readings in the catch basin after stirring the contents were at background (0.4 ppm) [10-21-83].

Photos 30B and 31B: Taken in the southwest corner of the warehouse, showing drum rings contained in the ashy material on the floor [10-21-83].

Photo 31B: (See Photo 30) [10-21-83].

Photo 32B: Taken from the same location as Photos 22 and 23, looking toward the west at the western interior wall of the warehouse. Also, it shows the entrance through the southwest corner of the warehouse [10-21-83].

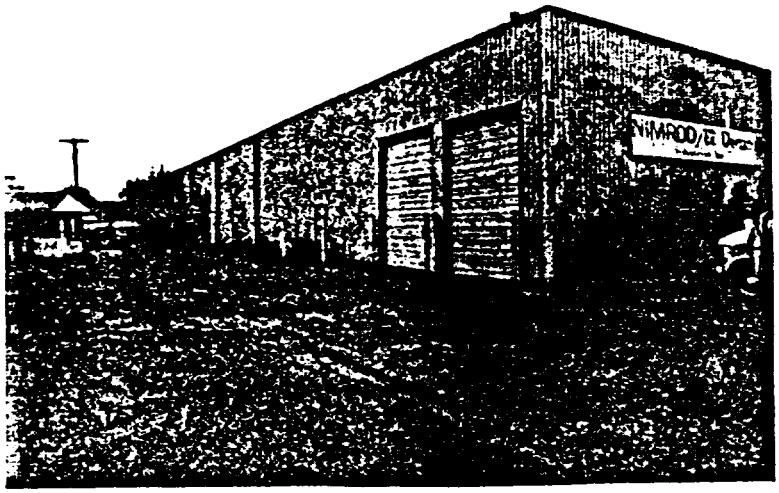


Photo 33B: Taken from the southwest corner of the warehouse. View is toward the north at the exterior of the west wall [10-21-83].

Photo 34B: Taken from the northeast corner of the warehouse. View is towards the west of the exterior of the north wall [10-21-83].

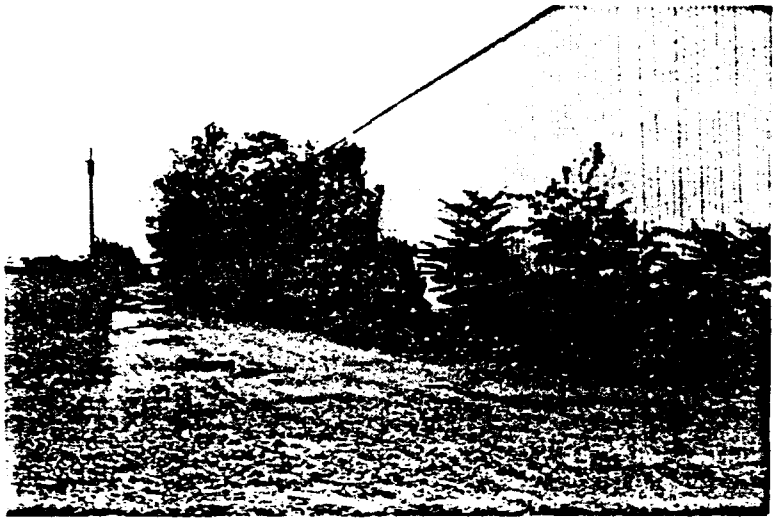


Photo 35B: Taken from the northeast corner of the warehouse. View is south along the exterior of the east wall [10-21-83].

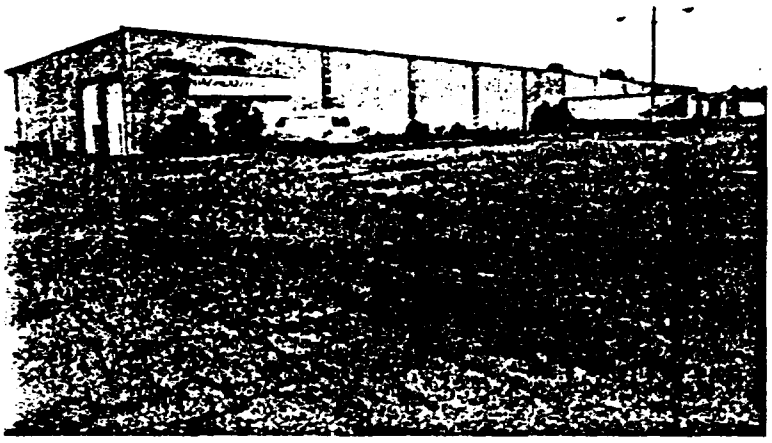


Photo 36B: Taken from the southwest corner of the warehouse. View is east along the exterior of the south wall [10-21-83].

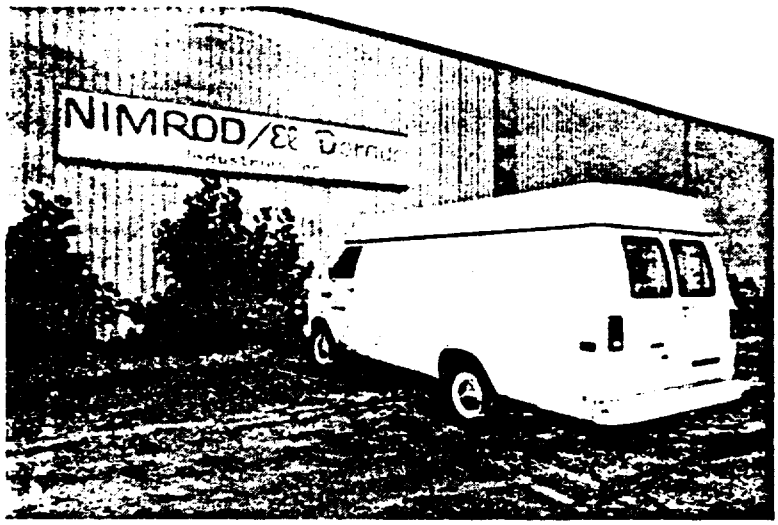


Photo 37B: Taken from th
southwest corner. Shows
southwest corner of the b
warehouse [10-21-83].

GLT442/12

ONSITE

FACILITIES INVENTORY

CHEM-DYNE SITE

October 22-24, 1983

Team Members: L. Holm, J. Fleissner, B. Berggren

Background HNu reading: 0.2-0.3 ppm

GLT442/10

Photo 1: Interior of the restroom in the southeast corner of the Chem-Dyne Building [10-22-83].

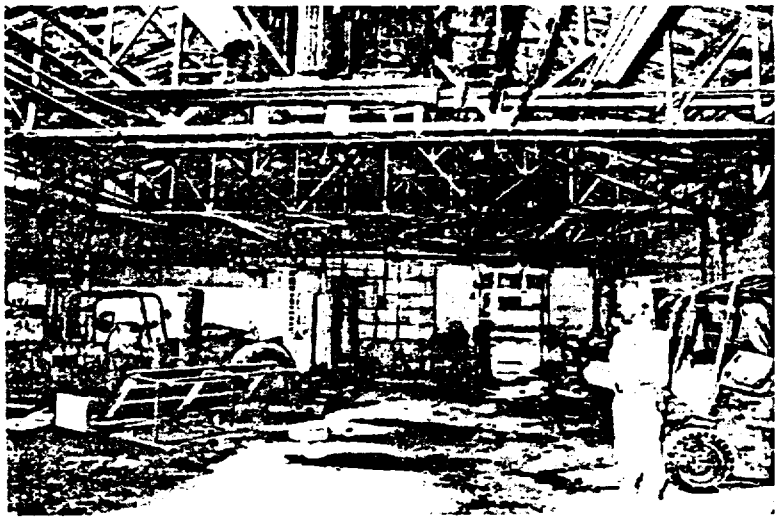


Photo 2: Viewing south showing the eastern half of the Chem-Dyne Building [10-22-83].

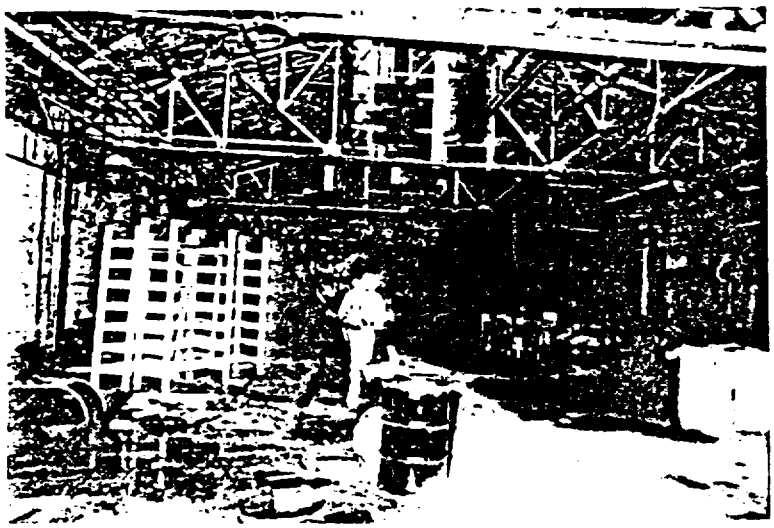


Photo 3: Viewing north showing the eastern half of the Chem-Dyne Building [10-22-83].

Photo 4: The east side of the Chem-Dyne Building showing the sample storage associated with O.H. Materials. HNu background readings in the Chem-Dyne Building are from 0.4 to 0.6 ppm [10-22-83].

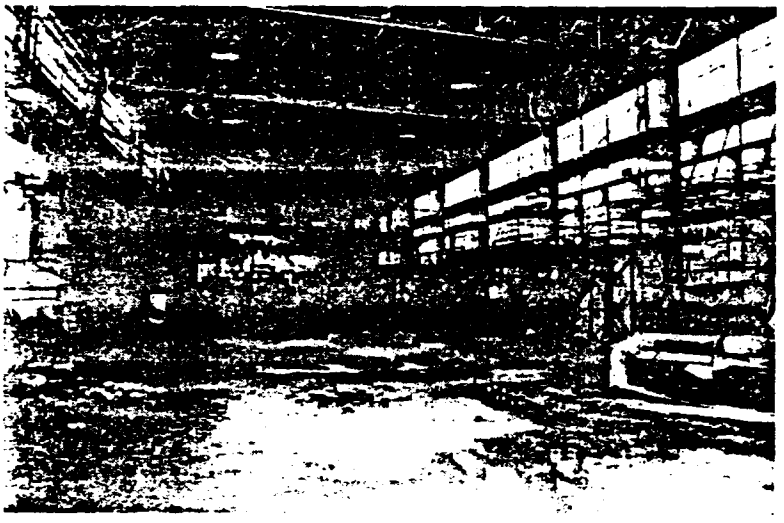


Photo 5: Taken from the northwest half of the Chem-Dyne Building viewing south [10-22-83].

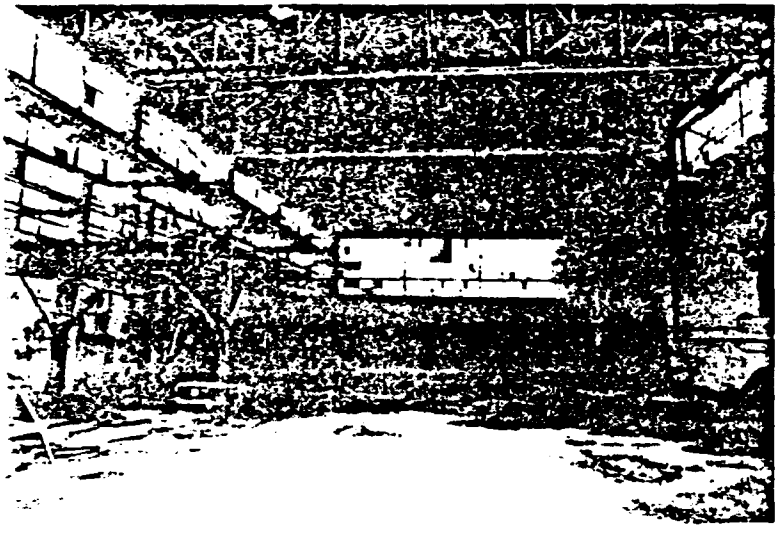


Photo 6: Taken from the southwest half of the Chem-Dyne Building viewing north [10-22-83].

Photos 7 and 8: Taken in southwest half of the Chem-Dyne Building viewing southwest at the southwest corner [10-22-83].

Photo 8 (See Photo 7) [10-22-83].

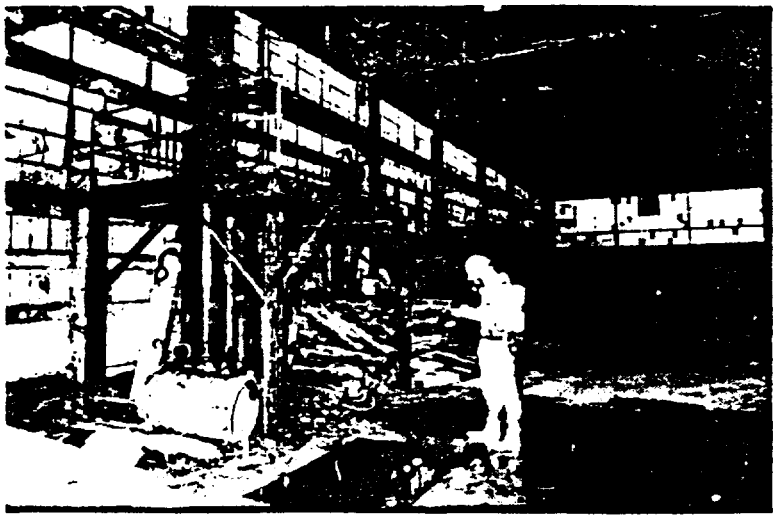


Photo 9: The western half of the Chem-Dyne Building where some mixing tanks were supported on platforms against the outside wall [10-22-83].

Photo 10: The western half of the Chem-Dyne Building viewing toward the interior wall, which separates the two halves, showing miscellaneous debris lying on the floor [10-22-83].

Photo 11: THe western hal. of the Chem-Dyne Building looking south toward the south wall, showing the standing water, the dye i the water, and condition of the building [10-22-83].

Photo 12: The eastern side of the Chem-Dyne Building just beyond the east-west trending dividers, viewing north, showing the office areas [10-22-83].

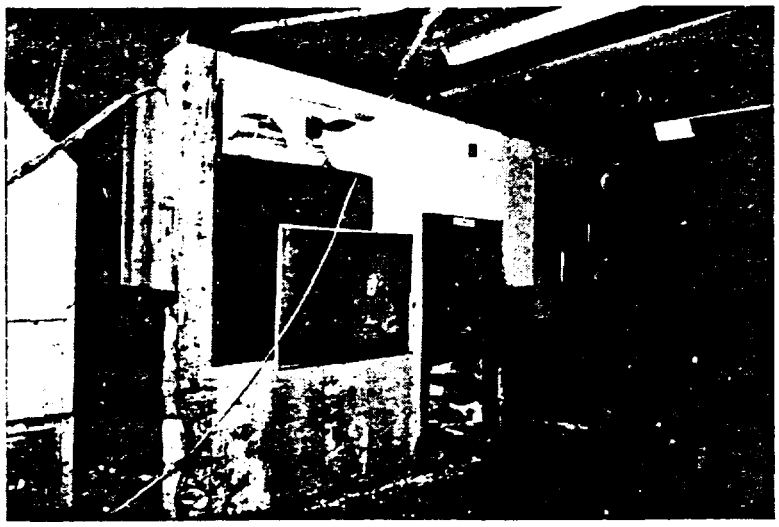
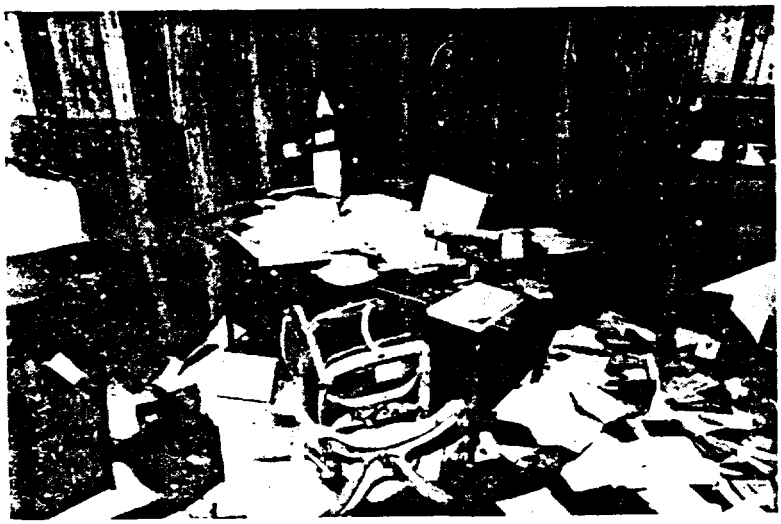


Photo 13: A closeup of the offices located in the northern end of the Chem-Dyne Building. The two-room office shown in Photo 15 contains papers, boxes, desks, and other office supplies [10-22-83].



Photos 14, 15 and 16: Shots of the interior of the northernmost office on the north half of the Chem-Dyne Building [10-22-83].

Photo 15: (See Photo 14 [10-22-83).

Photo 16: (See Photo 14 on preceding page) [10-22-83].

Photos 17 and 18: Interior of the adjacent office immediately south of previous photos. In both of these offices are file cabinets filled with papers relating to Spray-Chem Corporation, and other items associated with Chem-Dyne [10-22-83].

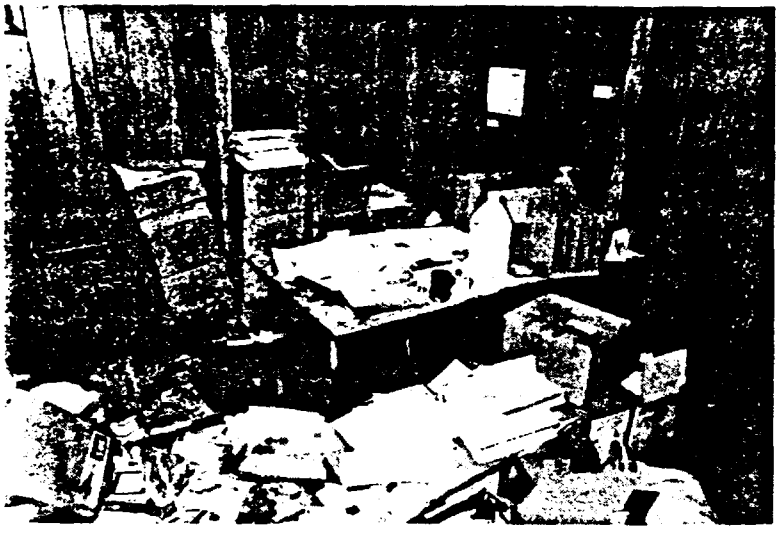


Photo 18: (See Photo 17) [10-22-83].

Photo 19: Taken in the northernmost half of the Chem-Dyne building just north of the two offices previously photographed [10-22-83].

Photo 20: Taken from the same location as Photo 19 viewing east along the northernmost wall of the Chem-Dyne building [10-22-83].

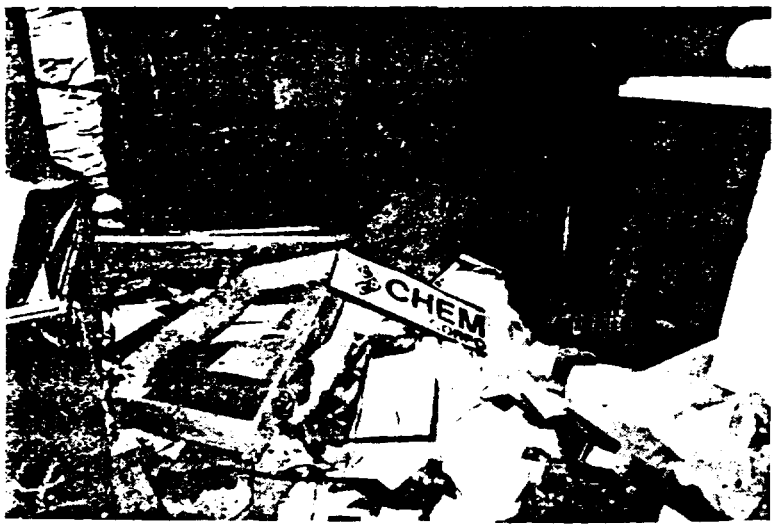


Photo 21: A small room at the northwest corner of the Chem-Dyne building [10-22-83].

Photo 22: A small room located just to the east of the room shown in Photo 21 [10-22-83].

Photo 23: The empty office of the small room located just to the east of Photo 21 [10-22-83].

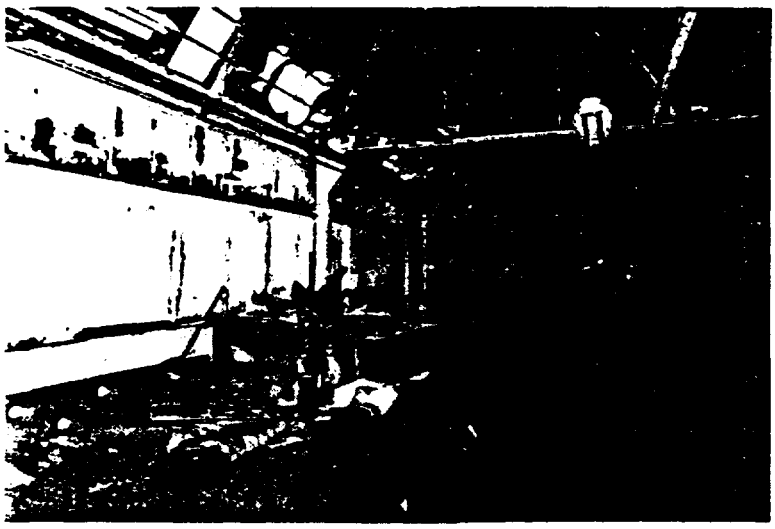


Photo 24: Photo taken just outside the two offices of the Chem-Dyne building viewing east along the northeast half of the Chem-Dyne building [10-22-83].

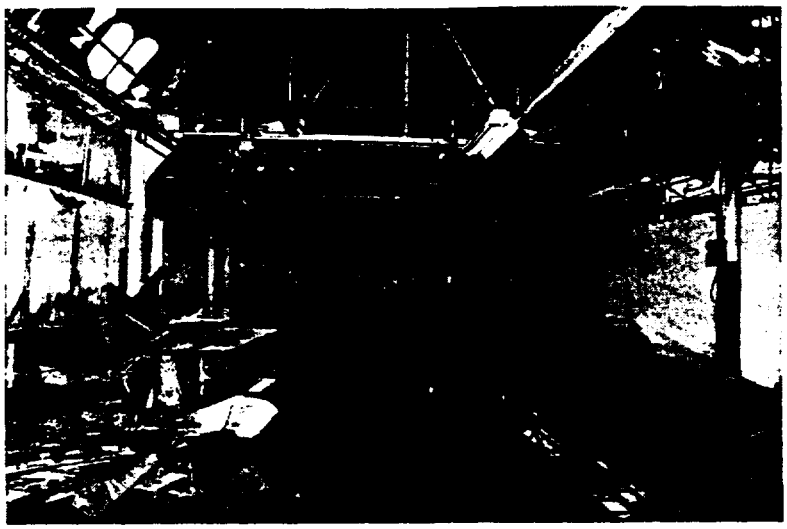


Photo 25: View in the same direction as Photo 24 [10-22-83].

Photo 26: Taken in the northeast wing of the Chem-Dyne building. It shows the condition of the portion of the building which was structurally damaged during fire April 1983 [10-22-83].

Photos 27 and 28: Taken of the eastern portion of the northeast wing of the Chem-Dyne building looking southeast, showing structural components of the building [10-22-83].

Photo 28: (See Photo 27 on preceding page) [10-22-83].

Photo 29: Photo from near the eastern wall of the northeast wing looking west showing the overhead beams and the structural damage caused by the fire [10-22-83].

Photo 30: Taken in the northeast wing of the Chem-Dyne building viewing east. Photo shows the stairway leading to a small room located just above the main floor of the northeast wing [10-22-83].

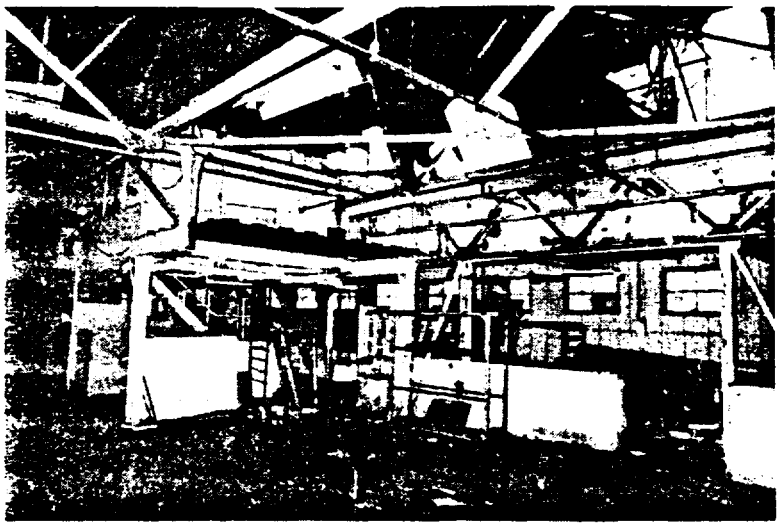


Photo 31: Photo in the same area as Photo 30, except from a position near the eastern wall of the northeast wing [10-22-83].

Photo 32: Taken in the northeast wing of the Chem-Dyne building viewing west along the northernmost wall of this wing [10-22-83].

Photo 33: Taken along the northernmost wall of the northeast wing viewing east [10-22-83].

Photo 34: Taken along the narrow hallway looking toward the east in the northeast wing of the Chem-Dyne building and showing a portion of the building damaged by the fire [10-22-83].

Photo 35: The stairway leading down to the tunnel of the Chem-Dyne building along the east wall of the southeast section [10-22-83].

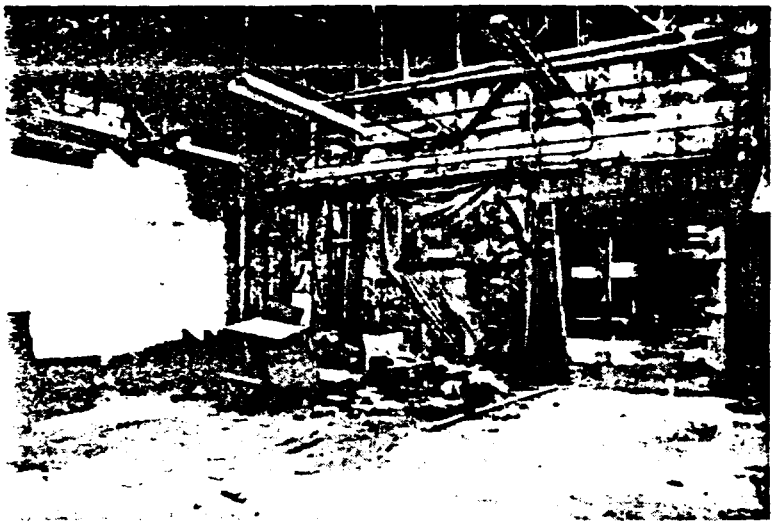


Photo 36: The north wall of the southeast section of Chem-Dyne building, the area immediately west of sample storage area shown in Photo 4. [10-22-83].

The next series of photos will be taken descending into the tunnel of the Chem-Dyne Building.

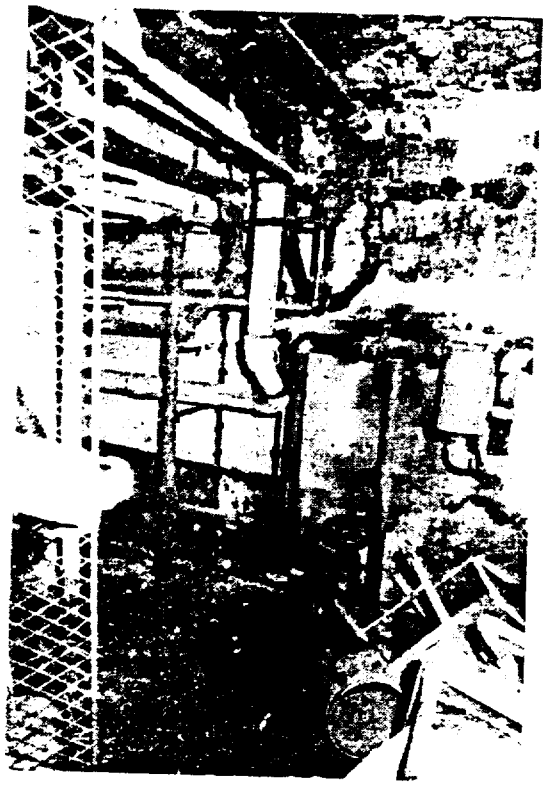


Photo 37: Taken directly at the entrance to the tunnel shown in Photo 36 [10-22-83].

Photo 38: Taken at the start of the tunnel which runs east-west and appears to run about 50 feet to a manhole [10-22-83].

Photo 39: Taken in the tunnel viewing east, about midway through the tunnel [10-22-83].

Photo 40: Taken at the intersection of the tunnel with the manhole where the tunnel ends, looking west down the tunnel back toward the Chem-Dyne building [10-22-83].

Photo 41: The stairway leading to the tunnel from the Chem-Dyne building [10-22-83].

Photo 42: Taken after descending a stairway along the east interior wall of the boiler house building. The photo is a shot of piping or conduit penetrations in the southern basement wall of the boiler house with multi-colored fluids slowly flowing out. HNu readings in the pipe/conduit were 150 to 170 ppm [10-22-83].

Photos 43 and 44: In the basement taken from the south end of the boiler house viewing north, at the northeast half of the boiler house basement [10-22-83].

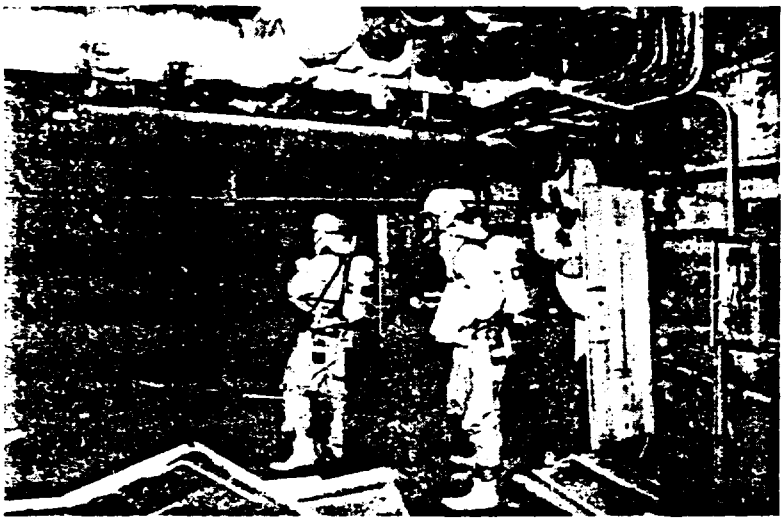
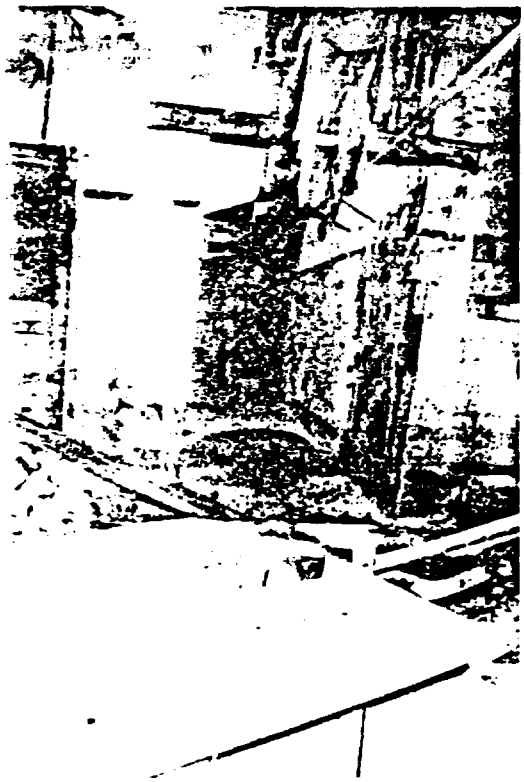


Photo 44: (See Photo 43)[10-22-83].



Photos 45 and 46: View toward the west, down a passageway connecting the east and west half of the basement [10-22-83].

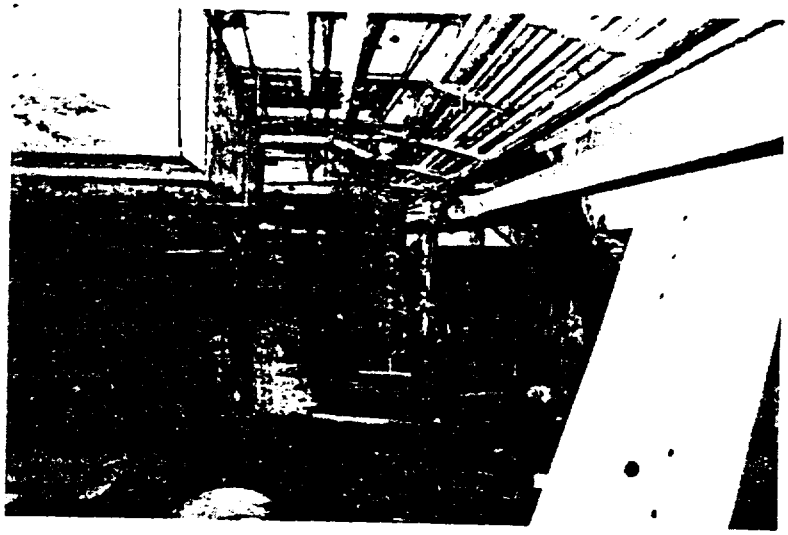


Photo 46: (See Photo 45 on preceding page) [10-22-83].

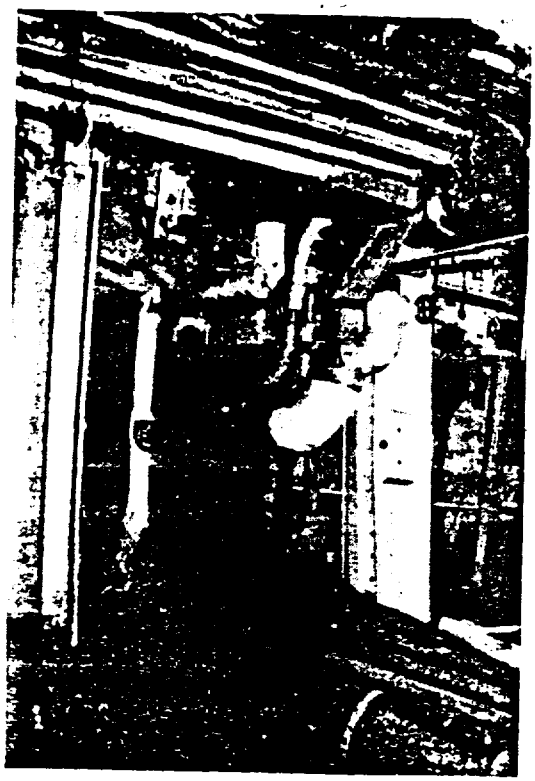
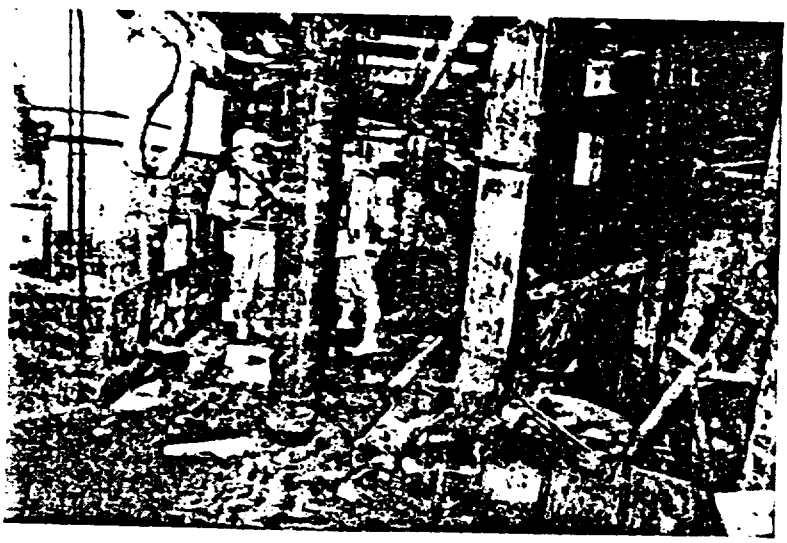


Photo 47: From the east half of the boiler house basement viewing east down a tunnel which goes in the direction of the Ford Building. Background readings with the HNu in the basement are about 0.6 ppm [10-22-83].



Photos 48 and 49: Taken from the northeast corner of the boiler house basement. Photo 48 is viewing east toward a water-filled volume apparently below the basement level. Photo 49 is to the north, showing the north basement wall of the boiler house [10-22-83].

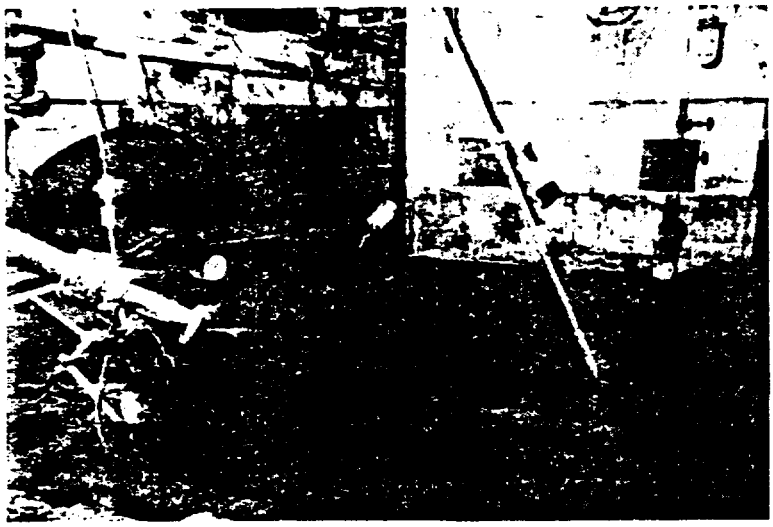


Photo 49: (See Photo 48 on preceding page)[10-22-83].

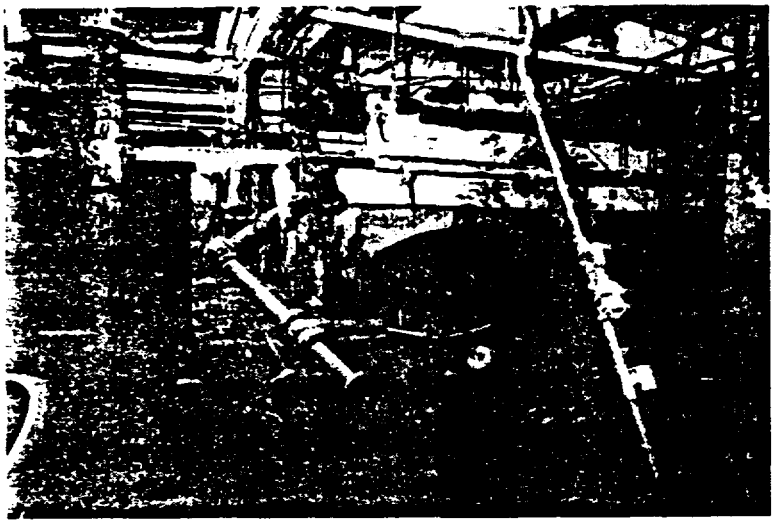


Photo 50: Taken from the same location, northeast corner of the boiler house basement viewing southwest across the flooded portion of the basement [10-22-83].

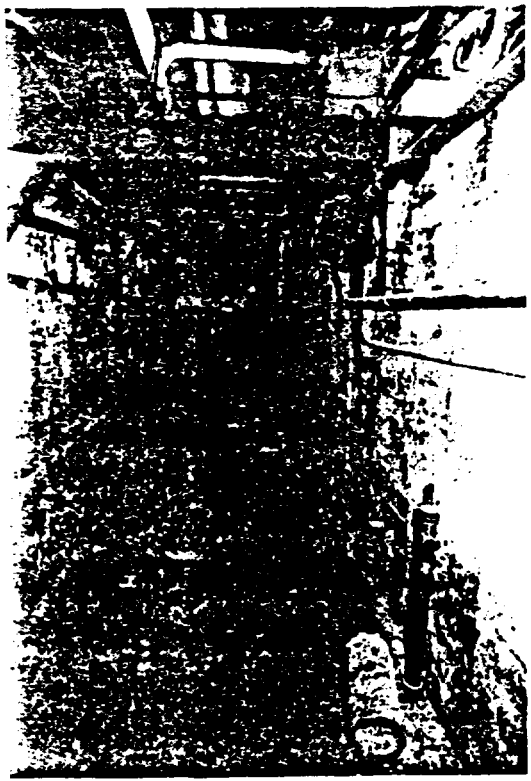
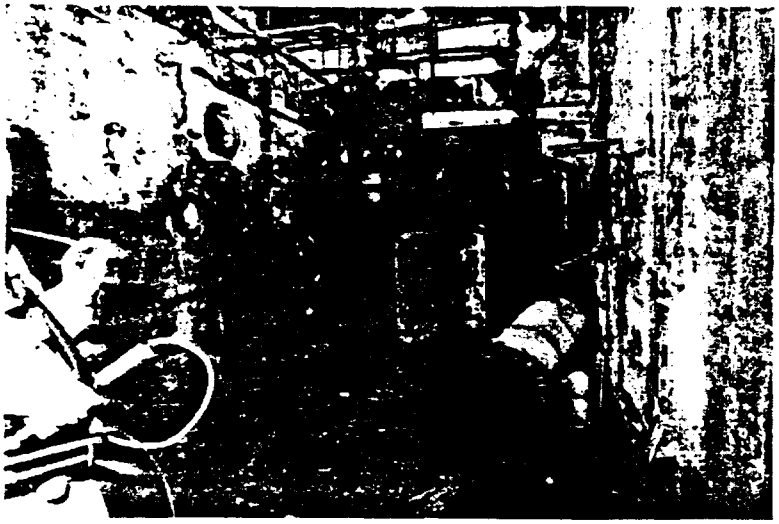
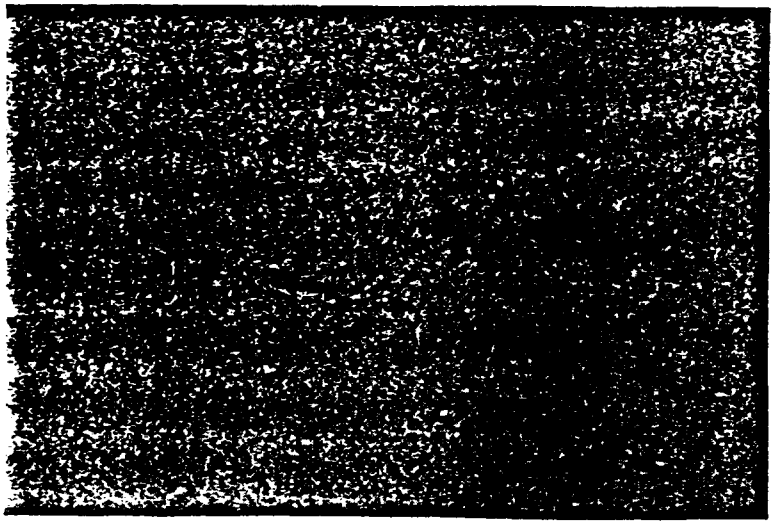


Photo 51: From the northeast corner of the boiler house basement viewing toward the west along the north wall of the basement [10-22-83].



Photos 52 and 53: Taken from the central portion of the west wall of the boiler house building. Photo 52 views east through a passageway connecting the east and west sides of the basement. Photo 53 views south along the west wall of the boiler house basement [10-22-83].

Photo 53: (See Photo 52) [10-22-83].



Photos 54 and 55: Photos of the southernmost of two vaults located along the western half of the boiler house basement [10-22-83].

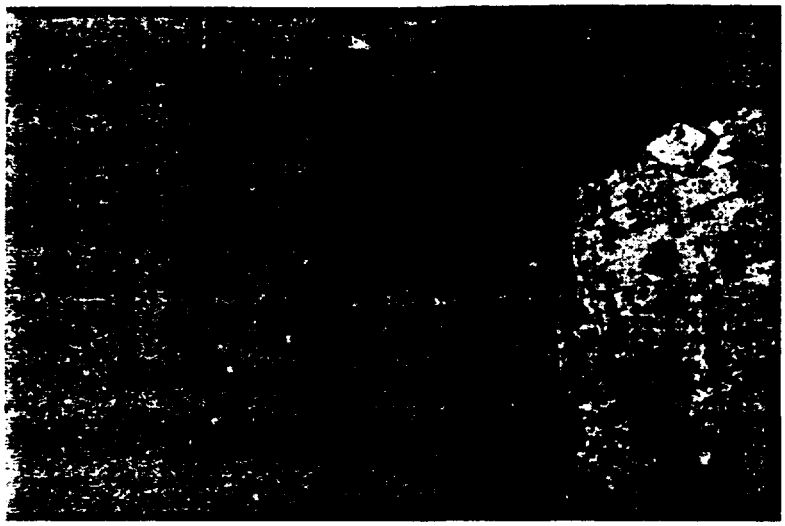


Photo 55: (See Photo 54 on preceding page) [10-22-83].

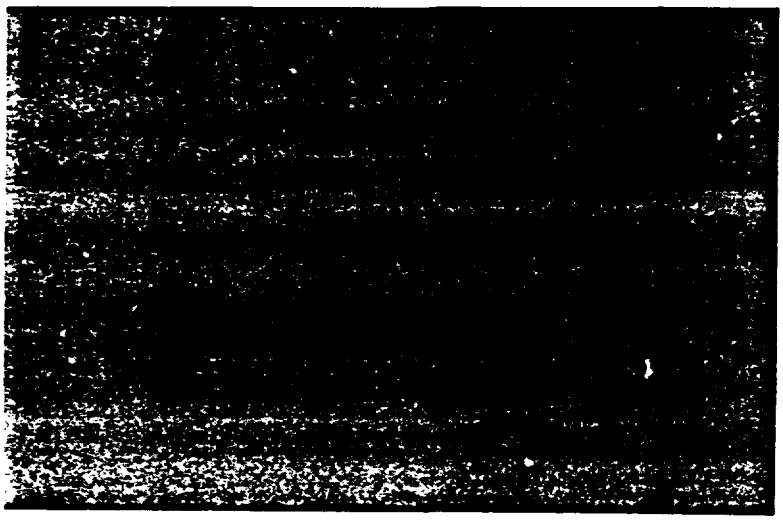


Photo 56: Photo of the northernmost of the two vaults located in the boiler house basement [10-22-83].

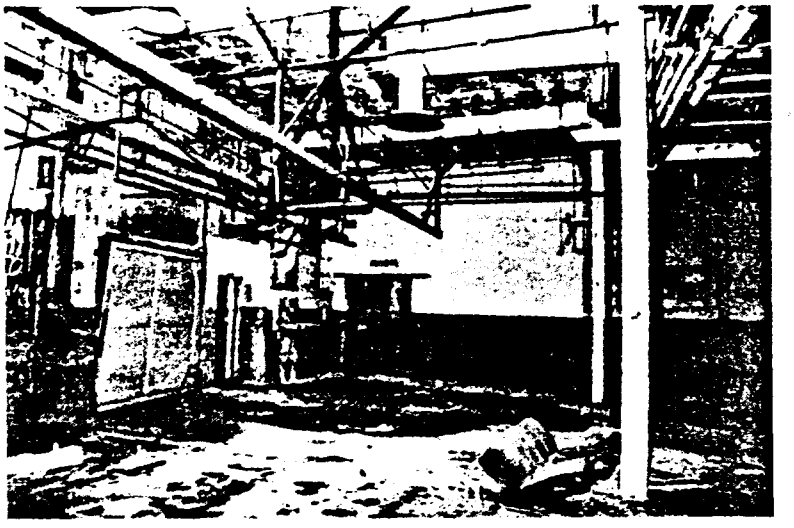


Photo 79: Taken from midway in the interior of the northern portion of Building C viewing toward the south and the wall dividing the building into several portions [10-24-83].

Photo 80: Taken from the doorway which is labeled on the wall above as "Room 2" viewing southwest into the small room. This doorway is located in the northern porton of Building C. South along the eastern wall of Building C through the interior is a third room labeled "Room 3." The rooms are empty. No photo. The southern portion of Building C along the west wall is through a doorway labeled "Room 4." Building C appears to be primarily concrete block construction with numerous rooms dividing it from the northern portion to the southern portion. The southern portion appears to be more highly divided.

Photos 81 and 82: Taken in the southern portion of Building C along the western portion of that building showing a room used for storage of plastic bottles and other various supplies for manufacturing [10-24-83].

Photo 82: (See Photo 81)[10-24-83].

Photo 83: A room just south of Photos 81 and 82 showing storage rooms with plastic bottles used for manufacturing [10-24-83].

Photo 84: Taken in the southern portion of Building C from the western wall viewing southeast toward offices located the southern wall of Building C [10-24-83].

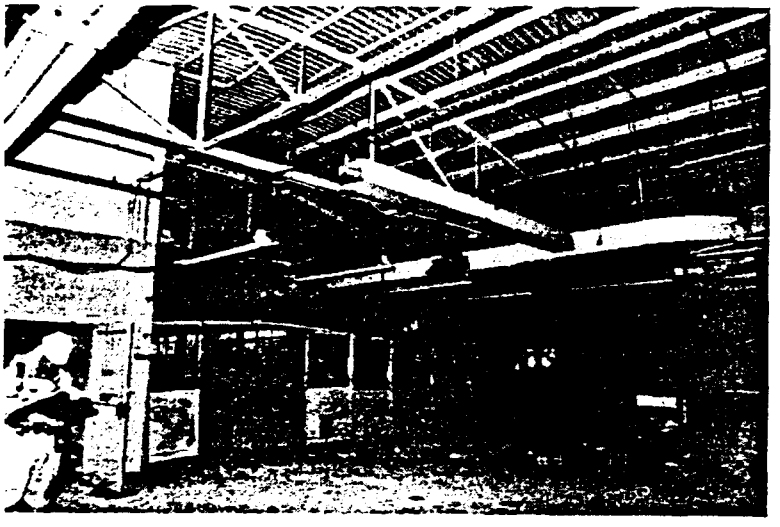
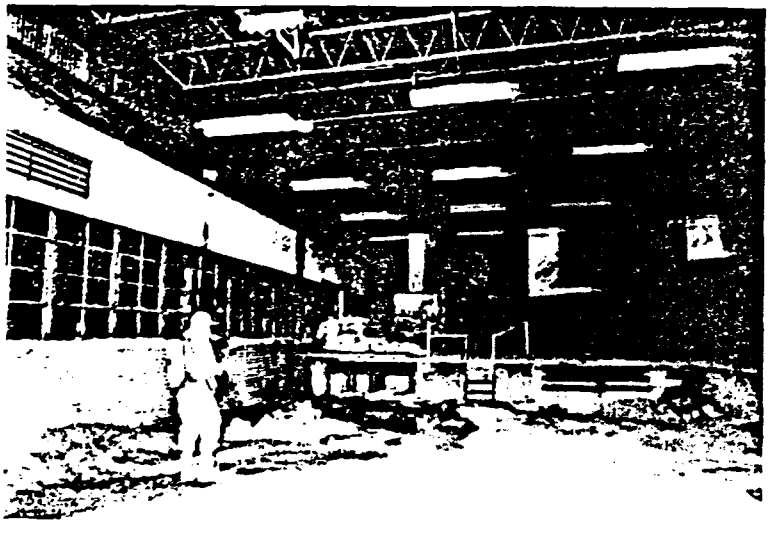


Photo 85: Taken from the southwest corner of the building viewing northeast and showing the super-structure [10-24-83].



Photos 86 and 87: Taken from the southern entryway into a loading dock located between Building C and Building A noted on the map as the loading dock. Photo 86 views northwest; Photo 87 views northeast [10-24-83].

Photo 87: (See Photo 86 on preceding page)[10-24-83].

Photos 88 and 89: Taken in a small shed located along the western wall of the coal bin approximately midway between the northern and southern ends. Photo 88 was taken from the north end of the shed, which is the south wall. Photo 89 is from the south wall or what remains of it, viewing north, looking at the interior [10-24-83].

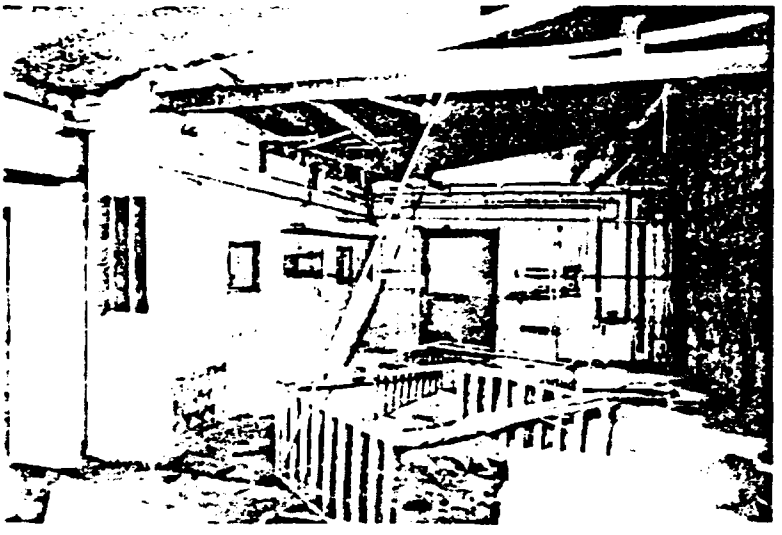


Photo 89: (See Photo 88)[10-24-83].

The next series of photos will begin from the boiler house basement, progressing through the tunnel which appears to connect to the Ford Building. The photographs will start at the west end of the tunnel, progressing towards the east.

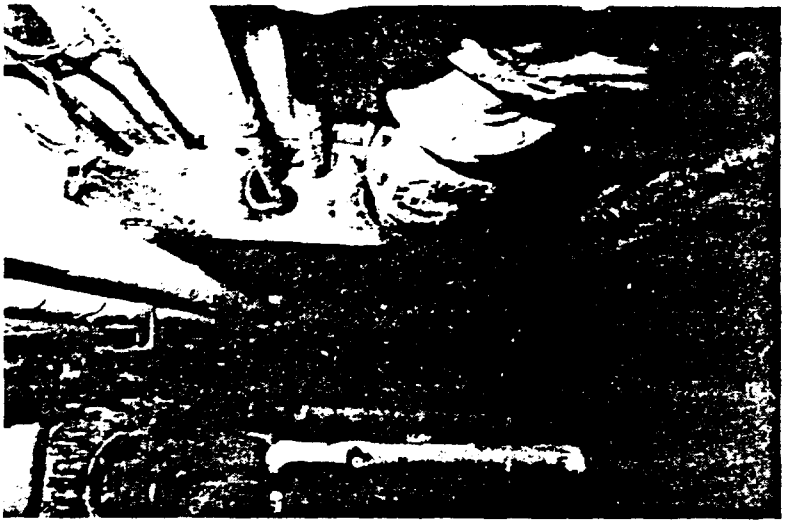


Photo 90: A photo viewing toward the east down the tunnel from its beginning on the east side of the boiler house basement [10-24-83].

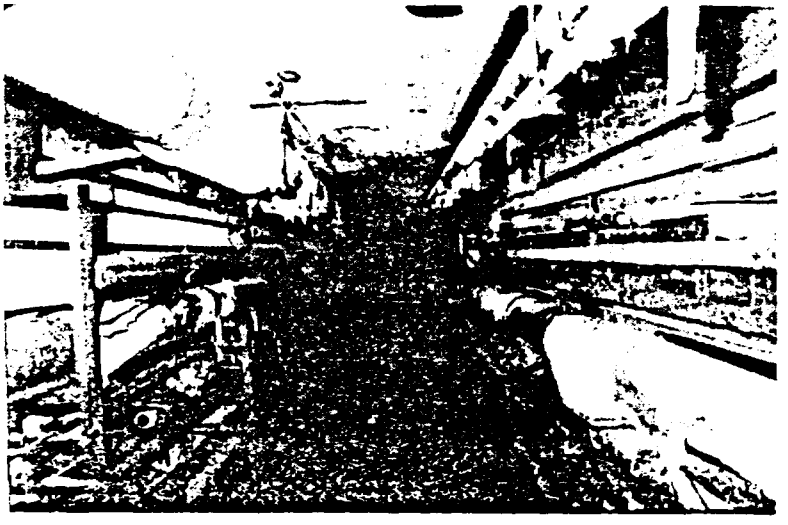


Photo 91: About 50 feet down the tunnel, again looking east down the tunnel [10-24-83].

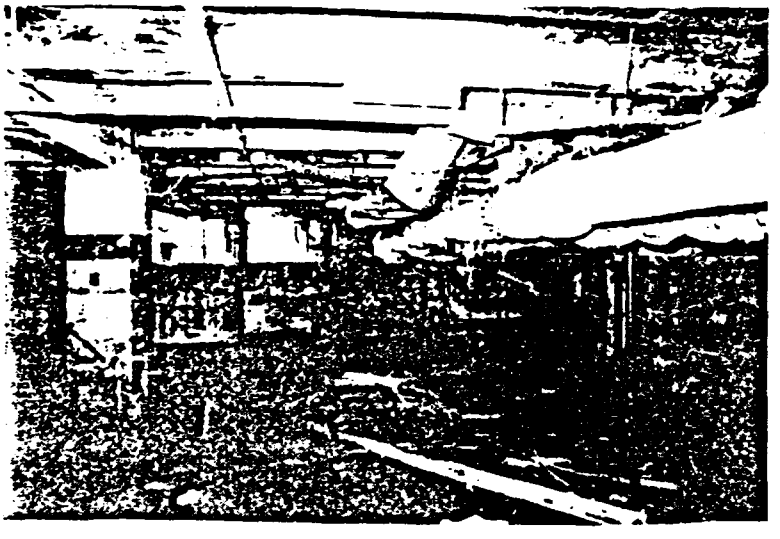


Photo 92: Within what appears to be the intersection between the basement of the Ford Building and the tunnel. The photo views toward the east northeast [10-24-83].

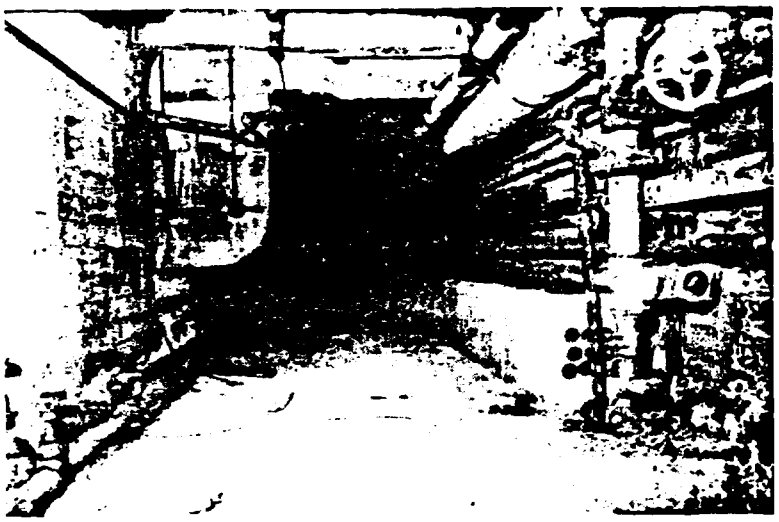


Photo 93: Taken approximately 60 feet east of the entrance between the tunnel and the basement area. The photo views toward the south and the tunnel continuing southward. The distance that the tunnel continues is unknown [10-24-83].

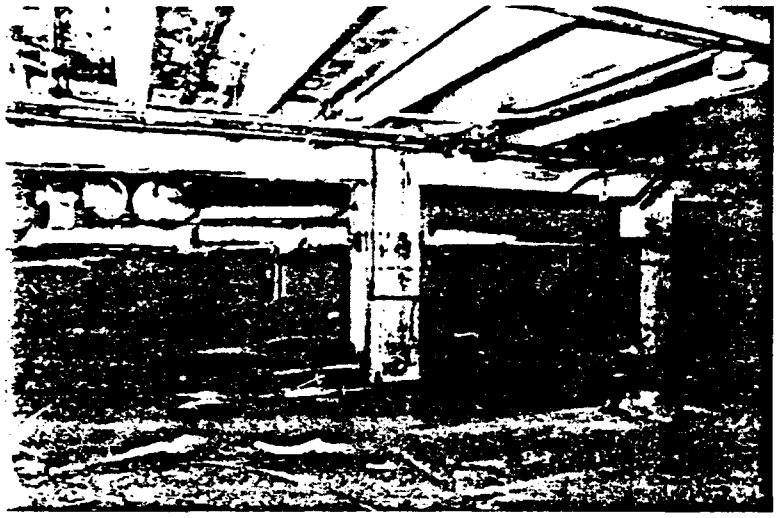


Photo 94: Taken from the basement area, approximately the northeast portion of it. The photo views toward the south wall of the basement area [10-24-83].

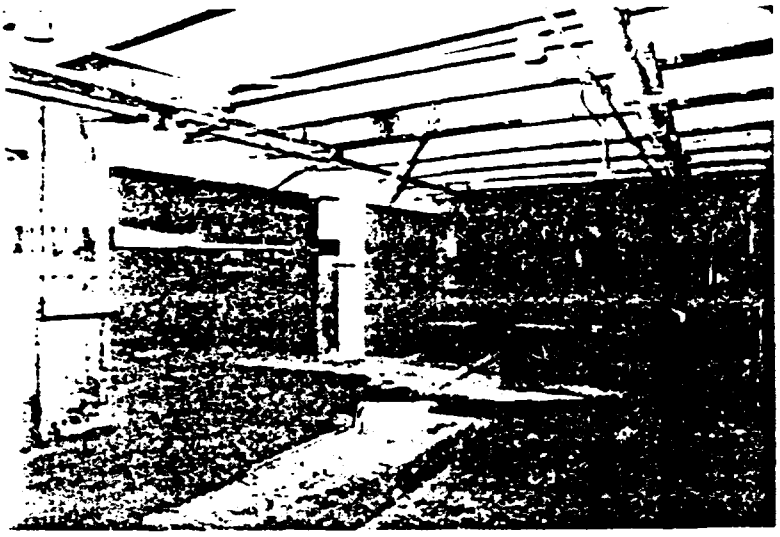


Photo 95: Taken from the same position looking toward the southwest, showing the piping and wall structures in the basement area [10-24-83].

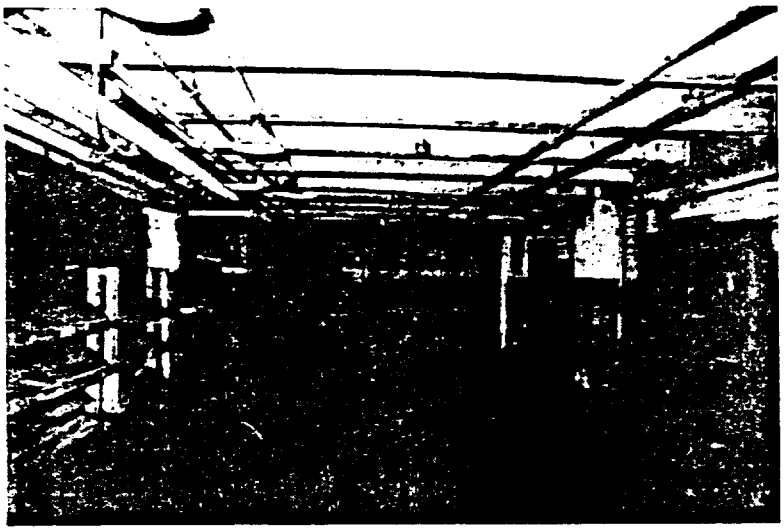


Photo 96: Taken from the same area as Photo 95 but viewing toward the west [10-24-83].

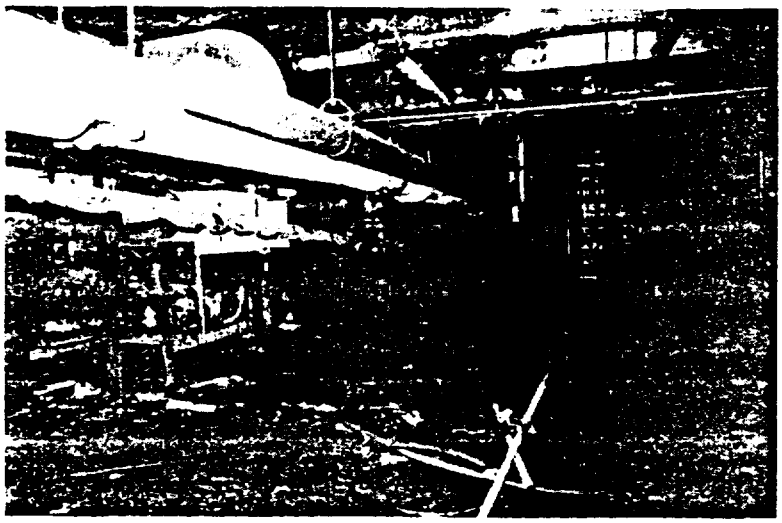


Photo 97: Taken from the central area of the basement where it intersects with the tunnel. This photo views back toward the west and the entranceway to the tunnel. To the north of where the tunnel intersects the basement area, approximately 40 feet, is a stairway, which ascends to the western wall of the Ford Building.

The following sequence of photos will be numbered starting with 1A. The photos are taken in the basement of the Ford Building. Entry into the gallery below the Ford Building is through a stairway in the southern portion of the building.

Photo 1A: Taken at the bottom of the stairs facing north down the utility gallery [10-24-83].

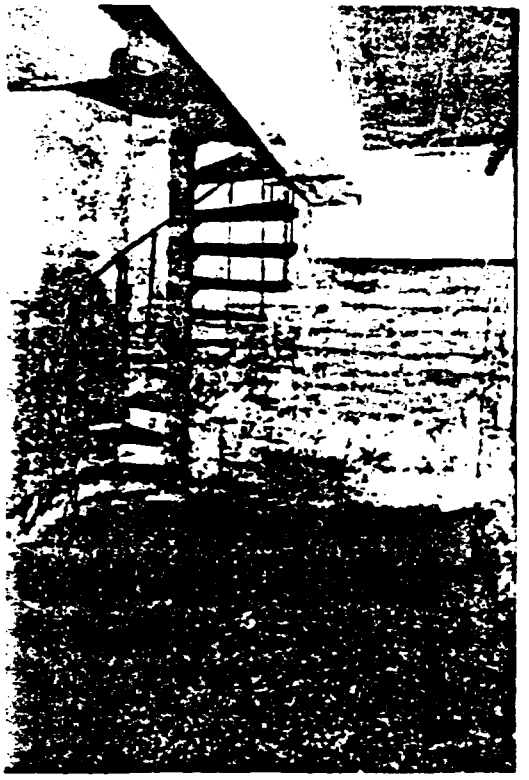


Photo 2A: Viewing back at the spiral staircase leading up to the ground floor of the Ford Building [10-24-83].

APPENDIX B
PHOTO LOG

ONSITE
FACILITIES INVENTORY
CHEM-DYNE SITE
Wednesday, November 2, 1983

Team Members: Larry Holm, Brad Berggren

The following photographs are taken of the exteriors of the Chem-Dyne site buildings. They are numbered beginning with number 201.

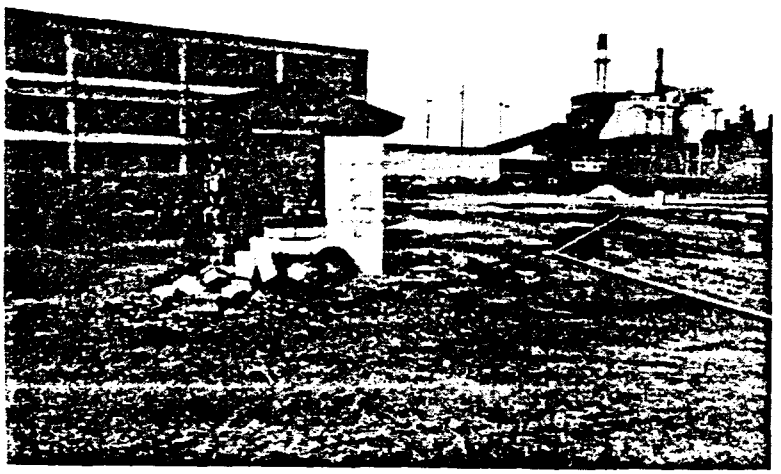


Photo 201: Viewing to the west at the Scale Building located at the southern portion of the facilities onsite. Right hand portion of the picture is the scale pit [11/2/83].

Photo 202: Viewing east at a tank semi-buried in the gravel with wooden covers constructed by O.H. Materials [11-2-83].

Photo 203: Showing the south wall of the Chem-Dyne Building taken from the southern extent of the loading docks leading into the southern portion of the Chem-Dyne Building [11-2-83].

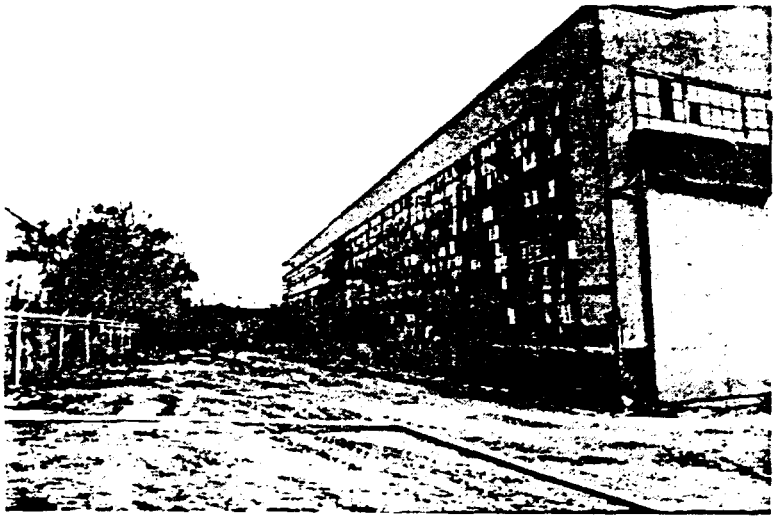


Photo 204: Taken from the southwest corner of the Chem-Dyne Building. The photo views north showing the western wall of the building exterior [11-2-83].

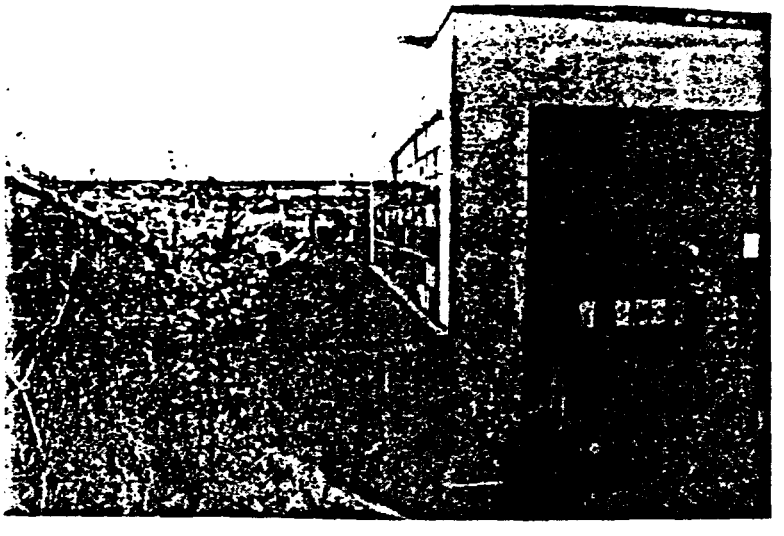


Photo 205: Taken from the top of the levy located at the northwest corner of the Chem-Dyne Building. The view is east and shows the exterior of the north wall of the building [11-2-83].

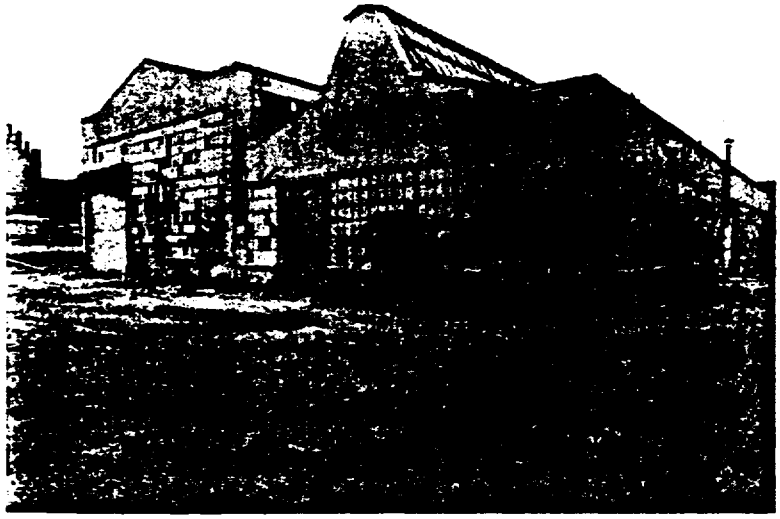


Photo 206: Taken from the southeast corner of the Chem-Dyne Building. Photo views toward the west and shows the exterior of the southern wall of the building [11-2-83].

Photos 207, 208, 209 and 210: Taken from the central portion of the east wall of the Chem-Dyne Building, panning from the south toward the north, showig the exterior of the building on the east side [11-2-83].

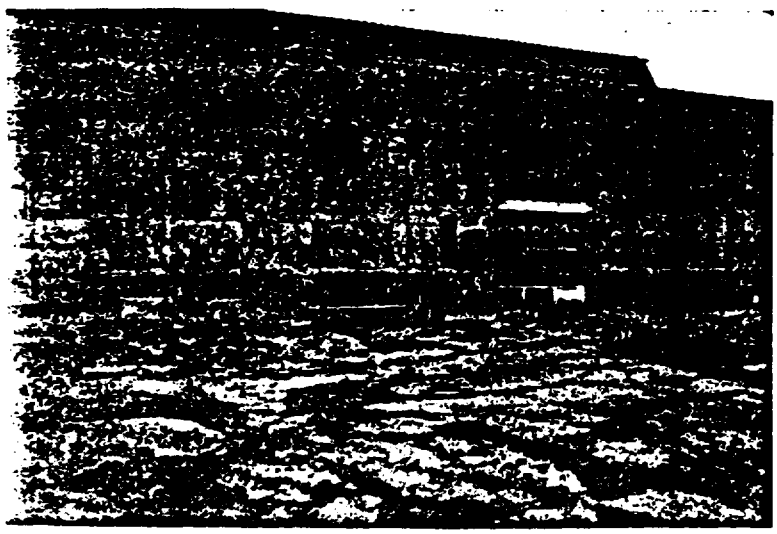


Photo 208: (See Photo 207)[11-2-83].

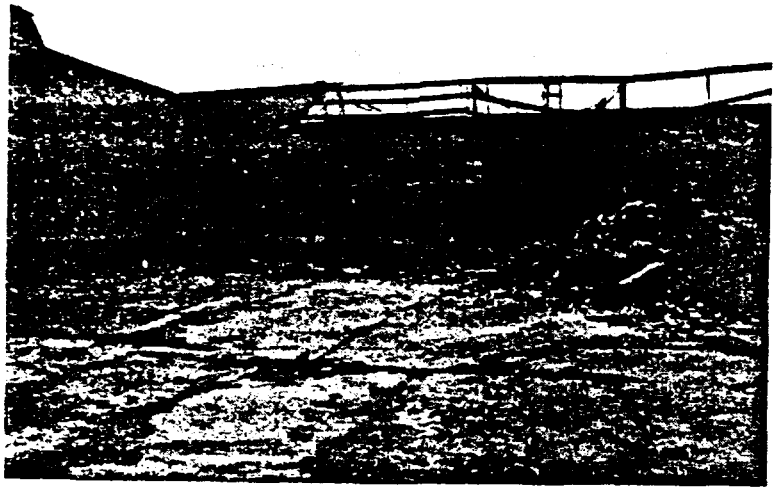


Photo 209: (See Photo 207 on preceding page) [11-2-83].

Photo 210: (See Photo 207 on preceding page) [11-2-83].

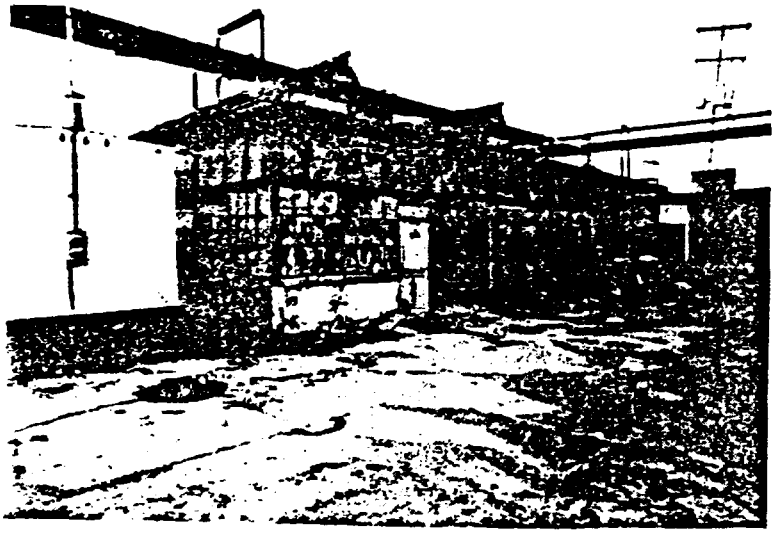


Photo 211: Taken from the southeast corner of the northern portion of the Chem-Dyne Building. Photo views toward the northwest showing the eastern wall of the northern portion of the building [11-2-83].

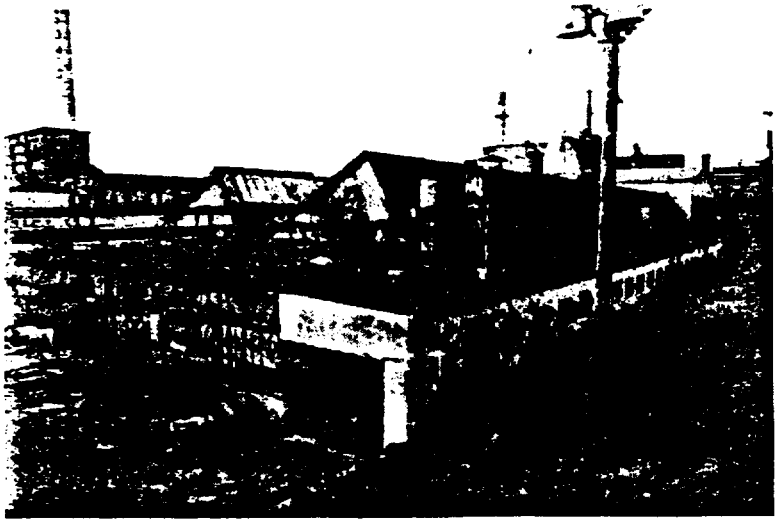


Photo 212: Taken from the northeast corner of the Chem-Dyne Building. Photo views toward the west and shows the northern wall and roof of the northern portion of the building [11-2-83].

Photo 213: Taken from the southwest corner of the garage located just south of the Chem-Dyne Building. Photo is view to the south and shows the north and west exterior walls of the garage [11-2-83].

Photo 214: Taken from the southwest corner of the garage located south of the Chem-Dyne Building. It shows the west and southern walls of the garage and the loading dock filled with water located just to the south of the onsite stack which is just south of the boiler house [11-2-83].

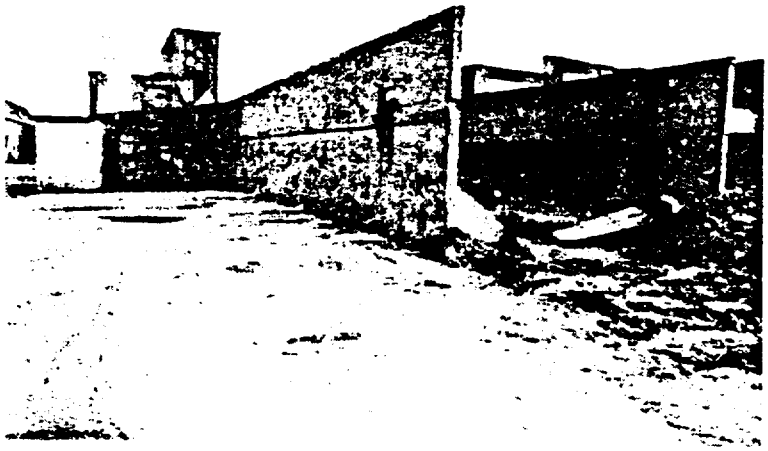
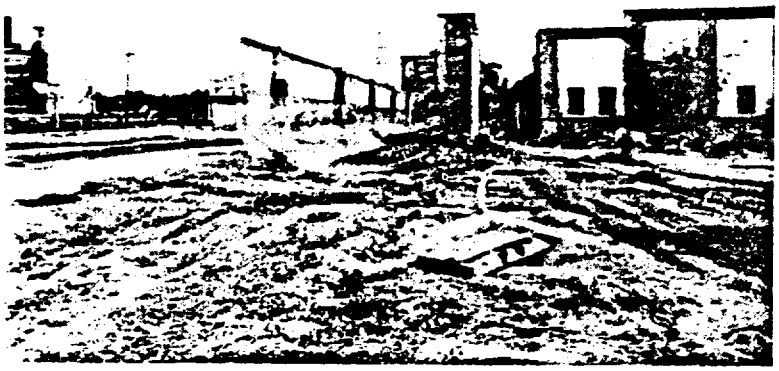


Photo 215: Viewing north, the photo is taken just off the southwest corner of the coal bin. Photo shows the southern wall of a shed attached to the west wall of the coal building [11-2-83].



Photos 216 and 217: Taken just south of the entrance into the coal bin. These photos are veiws to the north showing the coal bin construction and the stack located just to the north of it [11-2-83].

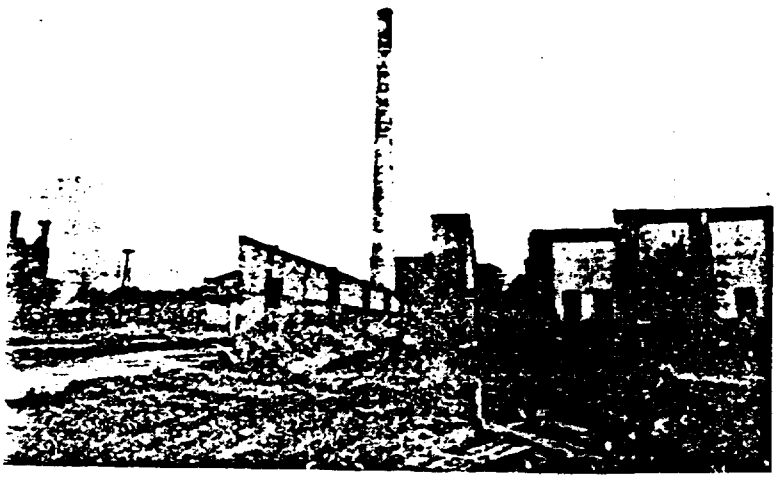
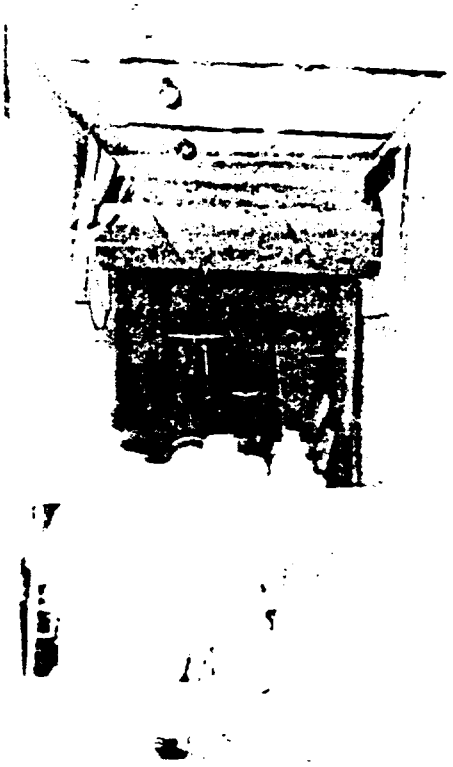


Photo 217: (See Photo 216)[11-2-83].



Photos 218 and 219: Taken within the piping vault approximately 30-40 feet south of the coal bin along the extension of the east wall. The vault is approximately 10 feet long by 8 feet wide and located approximately 10 feet below grade. Entrance to the vault is through concrete access hatch approximately 4 feet long and 2 feet wide [11-2-83].

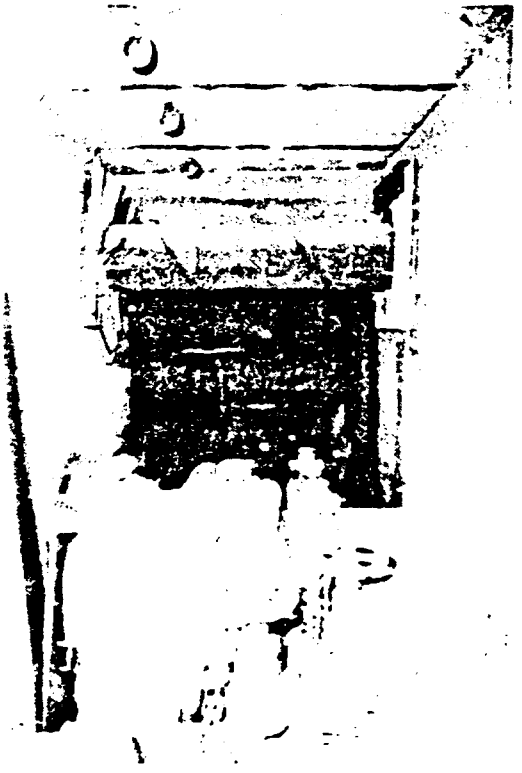


Photo 219: (See Photo 218) [11-2-83].

Photo 220: Viewing toward the west, photo shows the entrances into two metering vaults. One shown in photos 218 and 219 and another to the east of that approximately 20 feet. The entrance into the smaller easternmost concrete metering vault is approximately 8 feet by 4 feet [11-2-83].

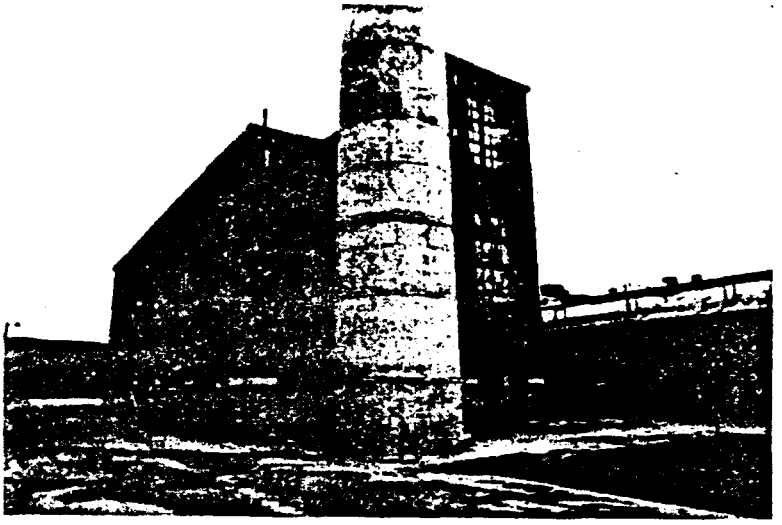


Photo 221: Taken from the southwest corner of the boiler building. Photo shows the exterior of the southern and western walls of that building. [11-2-83].

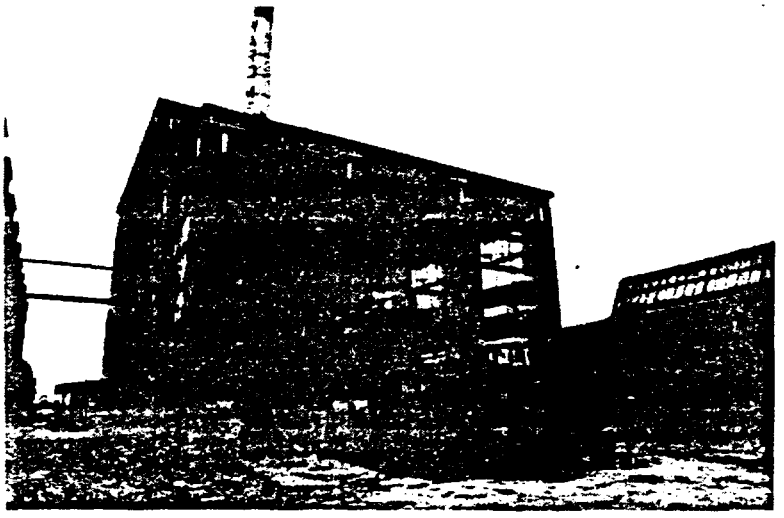


Photo 222: Taken from the north side of the boiler house. It shows the exterior of the north wall and entrances to the boiler house (Start of a new film roll) [11-2-83].

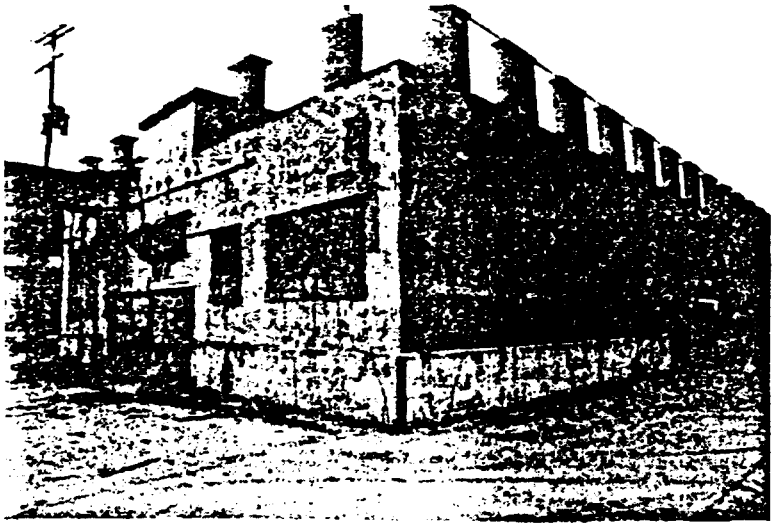


Photo 223: Taken from the northwest corner of Building C, located just east of the boiler house. The photo shows the north and west exterior walls [11-2-83].

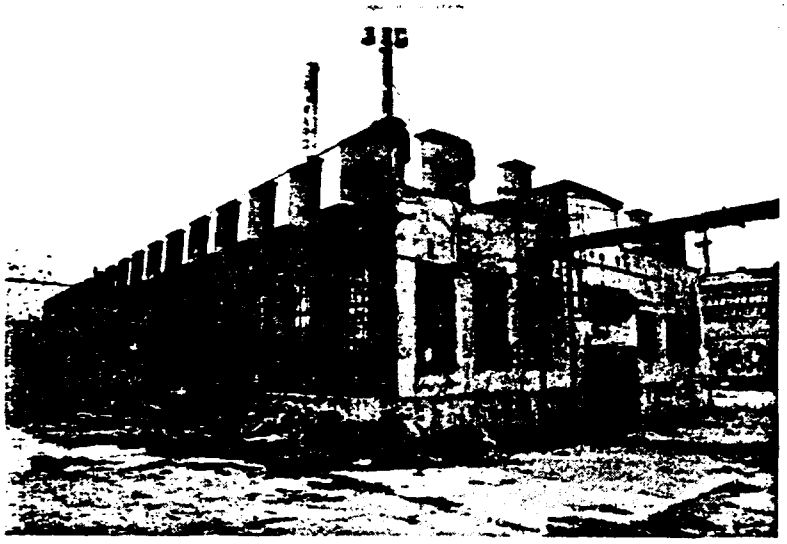
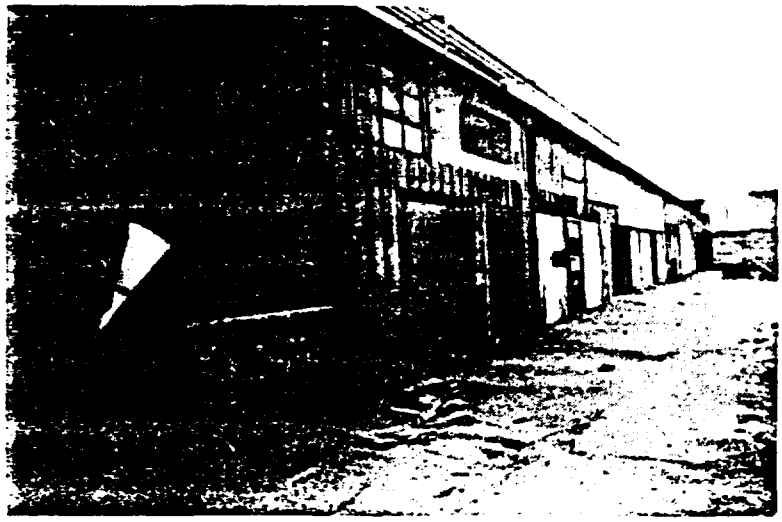


Photo 224: Taken off the northeast corner of Building C, again showing the exterior portions of the north and east walls of that building [11-2-83].



Photos 225 and 226: Taken midway in the alley between the boiler house building and Building C. The photos view toward the southeast and show the exterior of the western portion of Building C [11/2/83].

Photo 226: (See Photo 225) [11-2-83].

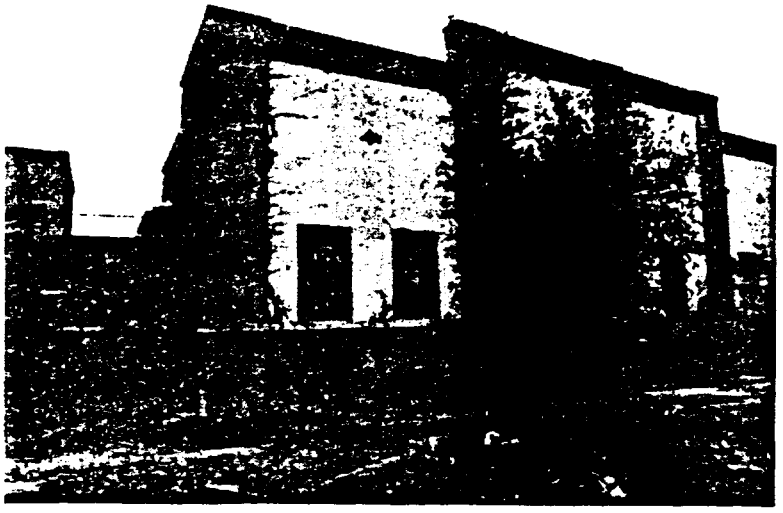


Photo 227: Taken from the southwest corner of Building C. The photo shows the exterior of the southern wall of that building [11-2-83].

Photo 228: Taken directly south of Building C. The photo views toward the northeast and southwest corner of the Ford Building. It shows the exterior portion of the south and west walls of the Ford Building [11-2-83].

Photo 229: Taken directly south of the Ford Building. The photo directed to the north views at the entranceway into that building [11-2-83].

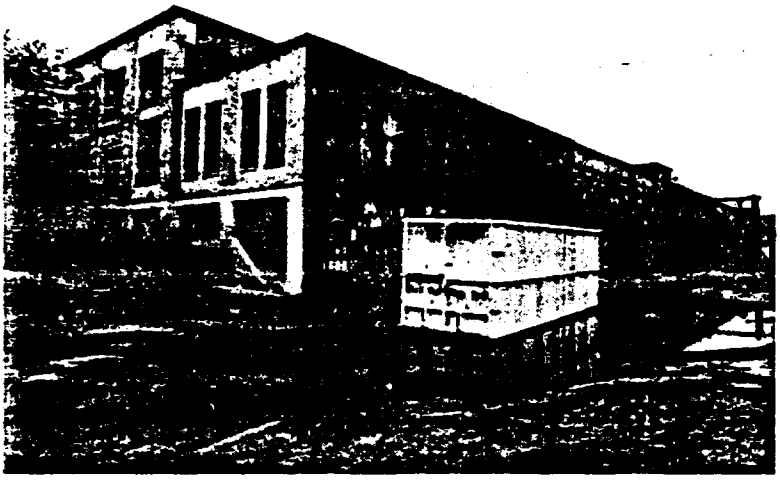


Photo 230: Taken off of the southeast corner of the Ford Building. The photo views the southern and eastern walls of the Ford Building. Also included in the photo is a hydrant located near that corner [11-2-83].

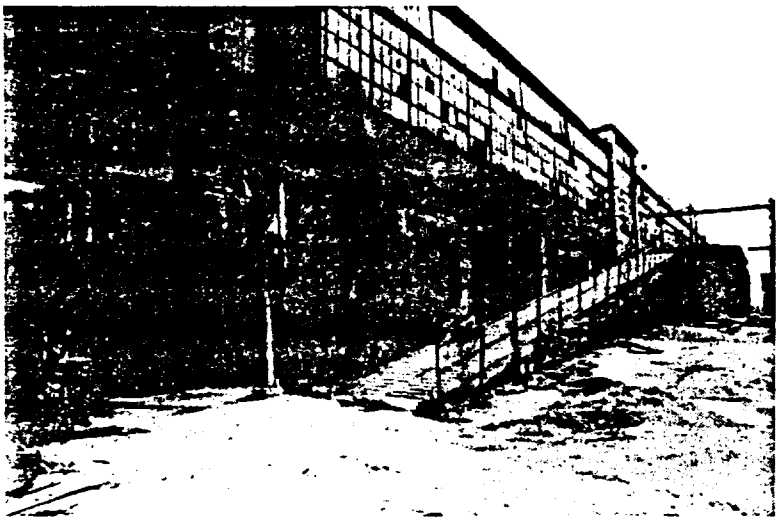


Photo 231: Taken along the southern portion of the eastern wall of the Ford Building, viewing toward the north, shows the loading bays and a ramp that leads to the upper level of the Ford Building [11-2-83].

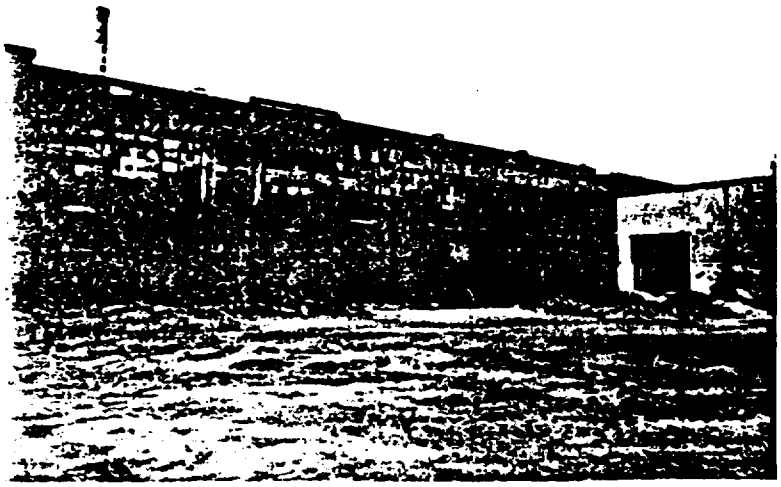


Photo 232: Taken east of the Ford Building. The photo views back toward the west. It shows the eastern wall of the Ford Building, and also the entry into the main level [11-2-83].

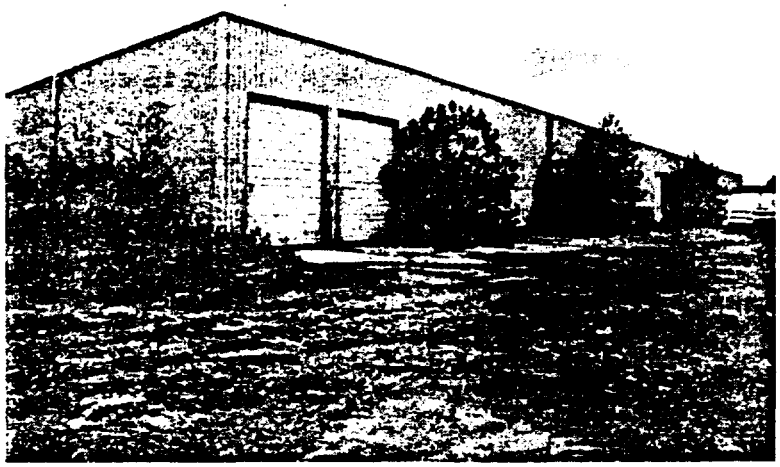


Photo 233: Taken south of the northwest corner of the Baylor warehouse. The photo shows the west wall and the main doors leading onto the site from that building [11-2-83].

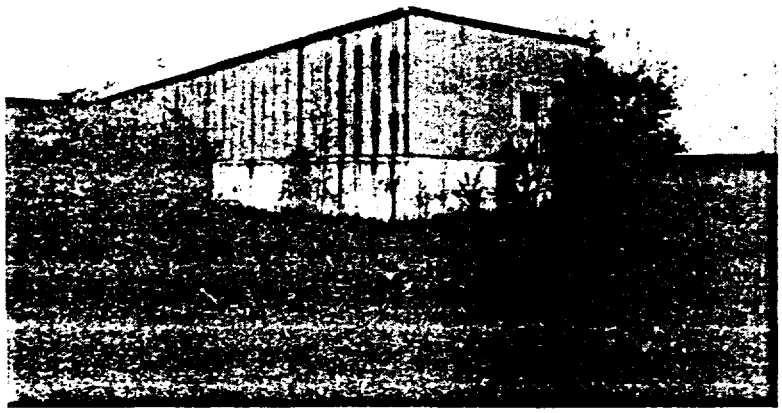


Photo 234: Taken from the southeast corner of the southern extension of Building D. The photo shows the exterior walls of the southern and eastern portion of that building [11-2-83].

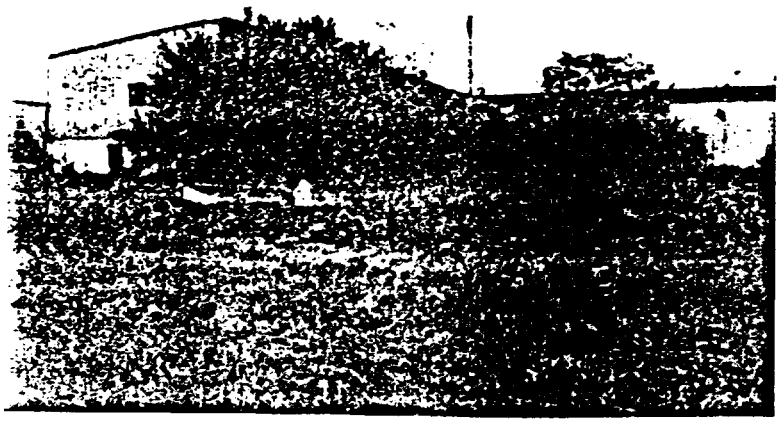


Photo 235: Taken off the northeast corner of Building D. The photo views back toward the southwest and shows the northern and eastern walls of that building [11-2-83].

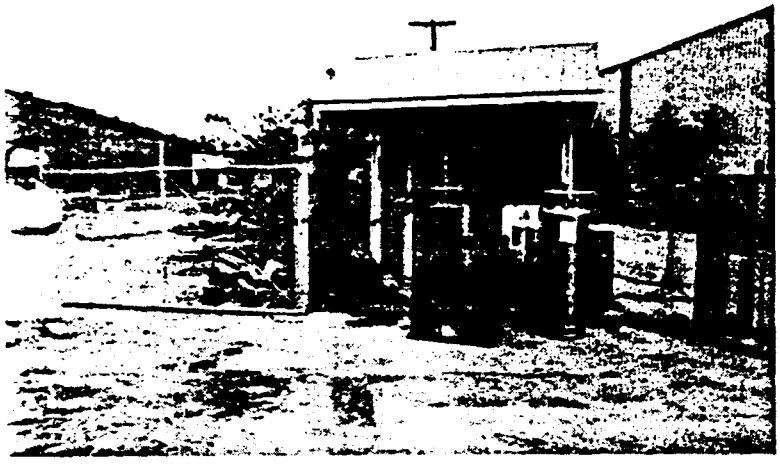


Photo 236: Taken from the east gate viewing toward the north, showing the guard facilities [11-2-83].

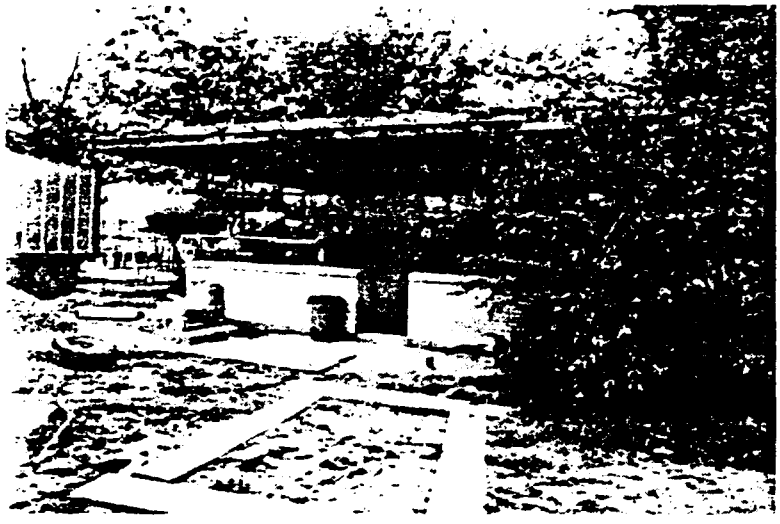


Photo 237: Taken from the south of the guard house located at the southern entrance to the Chem-Dyne property [11-2-83].

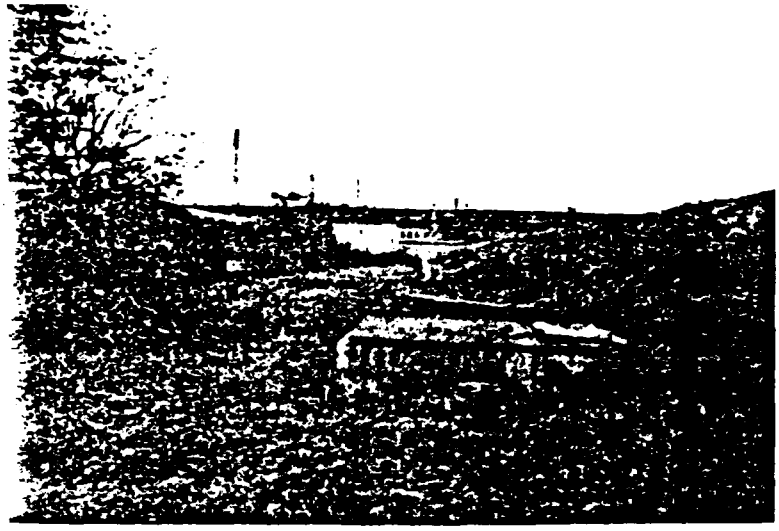


Photo 238: Viewing toward the west the eastern side of the lift station located on the south side of the Ford Canal, approximately 200 feet north of the Baylor trucking warehouse [11-2-83].

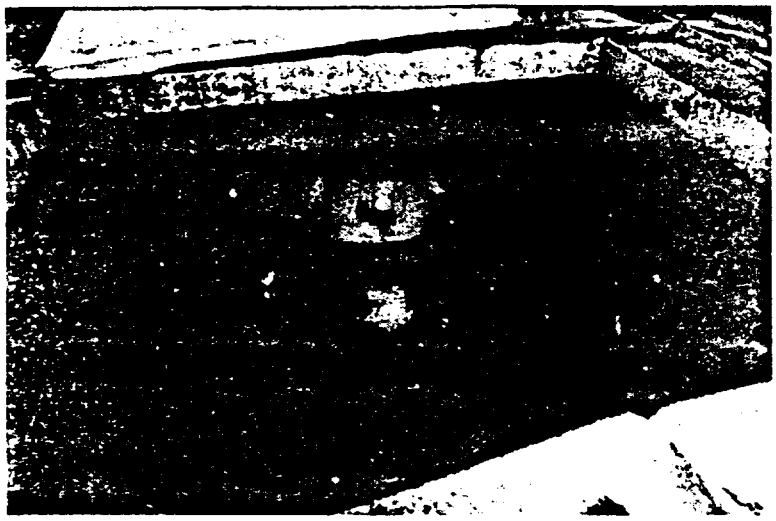


Photo 239: Viewing in through the opening in the roof at the north end of the lift station, showing the interior workings [11-2-83].

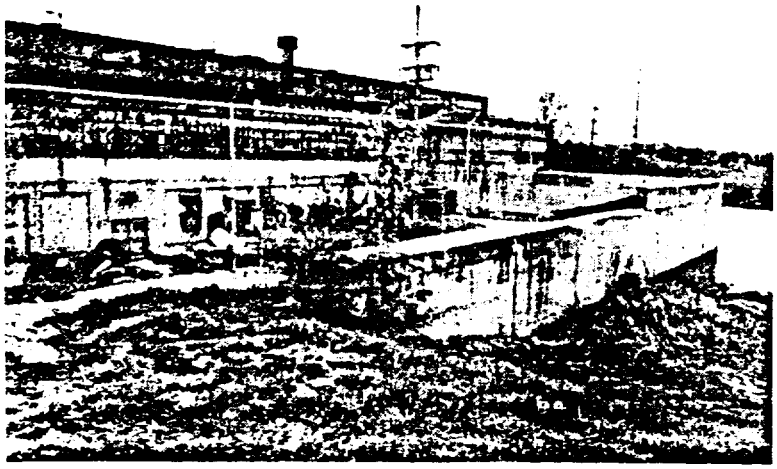


Photo 240: Taken from the levy along the northeast portion of the Ford Building, showing the eastern wall and miscellaneous equipment lying in the yard just to the east of the Ford Building. [11-2-83].

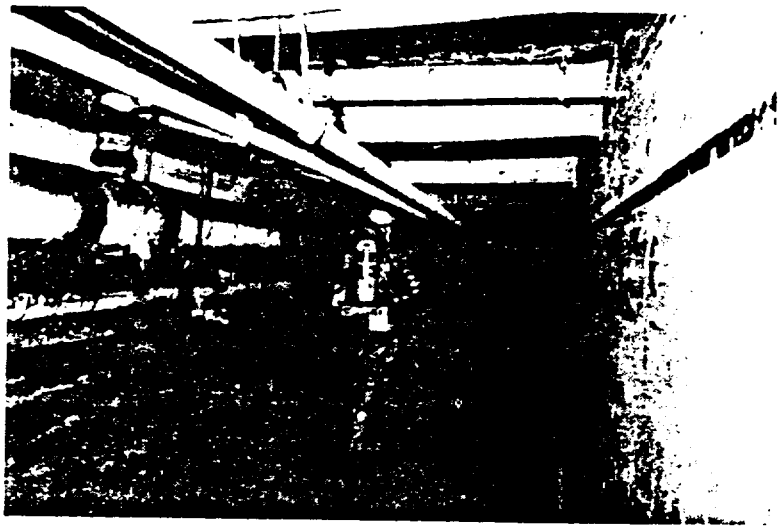


Photo 3A: In the utility gallery approximately 60-70 feet north of the entry of the spiral staircase viewing north [10-24-83].

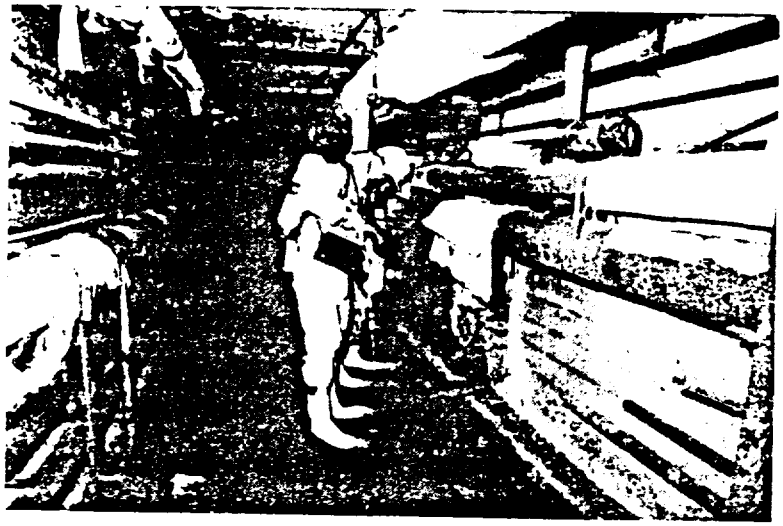


Photo 4A: Taken in the east-west trending tunnel connecting the boiler house and the Ford Building, approximately halfway between the two. There is a chute running north off the tunnel, which apparently has caved in and been closed off [10-24-83].

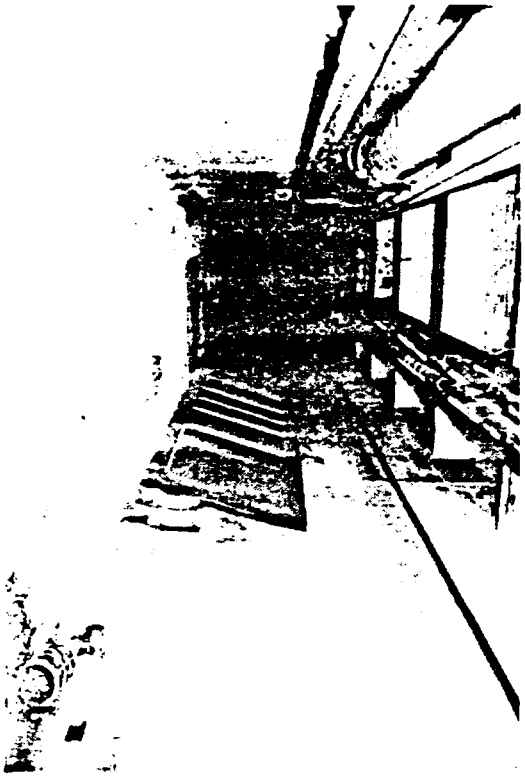


Photo 5A: Viewing north along a continuation of the north-south trending utility gallery under the Ford Building, where it intersects the room which is at the intersection with the east-west trending tunnel connecting Building C with the Ford Building. In the utility gallery trending north-south continuing north from the room with the intersecting of the tunnel running east-west from Building C HNu readings are 0.4-0.6 ppm.

Several sections of the tunnel trending north-south of the utility gallery in the Ford Building have areas of standing water several inches deep. The north-south trending utility gallery terminates in the north end of the Ford Building. There is a ladder and crawlway connecting the tunnel to the ground floor first floor of that building.

Just east of the continuation of the north-south trending utility gallery, running up and down the length of the Ford Building and running parallel to it, is a small utility gallery. There are other tunnels running parallel to it. This utility gallery runs north-south and has several sections of standing water several inches deep. It terminates in a similar area as the other tunnel [10-24-83].

Photo 6A: Taken on the ground floor of the Ford Building, showing the stairway leading down into the basement located near the midsection of the west wall [10-24-83].

Photo 7A: A photo of the easternmost of the two galleries running parallel northward from the intersection of the three tunnels in the basement of the Ford Building.

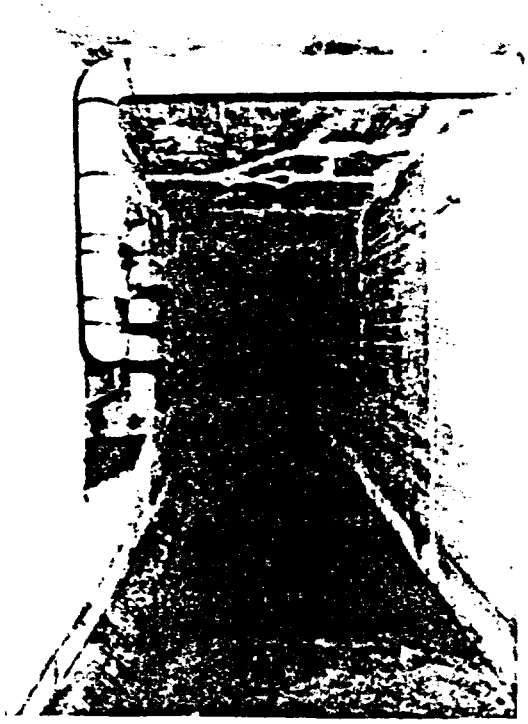


Photo 8A: A utility gallery running southward directly opposite of the two tunnels in the basement of the Ford Building [10-24-83].

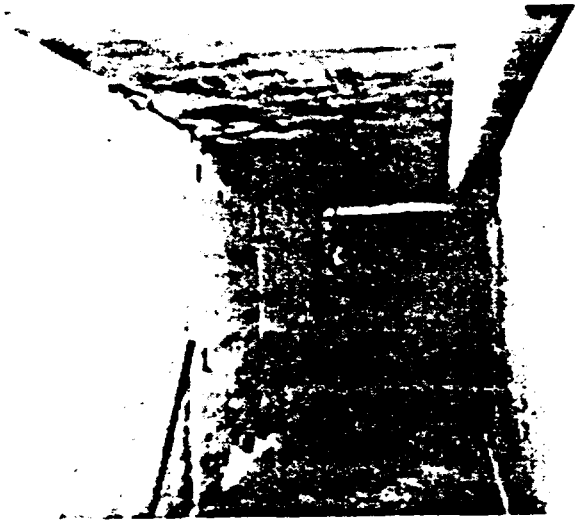


Photo 9A: Taken in the easternmost of the two tunnels running north-south in the southern portion of the Ford Building. This is a photo viewing south near the termination of that tunnel [10-24-83].

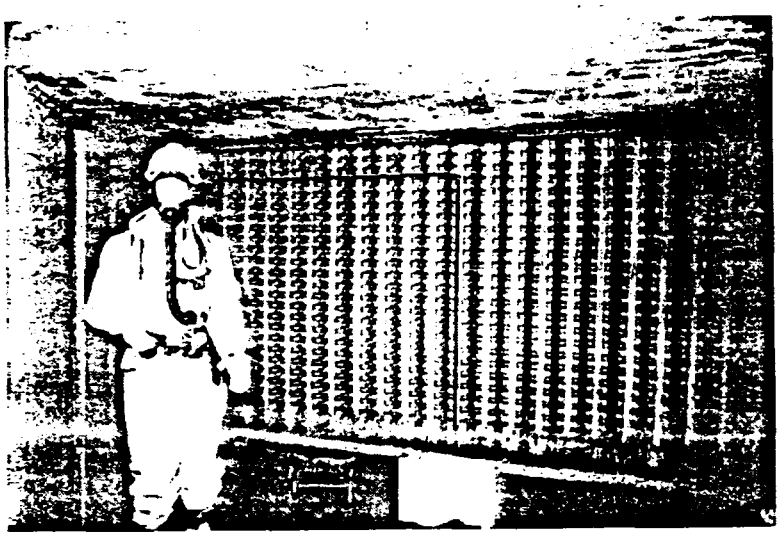


Photo 10A: A photo showing the termination of that tunnel and the heat exchangers and two small rooms to the east and west. Also there's a connection between the two tunnels at the termination of the easternmost tunnel [10-24-83].

Photo 11A: Shows the stairwell leading out of the southern end of the north-south trending tunnel or utility gallery in the Ford Building [10-24-83].

Photo 12A: The ground floor offices in the southern portion of the Ford Building just east of the exit from the stairwell to the basement [10-24-83].

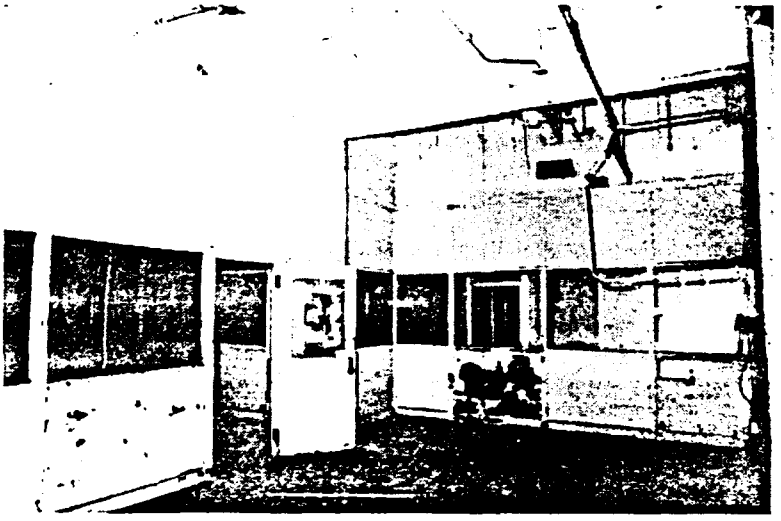


Photo 13A: The offices contained in the southern portion of the ground level of the Ford Building [10-24-83].

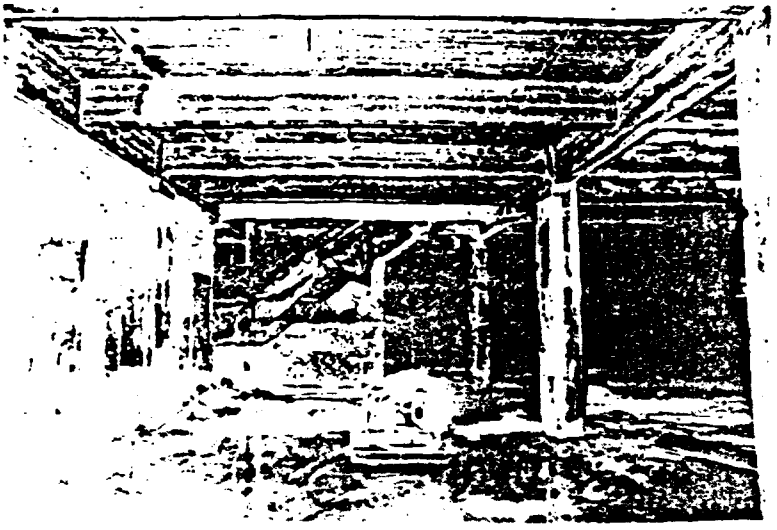


Photo 14A: Viewing west from an entranceway or opening just past the offices in the southern portion. It shows that interior stairway leading up to the second floor, also the columns and super-structure [10-24-83].

Photo 15A: Fromthe central portion of the Ford Building looking northwest toward the loading dock area, showing the west interior [10-24-83].

Photo 16A: Taken from the central portion of the Ford Building adjacent to the loading dock area connecting Building C with the Ford Building. This photo is viewing north showing the concrete columns and concrete cast ceiling. This photo also shows miscellaneous debris strewn about interior [10-24-83].

Photo 17A: Taken in the central portion north of where Photo 16A was taken. This photo is directed toward the west and shows the western wall of the interior, ground floor, Ford Building [10-24-83].

Photo 18A: A view to the west looking at an access which links Building C to the Ford Building [10-24-83].

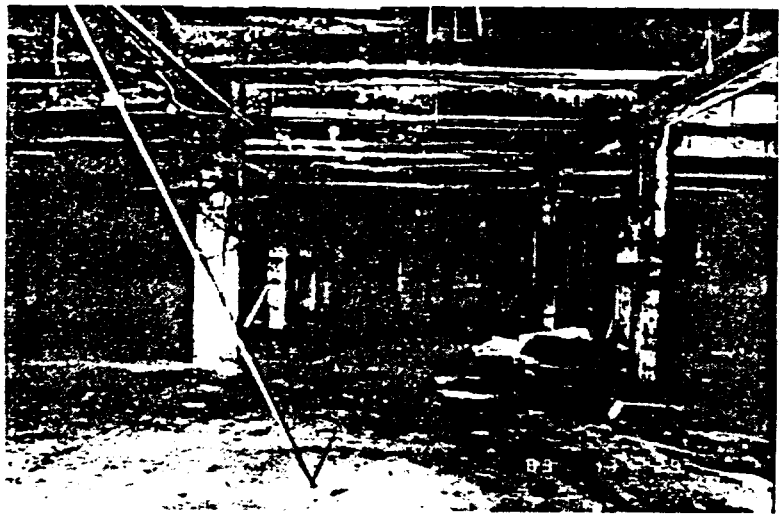


Photo 19A: A view to the east, showing a linkage hallway leading to the adjacent Building D [10-24-83].

Photo 20A: A photo of the north-central portion of the Ford Building viewing northwest and a stairwell leading up to the second level of the Ford Building [10-24-83].

Photo 21A: A photo inside the restroom located in the central northwest portion of the Ford Building [10-24-83].

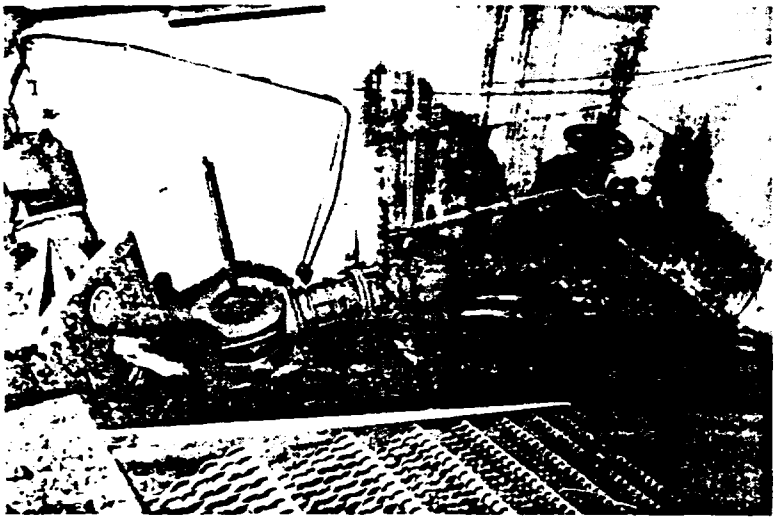
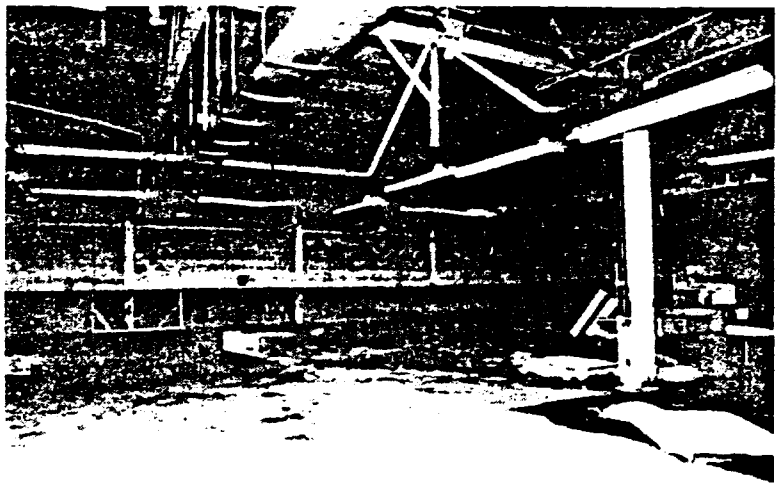


Photo 22A: A photo of a small pumphouse located outside the northeast corner of the Ford Building approximately 50 feet east of the east wall of the Ford Building [10-24-83].

Photo 23A: A photo from just south of the pump house showing the entrance through the south wall of the pump house, where 22A was taken [10-24-83].

Photo 24A: Viewing east to the southern portion of Building D [10-24-83].



Photos 25A and 26A: Taking the northern portion of building D showing to the southwest corner. Photo 25A views north; Photo 26A views northeast and shows the interior and superstructure. The catch basin located directly south of the southern portion of Building D has a HNu reading of 0.4 ppm which is also the background reading. In these catch basins are several feet of standing water.

The catch basin located directly south at the southeast corner of Building D has a HNu reading of 0.8 ppm in the catch basin with a background of 0.2 ppm. The HNu reading of 0.8 ppm does not change after stirring sediments in the water within the catch basin [10-24-83].

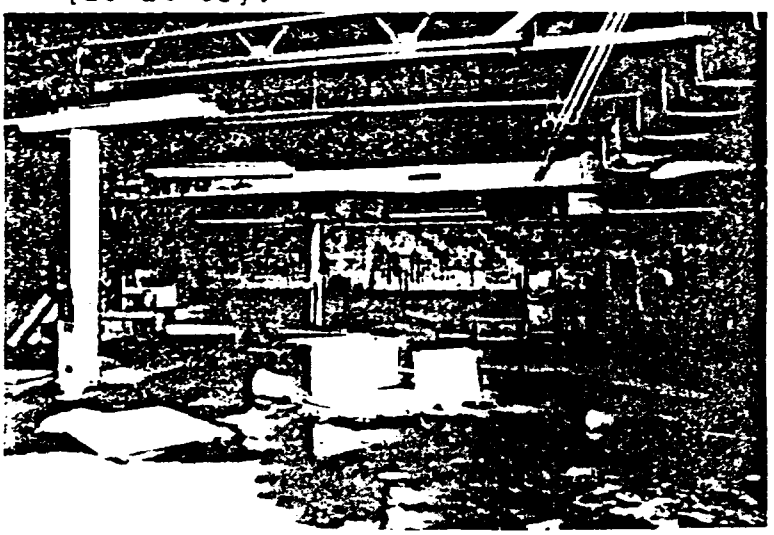
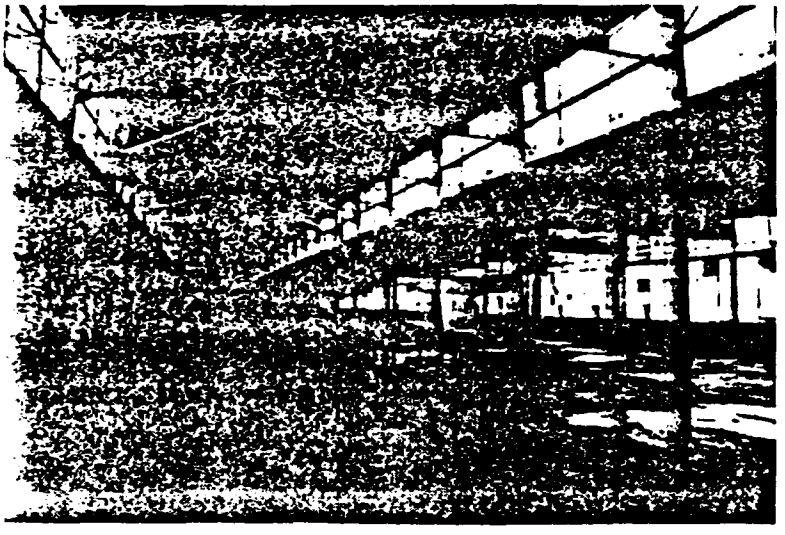


Photo 26A: (See Photo 25A)[10-24-83].

Photo 27A: From the southern interior of the upper floors of the Ford Building, photo views south toward the entranceway [10-24-83].

Photo 28A: Taken from the same position viewing northwest towards the northern interior offices on this floor [10-24-83].



Photos 29A and 30A: Taken inthe southern portion of the Ford Building, first floor or upper floor (as referred to previously) showing the floor and walls to the north [10-24-83].

Photo 30A: (See Photo 29A on preceding page) [10-24-83].

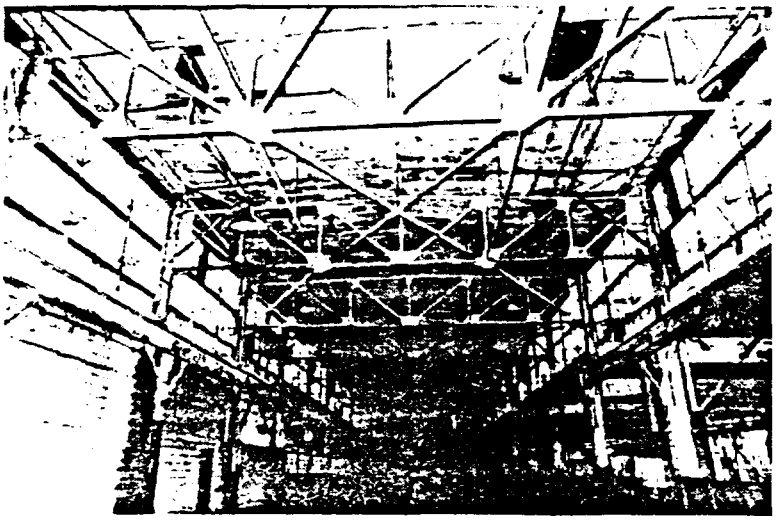


Photo 31A: In the same position as Photo 29A and 30A, also looking north at an upward angle to show the truss structure associated with the roof [10-24-83].

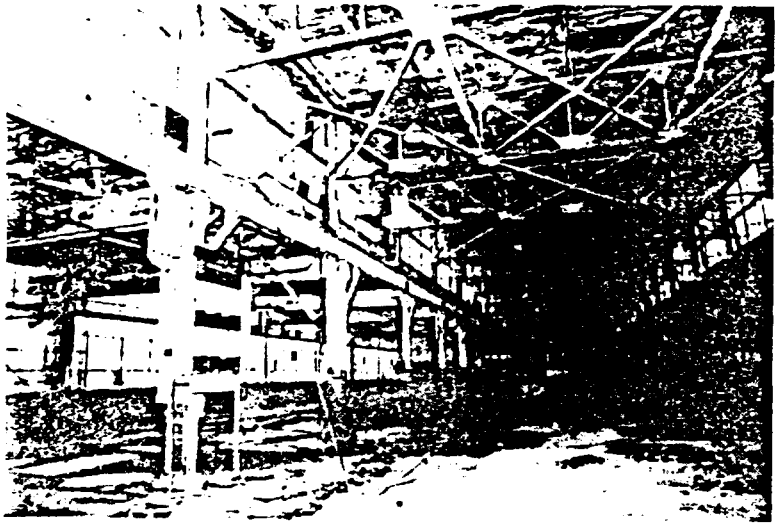


Photo 32A: Taken from the middle portion of the Ford Building's first floor, viewing northwest, showing the interior structure of the roof [10-24-83].

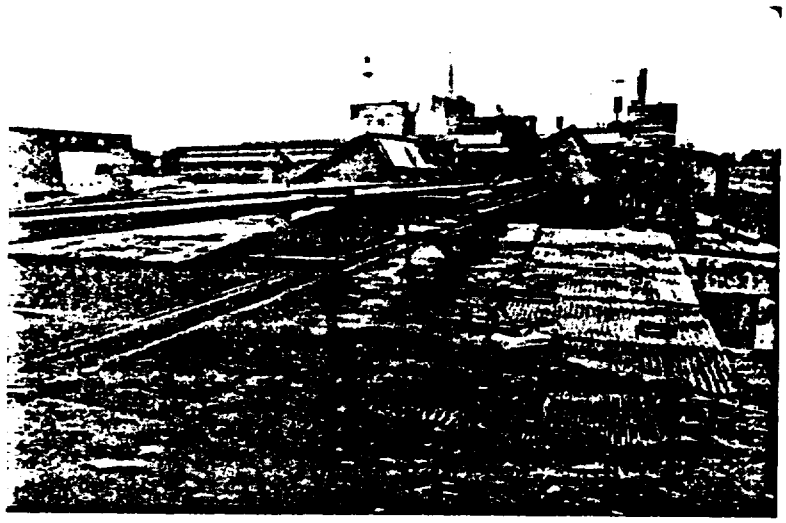
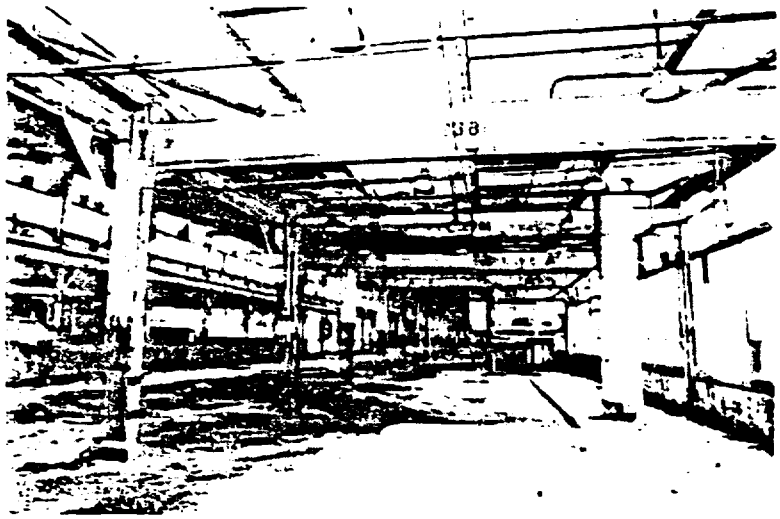


Photo 33A: Through the first floor west wall window in the Ford Building showing the fire-damaged portion of the Chem-Dyne Building roof [10-24-83].



Photos 34A and 35A: In the northern portion along the western half of the Ford Building's first floor. The photos are toward the south, showing the interior structural steel [10-24-83].

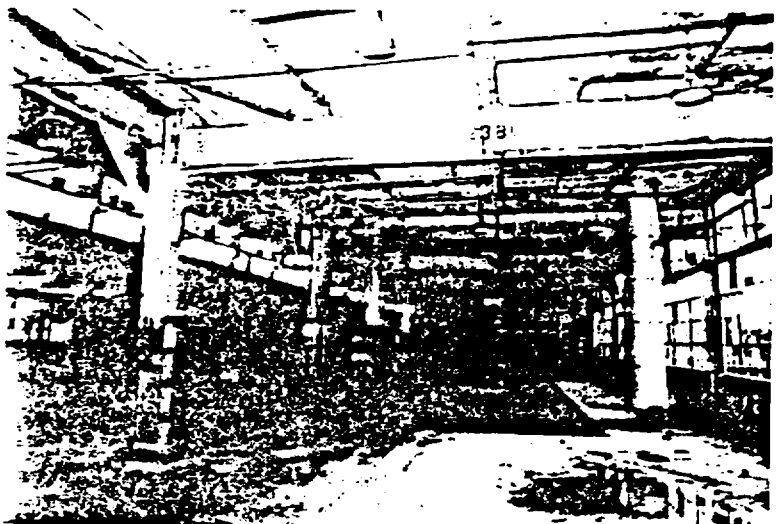


Photo 35A: (See Photo 34A) [10-24-83].

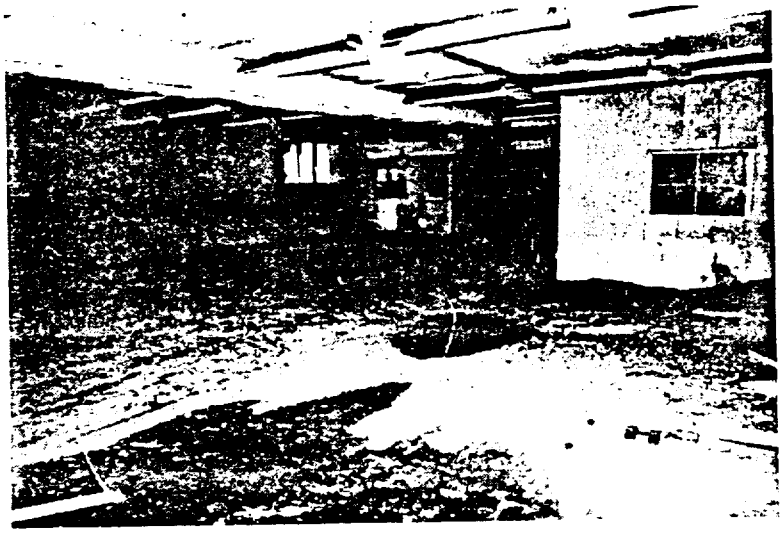


Photo 36A: A photo of the office space located on the second floor along the southern portion of the Ford Building. This is viewing the southern wall toward the north [10-24-83].

Sunday, October 24, 1983
Team: Larry Holm, Brad Berggren, John Fleissner

Photo numbers 57, 58, 59 and 60 were excluded. The photo numbering sequence resumes at number 61.

Photo 61: Boiler house at ground level viewing from the north end of the building. HNU background in the building is 0.4 ppm. Photo is taken from the entry at the northeast corner of the boiler house building viewing south [10-24-83].

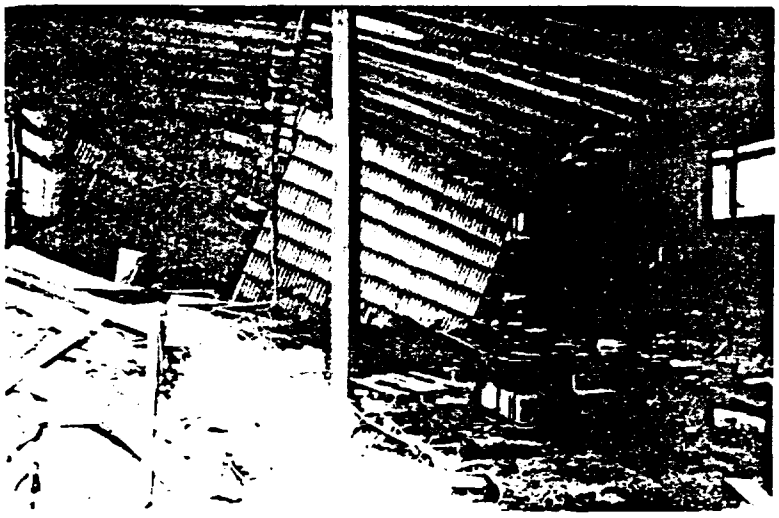


Photo 62: Taken from the same point viewing south, showing the interior of the building and the fallen second-story floor [10-24-83].

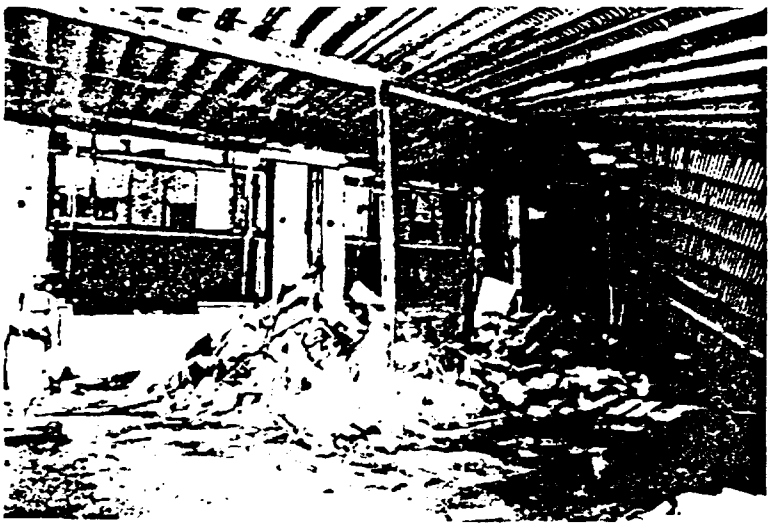


Photo 63: Taken from the northwest corner of the boiler house building viewing toward the southeast [10-24-83].

Photo 64: Taken just south of Photo 63. This photo shows the interior of the ground level of the boiler house building and shows sections where the second-story floor has fallen down [10-24-83].

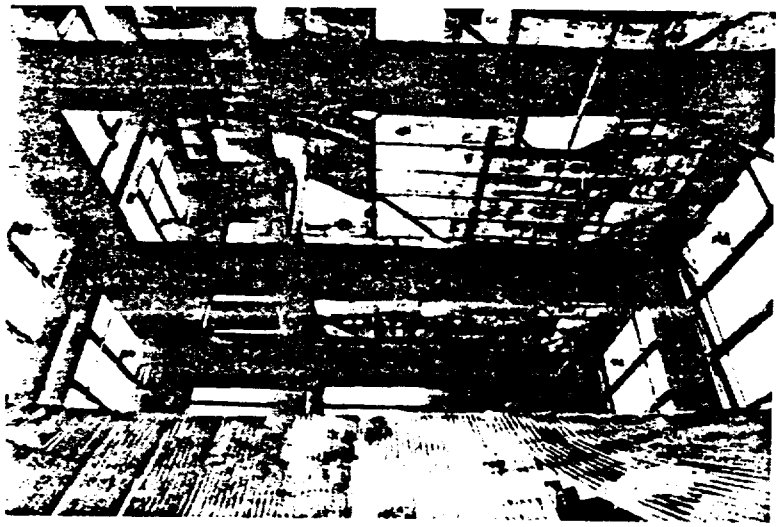


Photo 65: Taken from the middle of the boiler house building viewing south and upwards, showing the super-structure of the boiler house building [10-24-83].

Photo 66: Taken from the southwest corner of the boiler house building viewing east [10-24-83].

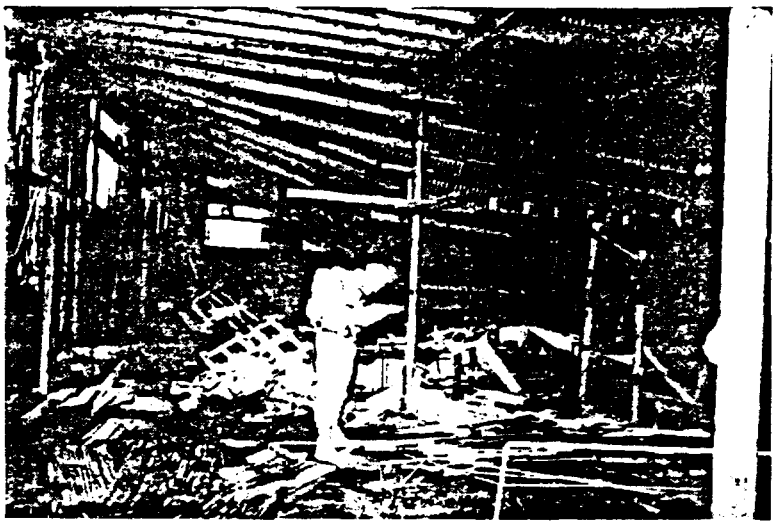


Photo 67: Taken from the same location as Photo 66 viewing north [10-24-83].

Photo 68: Taken from approximately the middle of the boiler house building viewing east toward the stairway leading to the basement, located about midway along the east wall of the building [10-24-83].

Photo 69: Taken from the north-central portion of the boiler house building viewing northwest at the doorway which is the entranceway to the boiler house ground level [10-24-83].

Photo 70: Taken in the garage in the northeast corner viewing south along the eastern wall of the garage [10-24-83].

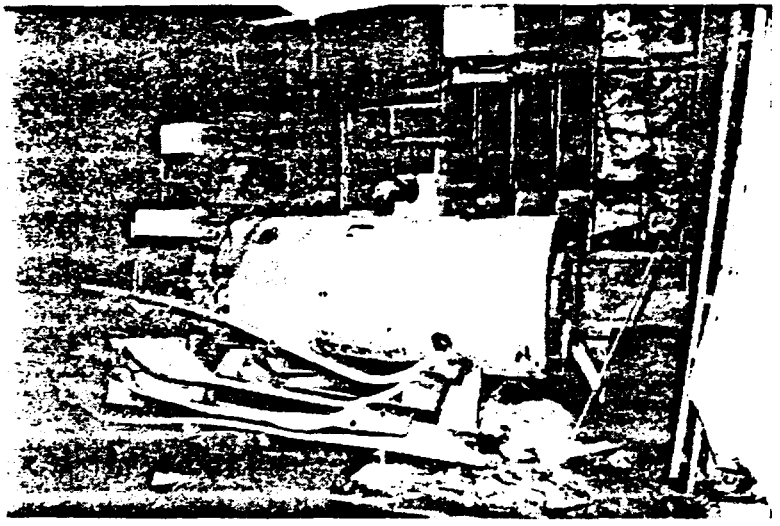


Photo 71: Taken from the same location as Photo 70, viewing southwest and showing the southwest and north interior walls of the garage [10-24-83].

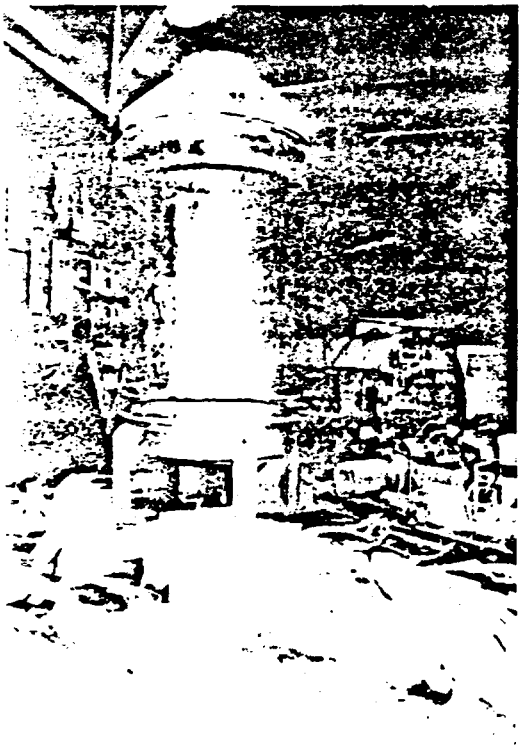
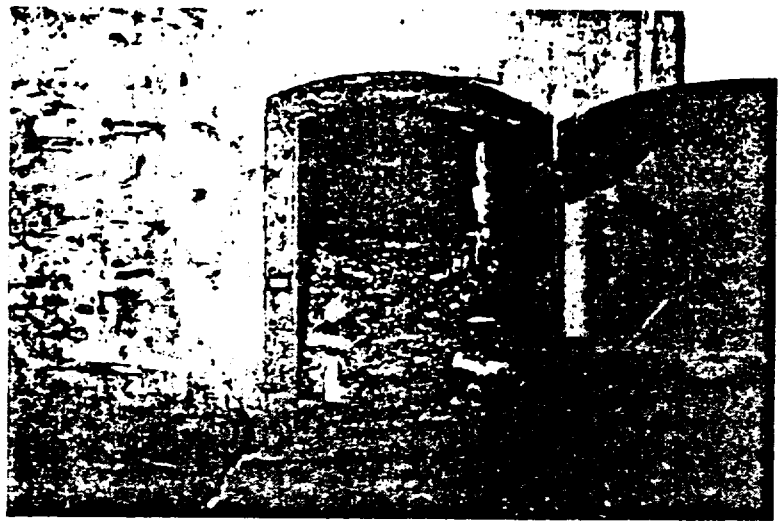


Photo 72: Taken within the garage from the southern half viewing north [10-24-83].



Photos 73 and 74: Taken through the access port of the stack located just south of the boiler house [10-24-83].

Photo 74: (See Photo 73) [10-24-83].

Photo 75: Taken midway in the north portion of Building C viewing north at the northwest corner of the building [10-24-83].

Photo 76: Taken from the north wall viewing west [10-24-83].

Photo 77: Taken from the same position viewing south [10-24-83].

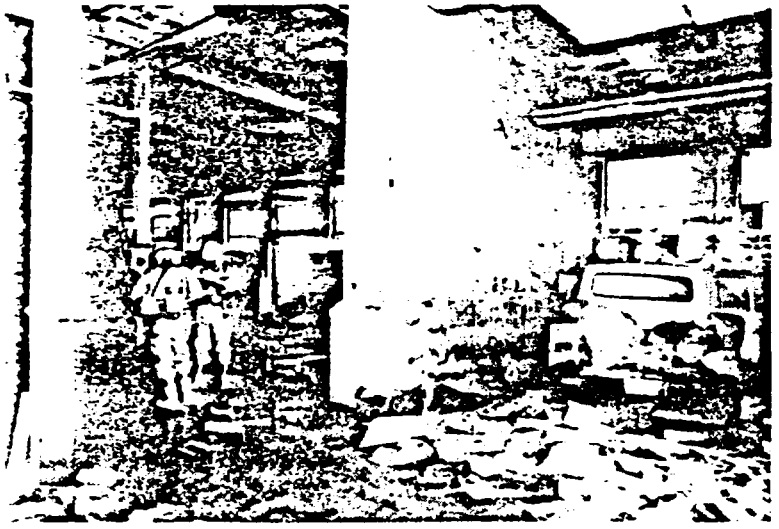


Photo 78: Taken also from the same position viewing southwest [10-24-83].

360

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ROBERT S. KERR ENVIRONMENTAL RESEARCH LABORATORY
P. O. BOX 1198
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April 17, 1984

MEMORANDUM

SUBJECT: Modeling Ground Water Flow and Contaminant Transport at Chem-Dyne

FROM: Joseph F. Keely, Hydrologist
Ground Water Research Branch

TO: See List of Addressees

This technical memorandum discusses the data requirements, assumptions, and limitations of ground water models at various levels of sophistication, as they might be applied to the Chem-Dyne site. A few simple scenarios are illustrated to give some "ball park" estimates of the time of travel of contaminants from Chem-Dyne to select wells down valley, and to show the impact of pumping wells on the affected flow system.

Generically, there are two general categories of models: analytical and numerical. The analytical models employ closed-form solutions so that a given set of conditions is evaluated by a simplified equation to yield a final answer in one attempt at solving, whereas numerical models employ iterative solutions of a matrix representing several equations which must be solved simultaneously to yield a "better" answer with each iteration. Analytical models have been simplified by requiring most imputs to be constant in space and time (e.g., use of a single value of hydraulic conductivity for the whole aquifer), whereas numerical models allow input parameters to vary from point to point (which, in part, gives rise to the many simultaneous equations to be solved).

There are sufficient data to begin constructing a numerical flow model of the Chem-Dyne site (e.g., variations in hydraulic conductivity and gradient adequately defined), except for one crucial relationship: the influence of the Miami River (and the Ford Hydraulic Canal) on ground water levels. Aquifer-stream interactions can be adequately back-calculated for many systems, but the extremely dynamic nature of the river stage at this site suggests that any estimates of this relationship will be nearly impossible to validate by the usual history matching techniques. Even if that were not so, the short time in which to prepare numerical models for the final RI report precludes those attempts now. Ergo, the less sophisticated analytical approaches will be entertained in succeeding paragraphs.

Using hydraulic conductivity and gradient values from the Draft RI (p. 3-53),

$$K = 1100 \text{ gpd/ft}^2 = 147 \text{ ft/day}$$
$$I = 0.002 \text{ ft/ft}$$
$$n = 0.30 \text{ dimensionless}$$

and the Darcy Law relationship for the velocity of the natural system,

$$V_{natural} = KI/n = \underline{0.98 \text{ ft/day}}$$

The FIT study had earlier noted that the average hydraulic conductivity and gradient values were somewhat different:

$$K = 5000 \text{ gpd/ft}^2 = 668 \text{ ft/day}$$
$$I = 0.0013 \text{ ft/ft}$$
$$n = 0.30 \text{ dimensionless}$$

so that $V_{natural} = \underline{2.9 \text{ ft/day}}$

The FIT study based its estimate of hydraulic conductivity on published reports and discussions with the Miami Conservancy District regarding average properties of the aquifer as a whole.

The Draft RI noted that values as high as 3800 gpd/ft^2 had been determined during the pumping test, but that the average value of hydraulic conductivity was 1100 gpd/ft^2. There is no inconsistency here, the aquifer is anisotropic and heterogeneous and as a result has a distribution of hydraulic conductivity values. The values determined during the RI study pumping test reflect local, shallow conditions and should be utilized in that light only. Those values are less appropriate for projections concerning the regional flow or for deeper zones of the aquifer (which appear to be the most permeable, and which supply most of the major pumping wells in the valley).

The hydraulic gradients used in the Draft RI and FIT reports are averaged (seasonally) values; the hydraulic gradient typically varied from less than 0.001 to more than 0.003 throughout each annual cycle. The effective porosity estimate of 0.30 was given by FIT as their best interpretation of grain size analyses and previously published reports; the Draft RI did not reference a porosity estimate.

Given the foregoing, it is also reasonable to base projections of flow away from the Chem-Dyne site on the following:

$K = 5000 \text{ gpd/ft}^2 = 668 \text{ ft/day}$ (FIT, for whole aquifer)
$I - 0.002 \text{ ft/ft}$ (Draft RI, recent average)
$n = 0.30$ dimensionless

in which case, $V_{natural} = \underline{4.5 \text{ ft/day}}$.

not already, capturing a great deal of the plume(s) as it (they) migrate down valley. Of course, similar comments apply to the Hamilton Well Field, but on a lesser scale because of the opportunity for interception and partial, if not total capture of the plume(s) by wells lying between Chem-Dyne and the Well Field (such as the Mercy Hospital well).

By comparing Figures 2, 3, and 4 it is easy to see that the capture zone dimensions are linearly related to the natural flow velocity; e.g., at 0.98 ft/day the downgradient stagnation point was 1040 feet for 1000 gpm, and at 2.9 ft/day the downgradient stagnation point was 352 feet. Hence, one can plot the values given here on a straight line and choose any natural/regional velocity to find corresponding capture zone dimensions.

One well is easily evaluated under the foregoing scheme, but the capture zone concept becomes much more complicated for situations involving several wells which may have overlapping zones. It is a matter of determining the x- and y- components of velocity contributed by each pumping stress to any observation point and then using that information to compute the magnitude and direction of a resulting vector. To illustrate this, two scenarios have been devised. The first, in Figure 5, shows the flow velocity and direction for waters at select points around the Mercy Hospital Well (3500 feet south of Chem-Dyne, pumping at 1000 gpm, with natural flow velocity = 2.9 ft/day flowing due south). The second, in Figure 6, is an expansion of the scenario in Figure 5; a second well has been located arbitrarily 500 feet west of Chem-Dyne and is also pumping 1000 gpm. By comparing the two figures, it is apparent that the influence of unknown wells on velocity patterns can be quite important. Complete identification of all wells lying between Chem-Dyne and any supply wells of interest (e.g., Mercy Hospital and Hamilton Well Field) will be necessary to ensure valid interpretation of all models used for future projections of contaminant transport.

Earlier it was noted that, for purposes of this discussion, numerical models were not a viable option, despite the valuable data collected to date on the variations of hydraulic conductivity and gradients. Part of the explanation proffered was that the relationship between the aquifer water levels and the stage of the Miami River is not yet adequately defined. In part also, numerical models will be extremely difficult to construct and validate for portions of the aquifer immediately southwest of the site and down valley (south) due to the lack of borehole logs, monitor wells, and hydraulic tests there. Finally, all two-dimensional models will suffer from an inability to accurately simulate the effects of the vertical flow components near-site and down-valley--these are particularly pronounced near the river. The few truly 3-D models that are available will be difficult to use because too few vertical head measurements are available (there are only eight pairs of clustered deep and shallow wells). These comments should not be taken as pessimistic appraisals designed to show the futility of attempting numerical models, rather they are intended to show that additional data must be gathered to ensure the validity of such attempts. Otherwise, further work with analytical models should be attempted and the results interpreted with a keen eye as to the assumptions invoked.

In summary, using available data and simple analytical models, it is easily shown that contaminants from Chem-Dyne can be drawn in by Champion Paper's wells, Mercy Hospital's well, and eventually by the Hamilton Well Field. It is quite clear that each well creates significant distortions in the flow direction and magnitude, so that identification of all wells is crucial for projections of future movement of contaminants from Chem-Dyne. Further, certain hydrologic relationships (aquifer-river and vertical flow) need to be studied in greater detail prior to attempting to construct numerical models for projections.

Addressees:
Don Bruce, U.S. EPA, Region V
Barry Sandals, Department of Justice, Washington, DC
Rob Clemens, U.S. EPA-Headquarters
Larry Holm, CH_2M Hill

FIGURE 1

CAPZONE VELDSTR PROGRAM

BY J.F.KEELY

```
10:WAIT 50:PRINT
   "CAP.ZONE/VEL.
   DSTR.-J.KEELY"
20:LF 5:CSIZE 5:
   COLOR 1
30:LPRINT "CAPZON
   EVELDSTRPROGRA
   M"
40:CSIZE 3:COLOR
   2:LPRINT "BY J
   .F.KEELY"
45:CSIZE 2:LF 2:
   COLOR 3:LPRINT
   "TIME=";TIME
50:DIM XWELL(50),
   YWELL(50),FLRT
   (50)
60:DIM XOBS(50),Y
   OBS(50)
70:DIM WXVEL(50),
   WYVEL(50)
80:COLOR 0:LF 3:C
   ALCINDEX=0:
   DEGREE
85:CALCINDEX=CALC
   INDEX+1:LPRINT
   "CALCULATION N
   O.";CALCINDEX:
   LF 3
90:INPUT "IS REG.
   VEL. KNOWN?(Yo
   rN) ";CHOICE
100:IF CHOICE=Y
    THEN GOTO 200
110:LPRINT "  REG.
    VEL. INPUTS ":
    GRAPH :LINE (0
    ,0)-(216,50),2
    ,3,B:TEXT :LF
    2:COLOR 0
120:INPUT "HYD.CON
    D.(GPD/SQ.FT.)
    ? ";HYDCND
125:LPRINT "HYD.CO
    ND(GPD/FT2)=",
    HYDCND
130:INPUT "HYD.GRA
    D.(FT/FT)? ";G
    RDNT
135:LPRINT "HYD.GR
    AD(FT/FT)=",GR
    DNT
140:INPUT "EFF.POR
    OSITY(DECIMAL)
    ? ";PRSTY
145:LPRINT "EFF.PO
    ROSITY(DEC)=",
    PRSTY
150:REGVEL=(HYDCND
    /7.48)*GRDNT/P
    RSTY
160:LF 1:CSIZE 3:
    COLOR 2
165:LPRINT "REG.VE
    LOCITY  (FT/DA
    Y)":CSIZE 2:
    COLOR 0:LPRINT
    "  ";REGVEL:LF
    1
170:CSIZE 3:COLOR
    2:LPRINT "<<<<
    <<>>>>>>":
    COLOR 0:CSIZE
    2:LF 4
200:INPUT "C-ZONE
    or V-DSTR.?(Co
    rV) ";CZVD
210:IF CZVD=VTHEN
    GOTO 700
220:LPRINT " CAPT.
    ZONE INPUTS ":
    GRAPH :LINE (0
    ,0)-(216,50),2
    ,3,B:TEXT :LF
    2:COLOR 0
230:INPUT "REG.VEL
    .(FT/DAY)? ";R
    EGVEL
240:LPRINT "REG.VE
    L.(FT/DAY)=",R
    EGVEL
250:INPUT "EFF.SAT
    .THICK.(FT)? "
    ;SATHK
255:LPRINT "EFF.SA
    T.THICK(FT)=",
    SATHK
260:INPUT "EFF.POR
    OSITY(DECIMAL)
    ? ";PRSTY
265:LPRINT "EFF.PO
    ROSITY(DEC)=",
    PRSTY
270:INPUT "FLOW RA
    TE(GPM)? ";FLR
    T
275:LPRINT "FLOW R
    ATE(GPM)=",FLR
    T
280:LF 1:CSIZE 3:
    COLOR 2
285:LPRINT "CAPTUR
    E ZONE DIMENSI
    ONS ":CSIZE 2:
    COLOR 0
290:STAGPTDWNGR=(F
    LRT*1440/7.48)
    /(2*Π*SATHK*PR
    STY*REGVEL)
295:LPRINT " STAGN
    ATION POINT":
    LPRINT " DOWNG
    RADIENT(FT)",S
    TAGPTDWNGR
300:UPGRCPZNWDTH=2
    *Π*STAGPTDWNGR
305:LPRINT "MAXIMU
    M UPGRADIENT":
    LPRINT "CAP.ZO
    NE WIDTH(FT)",
    UPGRCPZNWDTH
306:LF 1:CSIZE 3:
    COLOR 2:LPRINT
    "<<<<<<>>>>>>"
    :COLOR 0:CSIZE
    2:LF 4
310:INPUT "MORE CA
    LCULATIONS?(Yo
    rN) ";AGAIN
320:IF AGAIN=YTHEN
    GOTO 85
330:LF 2:CSIZE 4:
    COLOR 1
340:LPRINT " PROGR
    AM  OVER,  TH
    ANK YOU":LF 3:
    COLOR 0:CSIZE
    2:END
700:CSIZE 2:COLOR
    0:LPRINT " VEL
    .DSTR. INPUTS"
705:GRAPH :LINE (0
    ,0)-(216,50),2
    ,3,B:TEXT :
    COLOR 0:LF 2
710:INPUT "REG.VEL
    .(FT/DAY)? ";R
    EGVEL
715:LPRINT "REG.VE
    L.(FT/DAY)=",R
    EGVEL
```

```
720:INPUT "REG.FLO
    W DIR.(N=0,E=9
    0)?";THETA
725:LPRINT "REG.FL
    OW DIRECTION":
    LPRINT "(BEARI
    NG,DEGREES)=",
    THETA
730:INPUT "EFF.SAT
    .THICK.(FT)? "
    ;SATHK
735:LPRINT "EFF.SA
    T.THICK(FT)=",
    SATHK
740:INPUT "EFF.POR
    OSITY(DECIMAL)
    ? ";PRSTY
745:LPRINT "EFF.PO
    ROSITY(DEC)=",
    PRSTY
750:INPUT "# OF WE
    LLS(MAX=50)?";
    W:LF 2
755:FOR J=1TO W:
    CSIZE 3:COLOR
    2
757:LPRINT " WELL
    NO.";J:CSIZE 2
    :COLOR 0
760:INPUT "FLOW(GP
    M:+PUMP,-INJ)?
     ";FLRT(J)
765:LPRINT "FLOW R
    ATE(GPM)=",FLR
    T(J)
770:INPUT "WELL X-
    COORD.(FT)? ";
    XWELL(J)
775:LPRINT "WELL X
    -COORD.(FT)=",
    XWELL(J)
780:INPUT "WELL Y-
    COORD.(FT)? ";
    YWELL(J)
785:LPRINT "WELL Y
    -COORD.(FT)=",
    YWELL(J):LF 1
790:NEXT J
800:INPUT "# OF OB
    S.POINTS(MAX=5
    0)?";N:LF 2
810:FOR I=1TO N:
    CSIZE 3:COLOR
    2
815:LPRINT "OBS.PO
    INT";I:CSIZE 2
    :COLOR 0
820:INPUT "X-COORD
    .(FT)? ";XOBS(
825:LPRINT "X-COOR
    D.(FT)=";XOBS(
    I)
830:INPUT "Y-COORD
    .(FT)? ";YOBS(
    I)
835:LPRINT "Y-COOR
    D.(FT)=";YOBS(
    I):LF 1
836:CSIZE 3:COLOR
    2:LPRINT "<<<<
    <<>>>>>>":
    COLOR 0:CSIZE
    2
838:WXVEL=0:WYVEL=
    0
840:FOR J=1TO W
845:A=XOBS(I)-XWEL
    L(J):B=YOBS(I)
    -YWELL(J)
850:WXVEL(J)=((FLR
    T(J)*1440/7.48
    )/(2*Π*SATHK*P
    RSTY))*(A/(A^2
    +B^2))
851:WYVEL(J)=((FLR
    T(J)*1440/7.48
    )/(2*Π*SATHK*P
    RSTY))*(B/(A^2
    +B^2))
856:WXVEL=WXVEL+WX
    VEL(J)
857:WYVEL=WYVEL+WY
    VEL(J)
858:NEXT J
860:XVEL=(REGVEL*
    SIN THETA)-WXV
    EL
861:YVEL=(REGVEL*
    COS THETA)-WYV
    EL
865:LPRINT "VEL. X
    -COMPONENT":
    LPRINT "(FT/DA
    Y)=",XVEL
870:LPRINT "VEL. Y
    -COMPONENT":
    LPRINT "(FT/DA
    Y)=",YVEL
875:NETVEL=√(XVEL^
    2+YVEL^2)
880:LPRINT "NET VE
    L.(FT/DAY)=",N
    ETVEL
885:BETA=ATN (XVEL
    /YVEL)
886:IF SGN YVEL=-1
    THEN GOTO 893
887:IF SGN BETA=-1
388:GOTO 895
890:BETA=BETA+360:
    GOTO 895
893:BETA=BETA+180
895:LPRINT "NET FL
    OW DIRECTION":
    LPRINT "(BEARI
    NG,DEGREES)=",
    BETA:LF 1
896:CSIZE 3:COLOR
    2:LPRINT "<<<<
    <<>>>>>>":
    COLOR 0:CSIZE
    2
900:LF 1:NEXT I
910:INPUT "MORE CA
    LCULATIONS?(Yo
    r N) ";AGAIN
920:IF AGAIN=YTHEN
    GOTO 85
930:LF 2:CSIZE 4:
    COLOR 1
940:LPRINT " PROGR
    AM   OVER,   TH
    ANK YOU":LF 3:
    COLOR 0:CSIZE
    2:END
```

PROGRAM
OVER.
THANK YOU

FIGURE 2

CAPZONE
VELDSTR
PROGRAM

BY J.F.KEELY

CALCULATION NO. 1

REG.VEL. INPUTS

HYD.COND(GPD/FT2)=
1100
HYD.GRAD(FT/FT)=
0.002
EFF.POROSITY(DEC)=
0.3

REG.VELOCITY
(FT/DAY)
9.803921569E-01

<<<<<<>>>>>>

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
0.98
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
1000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
1042.158309
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
6548.073775

<<<<<<>>>>>>

CALCULATION NO. 2

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
0.98
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
2000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
2084.316618
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
13096.14755

<<<<<<>>>>>>

FIGURE 3

CAPZONE
VELDSTR
PROGRAM

BY J.F.KEELY

CALCULATION NO. 1

REG.VEL. INPUTS

HYD.COND(GPD/FT2)=
5000
HYD.GRAD(FT/FT)=
0.0013
EFF.POROSITY(DEC)=
0.3

REG.VELOCITY
(FT/DAY)
2.896613191

<<<<<<>>>>>>

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
2.9
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
1000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
352.1776355
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
2212.797345

<<<<<<>>>>>>

CALCULATION NO. 2

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
2.9
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
2000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
704.3552709
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
4425.594689

<<<<<<>>>>>>

OBS.POINT 8

X-COORD.(FT)= 0
Y-COORD.(FT)= 400

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-5.453287857
NET VEL.(FT/DAY)=
5.453287857
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 9

X-COORD.(FT)= 0
Y-COORD.(FT)= 300

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-6.30438381
NET VEL.(FT/DAY)=
6.30438381
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 10

X-COORD.(FT)= 0
Y-COORD.(FT)= 200

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-8.006575714
NET VEL.(FT/DAY)=
8.006575714
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 11

X-COORD.(FT)= 0
Y-COORD.(FT)= 100

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-13.11315143
NET VEL.(FT/DAY)=
13.11315143
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 12

X-COORD.(FT)= 0
Y-COORD.(FT)= 1

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-1024.215143
NET VEL.(FT/DAY)=
1024.215143
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 13

X-COORD.(FT)= 0
Y-COORD.(FT)=-1

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
1018.415143
NET VEL.(FT/DAY)=
1018.415143
NET FLOW DIRECTION
(BEARING, DEGREES)=
0

<<<<<<>>>>>>

OBS.POINT 14

X-COORD.(FT)= 0
Y-COORD.(FT)=-100

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
7.31315143
NET VEL.(FT/DAY)=
7.31315143
NET FLOW DIRECTION
(BEARING, DEGREES)=
0

<<<<<<>>>>>>

OBS.POINT 15

X-COORD.(FT)= 0
Y-COORD.(FT)=-200

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
2.206575714
NET VEL.(FT/DAY)=
2.206575714
NET FLOW DIRECTION
(BEARING, DEGREES)=
0

<<<<<<>>>>>>

OBS.POINT 16

X-COORD.(FT)= 0
Y-COORD.(FT)=-300

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
0.50438381
NET VEL.(FT/DAY)=
0.50438381
NET FLOW DIRECTION
(BEARING, DEGREES)=
0

<<<<<<>>>>>>

OBS.POINT 17

X-COORD.(FT)= 0
Y-COORD.(FT)=-400

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-3.303089078E-02
VEL. Y-COMPONENT
(FT/DAY)=
-0.089071195
NET VEL.(FT/DAY)=
9.499851328E-02
NET FLOW DIRECTION
(BEARING, DEGREES)=
200.3466419

<<<<<<>>>>>>

OBS.POINT 18

X-COORD.(FT)= 0
Y-COORD.(FT)=-500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-3.142508132E-02
VEL. Y-COMPONENT
(FT/DAY)=
-0.605969063
NET VEL.(FT/DAY)=
6.067833559E-01
NET FLOW DIRECTION
(BEARING, DEGREES)=
182.9686549

<<<<<<>>>>>>

OBS.POINT 19

X-COORD.(FT)= 0
Y-COORD.(FT)=-1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-2.491012544E-02
VEL. Y-COMPONENT
(FT/DAY)=
-1.654493728
NET VEL.(FT/DAY)=
1.654681241
NET FLOW DIRECTION
(BEARING, DEGREES)=
180.8625824

<<<<<<>>>>>>

OBS.POINT [illegible]

X-COORD.(FT)= 500
Y-COORD.(FT)= 0

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-2.119710674
VEL. Y-COMPONENT
(FT/DAY)=
-2.630218642
NET VEL.(FT/DAY)=
3.378050243
NET FLOW DIRECTION
(BEARING, DEGREES)=
218.8655716

<<<<<<>>>>>>

OBS.POINT 21

X-COORD.(FT)=-500
Y-COORD.(FT)= 0

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
2.042630286
VEL. Y-COMPONENT
(FT/DAY)=
-2.608195674
NET VEL.(FT/DAY)=
3.31285725
NET FLOW DIRECTION
(BEARING, DEGREES)=
141.933431

<<<<<<>>>>>>

OBS.POINT 22

X-COORD.(FT)= 500
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-5.493971113E-01
VEL. Y-COMPONENT
(FT/DAY)=
-3.364874479
NET VEL.(FT/DAY)=
3.409430663
NET FLOW DIRECTION
(BEARING, DEGREES)=
189.2730968

<<<<<<>>>>>>

OBS.POINT 23

X-COORD.(FT)=-500
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
4.085260571E-01
VEL. Y-COMPONENT
(FT/DAY)=
-3.308526057
NET VEL.(FT/DAY)=
3.333652383
NET FLOW DIRECTION
(BEARING, DEGREES)=
172.9609326

<<<<<<>>>>>>

OBS.POINT 24

X-COORD.(FT)= 500
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-8.722583382E-01
VEL. Y-COMPONENT
(FT/DAY)=
-2.822711287
NET VEL.(FT/DAY)=
2.954409183
NET FLOW DIRECTION
(BEARING, DEGREES)=
197.1719004

<<<<<<>>>>>>

OBS.POINT 25

X-COORD.(FT)=-500
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
5.520622394E-02
VEL. Y-COMPONENT
(FT/DAY)=
-1.188607058
NET VEL.(FT/DAY)=
1.189888426
NET FLOW DIRECTION
(BEARING, DEGREES)=
177.3407426

<<<<<<>>>>>>

FIGURE 4

CAPZONE
VELDSTR
PROGRAM

BY J.F.KEELY

CALCULATION NO. 1

REG.VEL. INPUTS

HYD.COND(GPD/FT2)=
5000
HYD.GRAD(FT/FT)=
0.002
EFF.POROSITY(DEC)=
0.3

REG.VELOCITY
(FT/DAY)

4.456327986

<<<<<<>>>>>>

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
4.5
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
1000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
226.9589206
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
1426.024955

<<<<<<>>>>>>

CALCULATION NO. 2

CAPT.ZONE INPUTS

REG.VEL.(FT/DAY)=
4.5
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3
FLOW RATE(GPM)=
2000

CAPTURE ZONE
DIMENSIONS

STAGNATION POINT
DOWNGRADIENT(FT)
453.9178413
MAXIMUM UPGRADIENT
CAP.ZONE WIDTH(FT)
2852.049911

<<<<<<>>>>>>

FIGURE 5

CAPZONE VELDSTR PROGRAM

BY J.F.KEELY

CALCULATION NO. 1

VEL.DSTR. INPUTS

REG.VEL.(FT/DAY)=
2.9
REG.FLOW DIRECTION
(BEARING, DEGREES)=
180
EFF.SAT.THICK(FT)=
100
EFF.POROSITY(DEC)=
0.3

WELL NO. 1

FLOW RATE(GPM)=
1000
WELL X-COORD.(FT)=
0
WELL Y-COORD.(FT)=
0

OBS.POINT 1

X-COORD.(FT)= 0
Y-COORD.(FT)= 3500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.191804327
NET VEL.(FT/DAY)=
3.191804327
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

OBS.POINT 2

X-COORD.(FT)= 0
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.240438381
NET VEL.(FT/DAY)=
3.240438381
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 3

X-COORD.(FT)= 0
Y-COORD.(FT)= 2500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.308526057
NET VEL.(FT/DAY)=
3.308526057
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 4

X-COORD.(FT)= 0
Y-COORD.(FT)= 2000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.410657571
NET VEL.(FT/DAY)=
3.410657571
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

OBS.POINT 5

X-COORD.(FT)= 0
Y-COORD.(FT)= 1500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.580876762
NET VEL.(FT/DAY)=
3.580876762
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 6

X-COORD.(FT)= 0
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-3.921315143
NET VEL.(FT/DAY)=
3.921315143
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 7

X-COORD.(FT)= 0
Y-COORD.(FT)= 500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-4.942630286
NET VEL.(FT/DAY)=
4.942630286
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

FIGURE 6

VEL.DSTR. INPUTS

REG.VEL.(FT/DAY)= 2.9
REG.FLOW DIRECTION (BEARING,DEGREES)= 180
EFF.SAT.THICK(FT)= 100
EFF.POROSITY(DEC)= 0.3

WELL NO. 1

FLOW RATE(GPM)= 1000
WELL X-COORD.(FT)= 0
WELL Y-COORD.(FT)= 0

WELL NO. 2

FLOW RATE(GPM)= 1000
WELL X-COORD.(FT)= -500
WELL Y-COORD.(FT)= 3500

OBS.POINT 1

X-COORD.(FT)= 0
Y-COORD.(FT)= 3500

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -2.042630286
VEL. Y-COMPONENT (FT/DAY)= -3.191804327
NET VEL.(FT/DAY)= 3.789452909
NET FLOW DIRECTION (BEARING,DEGREES)= 212.6176578

<<<<<<>>>>>>

OBS.POINT 2

X-COORD.(FT)= 0
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -1.021315143
VEL. Y-COMPONENT (FT/DAY)= -2.219123238
NET VEL.(FT/DAY)= 2.442865646
NET FLOW DIRECTION (BEARING,DEGREES)= 204.7134775

<<<<<<>>>>>>

OBS.POINT 3

X-COORD.(FT)= 0
Y-COORD.(FT)= 2500

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -4.085260571E-01
VEL. Y-COMPONENT (FT/DAY)= -2.491473943
NET VEL.(FT/DAY)= 2.524744729
NET FLOW DIRECTION (BEARING,DEGREES)= 189.3119043

<<<<<<>>>>>>

OBS.POINT 4

X-COORD.(FT)= 0
Y-COORD.(FT)= 2000

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -2.042630286E-01
VEL. Y-COMPONENT (FT/DAY)= -2.797868486
NET VEL.(FT/DAY)= 2.805314858
NET FLOW DIRECTION (BEARING,DEGREES)= 184.1755654

<<<<<<>>>>>>

OBS.POINT 5

X-COORD.(FT)= 0
Y-COORD.(FT)= 1500

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -1.201547227E-01
VEL. Y-COMPONENT (FT/DAY)= -3.100257871
NET VEL.(FT/DAY)= 3.102585377
NET FLOW DIRECTION (BEARING,DEGREES)= 182.2194653

<<<<<<>>>>>>

OBS.POINT 6

X-COORD.(FT)= 0
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -7.85627033E-02
VEL. Y-COMPONENT (FT/DAY)= -3.528501627
NET VEL.(FT/DAY)= 3.529376125
NET FLOW DIRECTION (BEARING,DEGREES)= 181.2754898

<<<<<<>>>>>>

OBS.POINT 7

X-COORD.(FT)= 0
Y-COORD.(FT)= 500

<<<<<<>>>>>>

VEL. X-COMPONENT (FT/DAY)= -5.520622394E-02
VEL. Y-COMPONENT (FT/DAY)= -4.611392942
NET VEL.(FT/DAY)= 4.611723386
NET FLOW DIRECTION (BEARING,DEGREES)= 180.6858953

<<<<<<>>>>>>

OBS.POINT 8

X-COORD.(FT)= 0
Y-COORD.(FT)= 400

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-5.179082875E-02
VEL. Y-COMPONENT
(FT/DAY)=
-5.132184719
NET VEL.(FT/DAY)=
5.132446033
NET FLOW DIRECTION
(BEARING,DEGREES)=
180.5781739

<<<<<<>>>>>>

OBS.POINT 9

X-COORD.(FT)= 0
Y-COORD.(FT)= 300

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.868041673E-02
VEL. Y-COMPONENT
(FT/DAY)=
-5.992829143
NET VEL.(FT/DAY)=
5.993026858
NET FLOW DIRECTION
(BEARING,DEGREES)=
180.4654097

<<<<<<>>>>>>

OBS.POINT 10

X-COORD.(FT)= 0
Y-COORD.(FT)= 200

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.583999744E-02
VEL. Y-COMPONENT
(FT/DAY)=
-7.704031731
NET VEL.(FT/DAY)=
7.704168107
NET FLOW DIRECTION
(BEARING,DEGREES)=
180.3409134

<<<<<<>>>>>>

OBS.POINT 11

X-COORD.(FT)= 0
Y-COORD.(FT)= 100

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.32394218E-02
VEL. Y-COMPONENT
(FT/DAY)=
-12.81912336
NET VEL.(FT/DAY)=
12.81919628
NET FLOW DIRECTION
(BEARING,DEGREES)=
180.1932602

<<<<<<>>>>>>

OBS.POINT 12

X-COORD.(FT)= 0
Y-COORD.(FT)= 1

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.082549272E-02
VEL. Y-COMPONENT
(FT/DAY)=
-1023.929096
NET VEL.(FT/DAY)=
1023.929097
NET FLOW DIRECTION
(BEARING,DEGREES)=
180.0022873

<<<<<<>>>>>>

OBS.POINT 13

X-COORD.(FT)= 0
Y-COORD.(FT)=-1

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.08297378E-02
VEL. Y-COMPONENT
(FT/DAY)=
1018.701033
NET VEL.(FT/DAY)=
1018.701034
NET FLOW DIRECTION
(BEARING,DEGREES)=
359.9977036

<<<<<<>>>>>>

OBS.POINT 14

X-COORD.(FT)= 0
Y-COORD.(FT)=-100

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-3.865689413E-02
VEL. Y-COMPONENT
(FT/DAY)=
7.59148107
NET VEL.(FT/DAY)=
7.591579492
NET FLOW DIRECTION
(BEARING,DEGREES)=
359.7082443

<<<<<<>>>>>>

OBS.POINT 15

X-COORD.(FT)= 0
Y-COORD.(FT)=-200

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-3.663253741E-02
VEL. Y-COMPONENT
(FT/DAY)=
2.477656491
NET VEL.(FT/DAY)=
2.477927285
NET FLOW DIRECTION
(BEARING,DEGREES)=
359.1529347

<<<<<<>>>>>>

OBS.POINT 16

X-COORD.(FT)= 0
Y-COORD.(FT)=-300

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-3.47622581E-02
VEL. Y-COMPONENT
(FT/DAY)=
0.768576972
NET VEL.(FT/DAY)=
0.769362708
NET FLOW DIRECTION
(BEARING,DEGREES)=
357.4103125

<<<<<<>>>>>>

Hence, further calculations in this discussion will focus on these three velocity estimates (V = 0.98, 2.9, and 4.5 ft/day).

In order to get a rough estimate of how long it would take for contaminants to reach a certain point down valley of the site, the three preceding estimates of the natural flow velocity can be used with the following assumptions:

(1) the aquifer properties are constant,

(2) no acceleration or deceleration of the contaminant plume occurs due to pumpage stresses,

(3) dispersion, sorption, biodegradation, and other processes negligibly affect the contaminant plume concentrations, and

(4) the natural flow direction is straight from the site to the point of interest.

Then, using the equation:

Time of Travel (days) = Distance to Point (feet) ÷ Velocity (ft/day), the following results are obtained:

	V = 0.98 ft/day	2.9 ft/day	4.5 ft/day
1,000 feet (arbitrary point)	1,020 days	345 days	222 days
3,500 feet (Mercy Hospital well)	3,571 days	1,207 days	778 days
15,000 feet (Hamilton Well Field)	15,306 days	5,172 days	3,333 days

The first assumption, constant aquifer properties, is a broad one, but cannot be further limited unless numerical modeling is attempted; for purposes of this discussion numerical models are not a viable option (more on that later) and simple, analytical models are employed exclusively. The second assumption, no velocity variations from pumping stresses, can be considerably relaxed since analytical models do allow for such inputs (this is done in subsequent examples). The third assumption, conservative contaminant behavior with no dispersion, can be eliminated if sufficient data are available since analytical models allow such inputs; unfortunately, reliable estimates of the kinetics and capacity for sorption, biodegradation, etc., are not readily available for this site. The final assumption, natural flow direct from site to point of interest, is not easily treated since it presupposes some idea of the directional changes in hydraulic conductivity and gradient (which are already assumed constant) and also presupposes that the points of interest lie along the same general line (not a bad assumption for the Mercy Hospital Well and the Hamilton Well Field).

In order to refine these rough estimates, the velocity variations from pumping stresses can be determined. Using the analytical modeling approach described by Keely and Tsang (Ground Water, Nov-Dec 1983), a short BASIC-language program, called CAPZONE-VELDSTR (for Capture Zones and Velocity Distributions), was prepared on a Sharp PC-1500 microcomputer and used to generate solutions to a few scenarios involving pumping wells down valley from the Chem-Dyne site. Figure 1 is a listing of that BASIC program; Figures 2-6 are fully documented runs of the program.

Figure 2 shows the computation of the natural/regional velocity (using the Draft RI estimates of hydraulic conductivity and gradient) and an estimate of what the lateral and downgradient limits of the capture zone of wells pumping 1000 gpm and 2000 gpm would be. What those calculations show, for example, is that a well pumping 1000 gpm (e.g., Mercy Hospital well or Champion Paper wells) will pull waters flowing toward the well from upgradient which lie within a 6550 feet-wide strip centered on the well. Hence, the Mercy Hospital well could easily entrap contaminated waters flowing south of Chem-Dyne, and the Champion Paper Wells could easily capture portions of the Chem-Dyne contaminant plume(s) west of the site since these lie within the lateral limits of the capture zone. Note that the second capture zone estimate in Figure 2 shows that twice the flow (2000 gpm) yields twice the capture zone dimensions; in other words, flow rate and capture zone are linearly related, all other factors held constant. Thus, one can multiply the dimensions given by the fraction of flow for different flow rates; it is not necessary to re-run the program each time unless other parameters change.

Figures 3 and 4 are similar analyses, but with the natural/regional velocity values of 2.9 ft/day and 4.5 ft/day, respectively. As expected, the capture zone dimensions shrink considerably as the natural flow velocity is increased. Naturally, all of these analyses assume homogenous, isotropic conditions. If, as shown during the pumping test, the aquifer is nonhomogenous and/or isotropic, the capture zone dimensions will be affected substantially. If the nonhomogeneities result in large portions of the 100 feet saturated thickness being at lower hydraulic conductivity or porosity values, then the capture zones will be expanded. If the major axis of anisotropy nearly parallels the predominant direction of flow, then the distance to the downgradient stagnation point will be lessened and the lateral limits of the capture zone will be expanded. Conversely, if the major axis of anisotropy is nearly perpendicular to the predominant direction of flow, then the distance to the downgradient stagnation point will be much greater and the lateral limits whill shrink inward. Down valley of Chem-Dyne, the former situation (anisotropy parallel to flow) is expected, whereas near site the latter situation is expected (anisotropy perpendicular to valley flow trends). Weighing these factors, it is probable that Champion Paper wells do capture some of the Chem-Dyne contaminant plume(s) and it is probable that Mercy Hospital's well will be, if it is

OBS.POINT 17

X-COORD.(FT)= 0
Y-COORD.(FT)=-400

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-0.346712143
NET VEL.(FT/DAY)=
0.346712143
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 18

X-COORD.(FT)= 0
Y-COORD.(FT)=-500

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-0.857369714
NET VEL.(FT/DAY)=
0.857369714
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 19

X-COORD.(FT)= 0
Y-COORD.(FT)=-1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
0
VEL. Y-COMPONENT
(FT/DAY)=
-1.878684857
NET VEL.(FT/DAY)=
1.878684857
NET FLOW DIRECTION
(BEARING, DEGREES)=
180

<<<<<<>>>>>>

OBS.POINT 20

X-COORD.(FT)= 500
Y-COORD.(FT)= 0

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-2.042630286
VEL. Y-COMPONENT
(FT/DAY)=
-2.9
NET VEL.(FT/DAY)=
3.547159213
NET FLOW DIRECTION
(BEARING, DEGREES)=
215.1591534

<<<<<<>>>>>>

OBS.POINT 21

X-COORD.(FT)=-500
Y-COORD.(FT)= 0

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
2.042630286
VEL. Y-COMPONENT
(FT/DAY)=
-2.9
NET VEL.(FT/DAY)=
3.547159213
NET FLOW DIRECTION
(BEARING, DEGREES)=
144.8408466

<<<<<<>>>>>>

OBS.POINT 22

X-COORD.(FT)= 500
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-4.085260571E-01
VEL. Y-COMPONENT
(FT/DAY)=
-3.717052114
NET VEL.(FT/DAY)=
3.739434443
NET FLOW DIRECTION
(BEARING, DEGREES)=
186.2719729

<<<<<<>>>>>>

OBS.POINT 23

X-COORD.(FT)=-500
Y-COORD.(FT)= 1000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
4.085260571E-01
VEL. Y-COMPONENT
(FT/DAY)=
-3.717052114
NET VEL.(FT/DAY)=
3.739434443
NET FLOW DIRECTION
(BEARING, DEGREES)=
173.7280271

<<<<<<>>>>>>

OBS.POINT 24

X-COORD.(FT)= 500
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
-5.520622394E-02
VEL. Y-COMPONENT
(FT/DAY)=
-3.231237344
NET VEL.(FT/DAY)=
3.231708913
NET FLOW DIRECTION
(BEARING, DEGREES)=
180.9788126

<<<<<<>>>>>>

OBS.POINT 25

X-COORD.(FT)=-500
Y-COORD.(FT)= 3000

<<<<<<>>>>>>

VEL. X-COMPONENT
(FT/DAY)=
5.520622394E-02
VEL. Y-COMPONENT
(FT/DAY)=
-3.231237344
NET VEL.(FT/DAY)=
3.231708913
NET FLOW DIRECTION
(BEARING, DEGREES)=
179.0211874

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