GROUND PENETRATING RADAR SURVEY RESULTS

FOR THE
INVESTIGATION FOR THE LOCATION OF:

Underground Storage Tanks & Utilities

AT:

77 Cooper St.
Meriden, CT

PREPARED FOR:

Advanced Environmental, Interface, Inc.
Middlefield, CT

PREPARED BY:

SUB-SURFACE INFORMATIONAL SURVEYS, INC.
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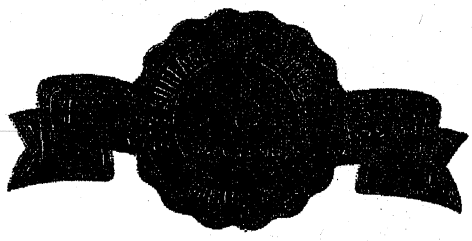
EASTLONGMEADOW, MA 01028



July 14, 2005

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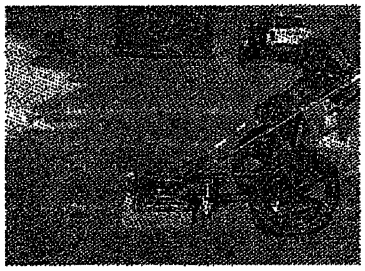

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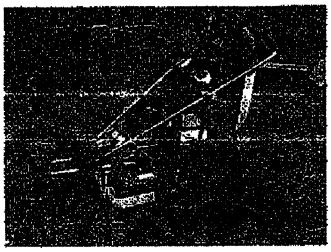
1.0 Introduction

In accordance with your authorization, Sub-Surface Informational Surveys, Inc. (SIS) reports to you the results of the ground penetrating radar survey performed on July 14, 2005 at 77 Cooper Street in the City of Meriden, CT. This survey was directed by your approval of SIS quotation #1.2670.05 dated June 16, 2005.

1.1 Purpose and Scope

The purpose of the survey was to mark out utilities and investigate for the presence of suspected underground storage tanks.



SIR-3000 GPR Portable System with 400 MHz antenna

2.0 Geophysical Survey

The geophysical survey was performed by Sub-Surface Informational Surveys, Inc. A transducer operator / supervising GPR technician performed the survey.

2.1 Geophysical Survey Procedures

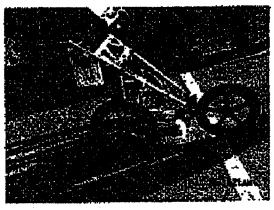
The depth setting for the GPR survey was approximately 10.0' for the underground storage tank investigation. A 4.5' (average) grid was implemented in both north/south and east/west directions.

The following is an explanation of the equipment used during our survey:

1. **Pipehorn 500 Dual-Transmitter, Dual-Frequency Locator:** This unity has two separate transmitters. One operates at the highest frequency available in sweeping an area of tracing poor conductors such as iron pipes, fiber optic cable or tracer tape. A second, low frequency transmitter enables us to quickly isolate a single conductor in congested areas, or to trace for a long distance. **NOT IMPLEMENTED**

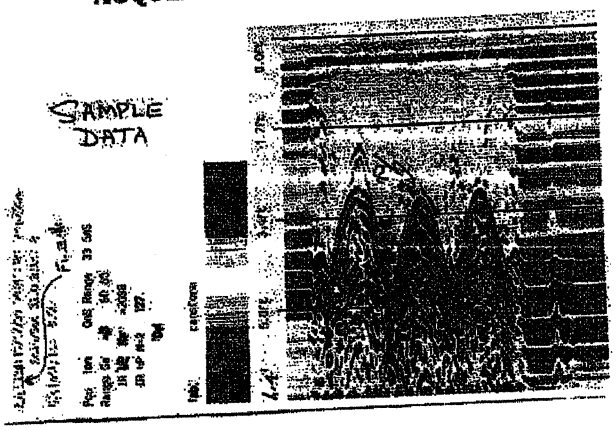
2. **The Subsite 75R/75T:** This unit provides digital signal processing for a variety of applications. The unit offers Active, Passive and Beacon locating modes. The unit transmits via direct line connections, induction clamp or induces broadcast signals. An 80 kHz frequency facilitates locating metallic lines with insulators that weaken or block low frequencies. In passive mode, detects signals generated by 50/60 HZ power as well as radiated radio frequencies. **NOT IMPLEMENTED**

3. **SIR-3000.** The method also used to conduct the geophysical survey included GPR equipment which consists of a **sub surface interface radar (SIR-3000)** computer manufactured by Geophysical Survey Systems, Inc., power supply, graphic recorder, video display unit and transmitting/receiving antenna. The equipment is known collectively as a **GPR system.** The transmitting/receiving antenna transmits electromagnetic signals into the subsurface and then detects, amplifies and displays reflections of the signal on a graphic recorder and a video display unit. As the antenna is moved slowly across the ground surface or surface of contact, a radar image of the subsurface is produced. The maximum depth of penetration of the GPR signal and the resolution of the reflections are a function of the antenna frequency and the electrical properties of the subsurface. As electrical conductivity of the subsurface increases, GPR signal penetration decreases. GPR reflections are produced by spatial changes in the physical properties of the subsurface (I.e., type of material, presence of any subsurface fluid and porosity) and related changes in the electrical properties of the subsurface material in the path of the signals. The greater the difference, the stronger the observed GPR reflection will be. Characteristics that are considered in the interpretation of GPR data from a given site include the size, shape and amplitude of the reflections. Metallic UST's, utilities and conduits have electrical properties uniquely different from those of the soils in which they are buried. As a result, the GPR reflections are usually of high amplitude and have distinctive shapes. For GPR profiles orientated perpendicular to the long axis of a tank, the signature is similar to a hyperbola. The signature is also a function of the tank diameter.



LIMITATIONS: Pipes and/or conduits under favorable dielectric conditions must maintain a minimum of one inch hyperbolic feature for each one foot of penetration. Metal pipes have very defined subsurface reflections. Plastic is far more subtle due to the physical structure of the conduit. Other types of pipes such as *clay, RCP, Orangeburg, etc.,* are very difficult to identify in the surrounding geology due to their very subtle make-up and porosity. They sometimes *clone* themselves to the surrounding soils which will not show enough of a signature different to identify the pipe from the surrounding geology. The higher the conductivity of the soils, the less in the depth of penetration.

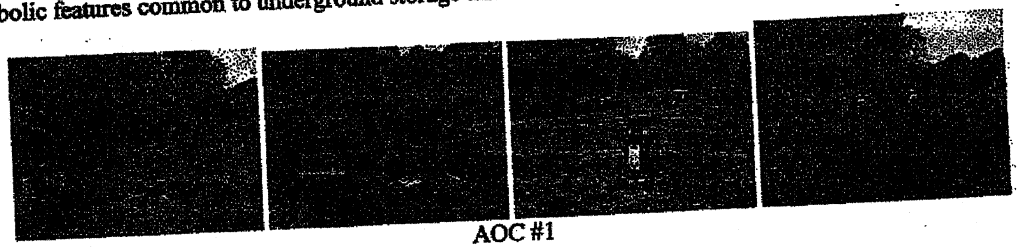
ACQUIRED DATA EXPLANATION



Above represents a sample of data collected by Sub-Surface Informational Surveys, Inc. on October 17, 1999 at a site in the State of Connecticut. It shows three (3) underground storage tanks with a marked centerline. The data FILE# is located on the left tab which also shows the nanosecond (depth) setting, dielectric constant, etc., which is set by our SIR-2000 computer operator. Please match the FILE# on the data with the same FILE# in this report for an explanation of the collected data. NOTE: The above is not part of the data collected for this survey.

2.2 Geophysical Survey Results

Multiple selected areas were surveyed using Ground Penetrating Radar (GPR). Area of Concern (AOC) #1 represented an open [low vegetation] field near TB-3 and MW-2 as indicated in attached Figure 3 (site map) which measured approximately 50' X 80'. Traverses were conducted in both north/south and east/west direction showing no parabolic features common to underground storage tanks. Refer to DZT Data File AEI (Radar profile)

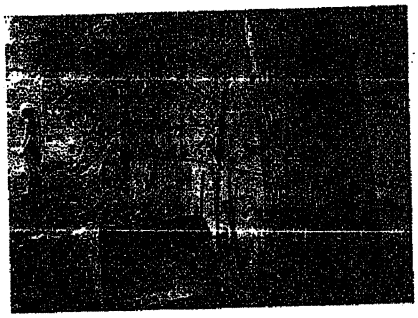


AOC #1

AOC #2 referred to as the "oil tank bunker" (east of the power plant) represented the scanning of an area of approximately 33' X 18'. DZT GPR Data File #AEI59 represents approximately 105' of continuous data showing upper soils to approximately 4.0' below the surface where there is an interface change possibly due to the native soils. There is a slight increase in moisture near 6.5' below the surface with no unusual anomalies to indicate the presence of any underground storage tanks.

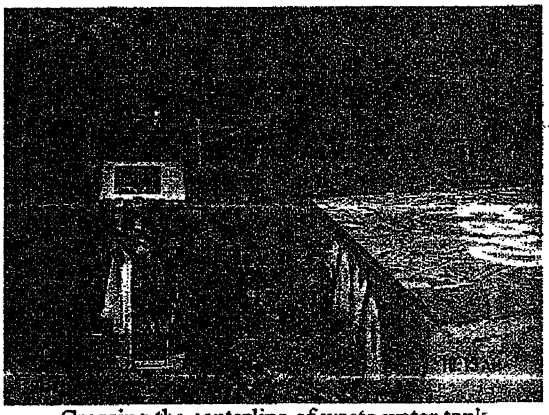
Above photos were taken in AOC#2 where there is a visible [open] pipe which could be that of a former drain as seen in the above right hand photo. No parabolic features associated with this pipe were found in the areas shown in the left and center photos.

AOC #3 - There was a pipe adjacent to the building which was not connected to any anomaly. This area was southeast of AOC #2. (Refer to DZT File AEI63) AOC#4 near MW-1 showed no unusual anomalies

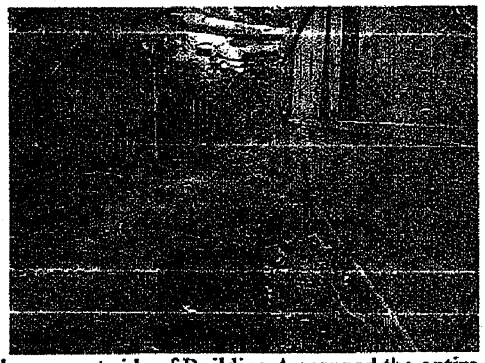


AOC#4 was the scanning of an existing tank referred to as "waste water tank". The long axis and centerline was scanned with the end painted on site on the day of the survey. This area also had a gas line which was marked on site along with a pipe that appeared to come from the end of the tank area and was directed towards the harbor brook. Refer to DZT File #72 for parabolic feature of tank and exiting pipe.

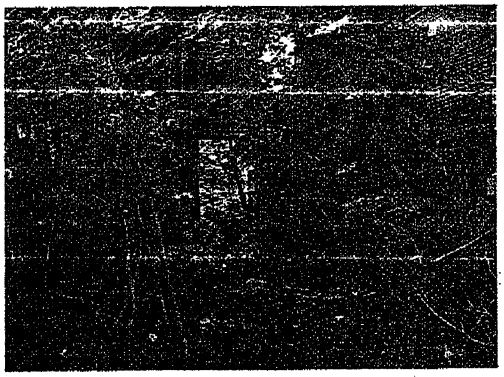
AOC#6 represented a long corridor on east side of Building A. The gas line was marked at various intervals and the approximate depth was marked on the side of the building. Traverses were conducted both crossing the corridor and running its' long axis. NOTE: Utilities viewed in the data were painted on site on the day of the survey.

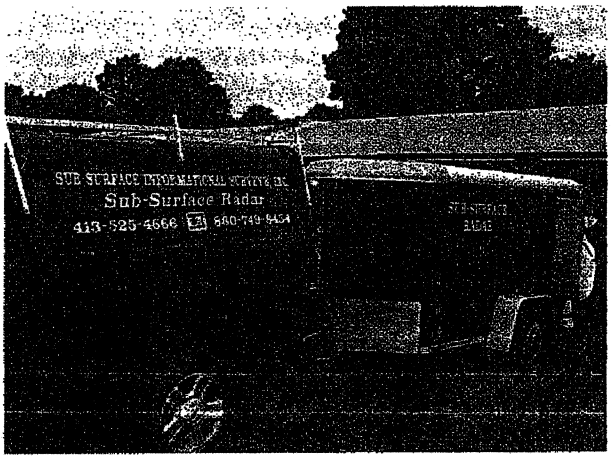


Crossing the centerline of waste water tank

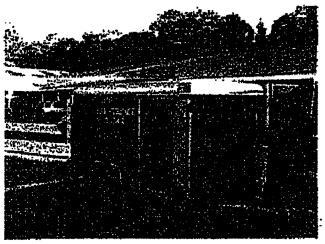


Corridor on east side of Building A scanned the entire length





Real-time data collection



END OF REPORT

GPR ANALYTICAL RESULTS--SIR 3000

The attached analytical result are copies of GPR Data Files collected in the field and reproduced at our corporate office. After reviewing the data, selected samples are taken and duplicated for this report.

Copies are made under the following guidelines:

A. When there are distinctive differences in the collected data. NOTE: When one traverse is almost identical in characterization to another, only one copy would be reproduced.

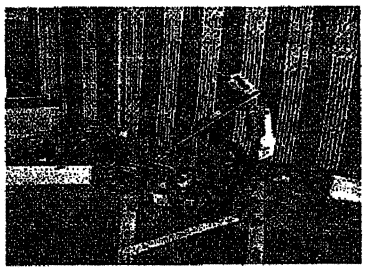
B. If there is a significant difference with suspected anomaly found within the data.

C. In the location of anomalies, such as pipes, and/or conduits, underground storage tanks or other specific characteristics important to the investigation, such data is copied and annotated.

D. Samples of *signal refusal*, (water, clay, or some other highly conductive sub-surface interface).

E. Requested data.

F. Specific locations of rebar and conduits using encoder wheel with measured bench marks.



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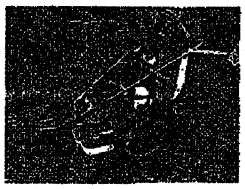
DSC00048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DSC00050

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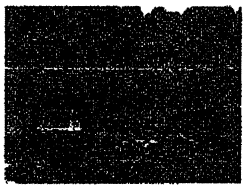
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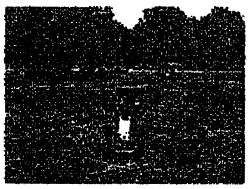
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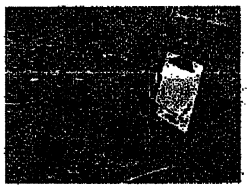
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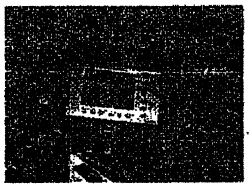
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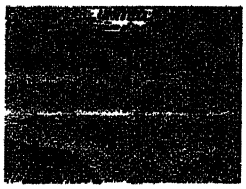
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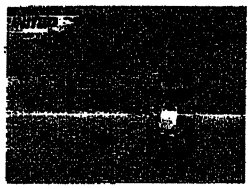
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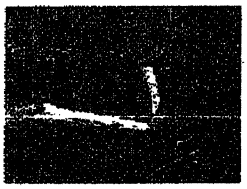
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DSC00065

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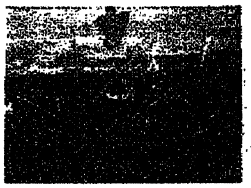
DSC00068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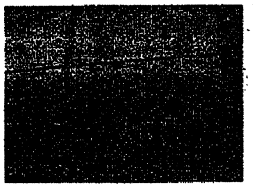
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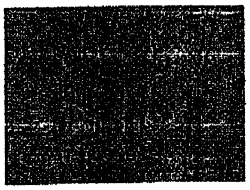

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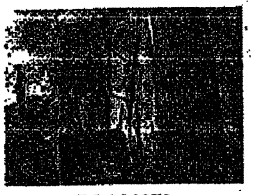

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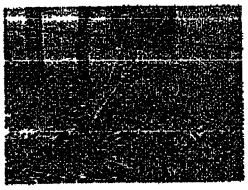

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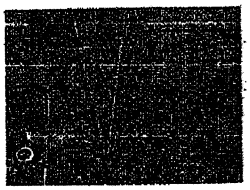

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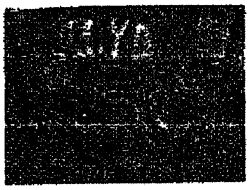

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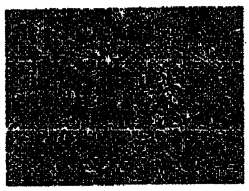

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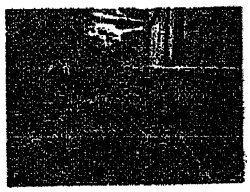

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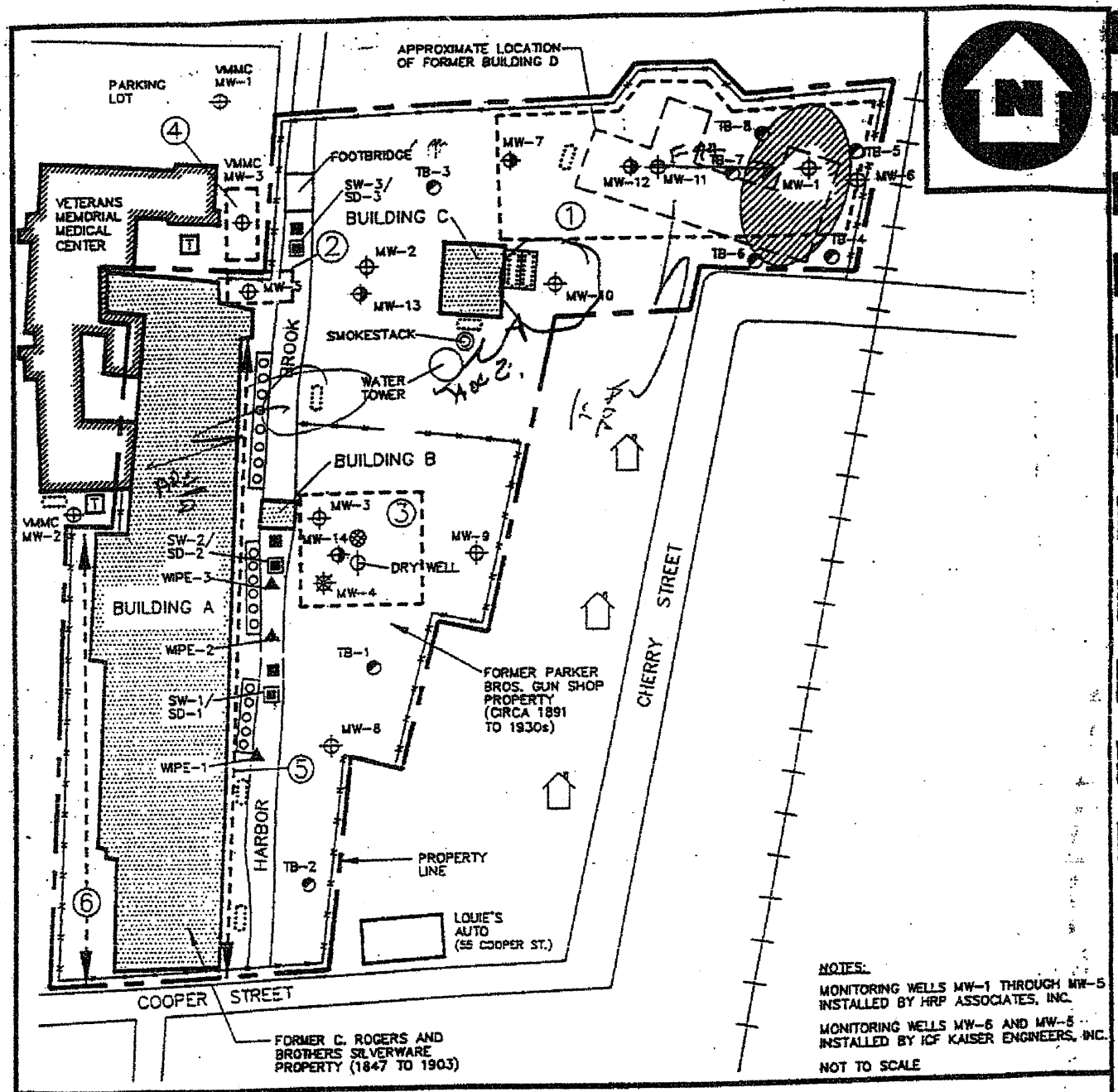


LEGEND

- DESTROYED OVERBURDEN MONITORING WELL
- SHALLOW OVERBURDEN MONITORING WELL
- DEEP OVERBURDEN MONITORING WELL
- CATCHBASIN
- RAILROAD TRACKS
- FENCE
- DUST COLLECTOR AREA (DUST PILES)
- ESTIMATED AREA OF SOIL CONTAMINATION
- UNDERGROUND STORAGE TANK (UST)
- START SEDIMENT AND SURFACE WATER SAMPLING LOCATION
- START RETAINING WALL WIPE SAMPLE LOCATION
- SOIL GAS SURVEY AREAS
- TRANSFORMER
- HRP SEDIMENT SAMPLE LOCATION
- HRP SOIL BORING LOCATION
- RESIDENCE

SAMPLE LOCATION PLAN

INTERNATIONAL SILVER CO.
FACTORY H
COOPER STREET
MERIDEN, CONNECTICUT

WESTON® MANAGERS DESIGNERS/CONSULTANTS
REGION I SUPERFUND TECHNICAL ASSESSMENT AND RESPONSE TEAM

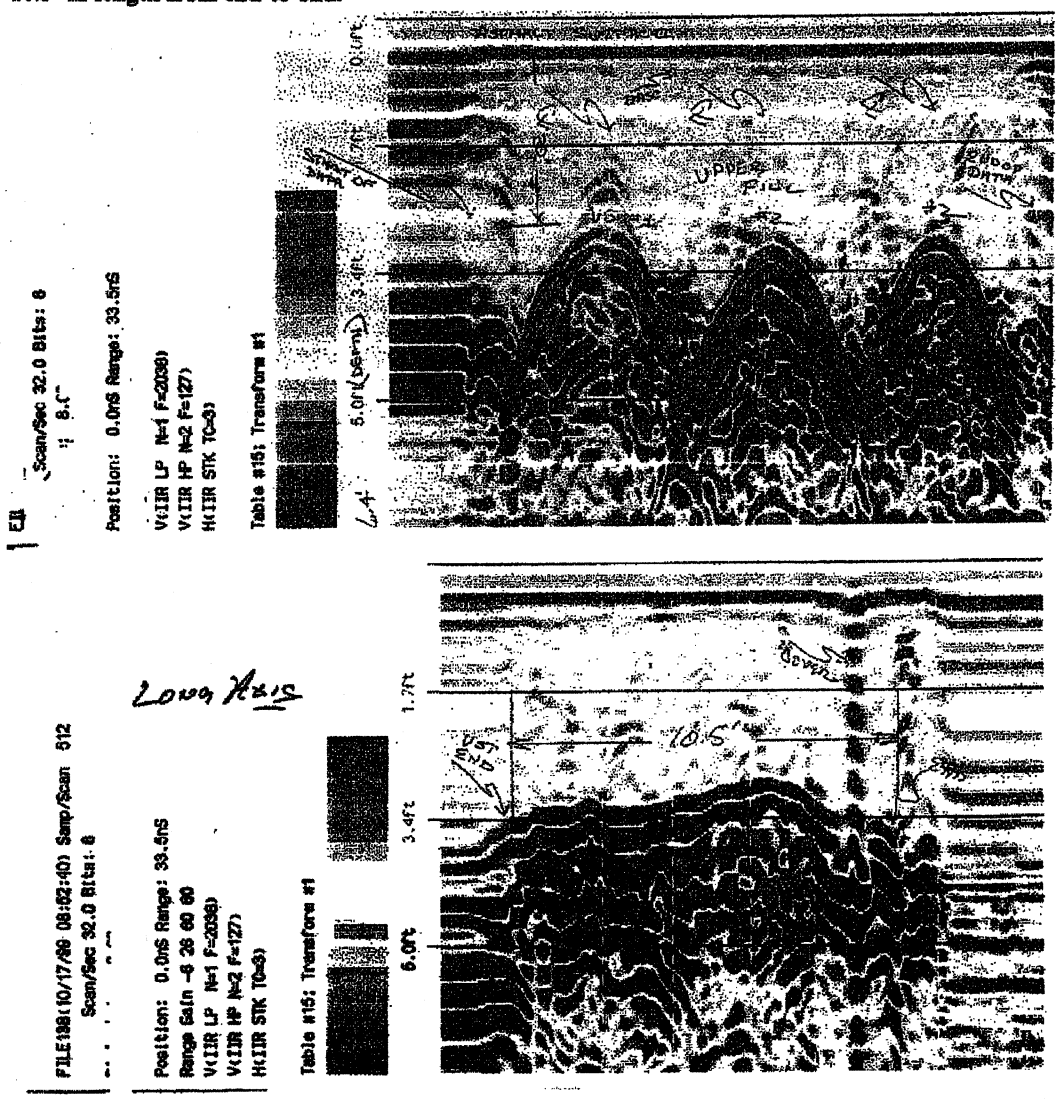
TDD #	DRAWN BY:	DATE
98-05-0098	W. SHAW	7/10/97

FILE NAME: P:\BSA\97050026\FIGURES\INSILC03

FIGURE 3

GPR REPORT

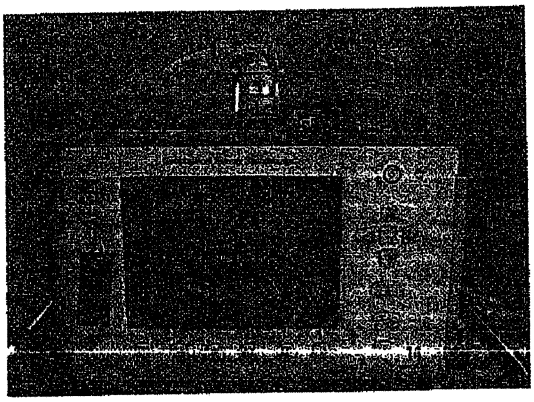
The profiles shown below represent copies of real data collected in the field. Each collected piece of data is issued a FILE# on the information tab to the left of the data. This FILE# is referenced within the report. Each piece of data is annotated from the information collected in the field such as estimated depth, length, direction or any other information that may be helpful to the subsurface investigation. The computer settings such as dielectric values, range in nanoseconds etc., is part of the information tab. The vertical benchmarks indicate points designated on the surface for the purpose of pinpointing a particular anomaly. This is used to estimate sometimes width or length or even distance between surface points such as fence posts, white lines in parking lots, centerlines of vehicles etc. The ↓↑ sign indicates 180 degree change in direction such as from a northerly traverse to a southerly traverse within the same piece of data. The profile below (FILE134) represents a perpendicular traverse over three 1,000g underground storage tanks at approximately 30" below the asphalt surface. The vertical benchmarks represent the centerline of each tank which was marked with marking paint on the surface per customer request. FILE138 is traversing over the long axis of one of the tanks with the vertical benchmarks at 2' intervals. The tank shows a profile of 10.5' in length from end-to-end.



GPR PROFILES OBTAINED IN THE FIELD

The attached copies are reproductions from data acquired in the field from the GSSI, SIR 3000 Geophysical computer. The original copies are downloaded on a T-104 thermal printer and reproduced on our commercial copier. Photo's are taken by a Sony DSC-F707 Digital still camera, using a 128 MB memory stick. The camera has the ability to take pictures in a no-light environment, which is useful for inside low light or no light building interiors, or during overcast days.

The pictures are downloaded in a Photo Suite program and reproduced at 640 X 480: 0.35 mega pixels. In addition, a disc is supplied with most reports of all the important photo's taken at the survey site. The image size duplicated makes it easy for e-mail attachments to be sent to your customer.



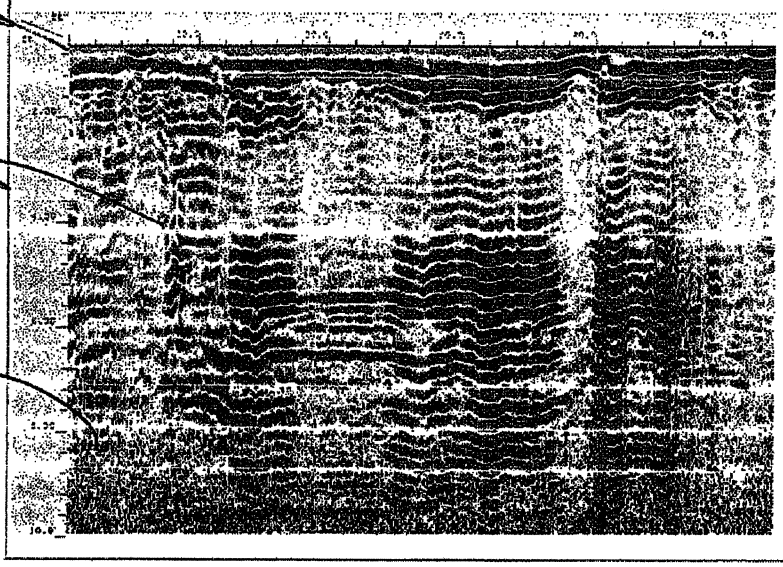
AS144

'70' of continuous east/west data in ADC87 showing no unusual anomalies. High conductivity (moisture) is present near 7.5' below the surface.

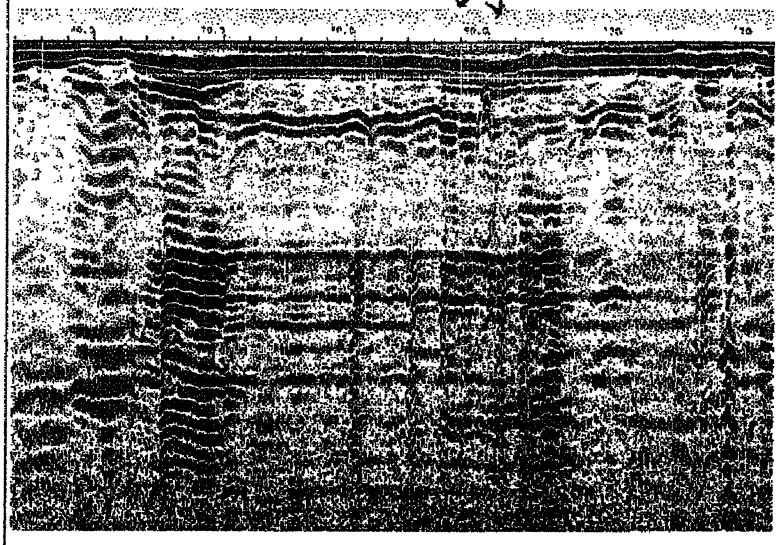
Created Jul, 14 2005, 08:33:04 Modified Jul, 14 2005, 08:34:18
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 180 Scans/Meter 99.035' Meters/Vert 2.4384
Dial Constant 8

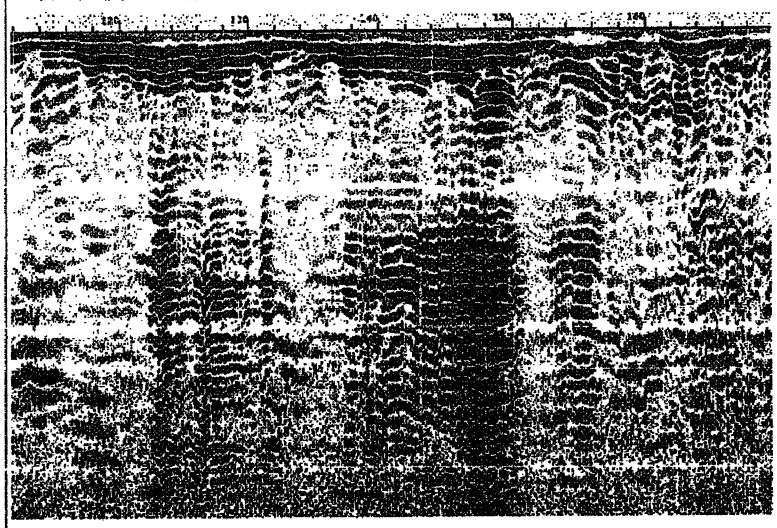
CHANNEL 1 400MHz
Position 3.56 mS Range 57 mS
Range Gain (dB) -10.0 30.0 47.0
Position Correction 1.505 mS
Vert [illegible] 800 MHz
Vert [illegible] -100 MHz
Position Correction 3.56 mS

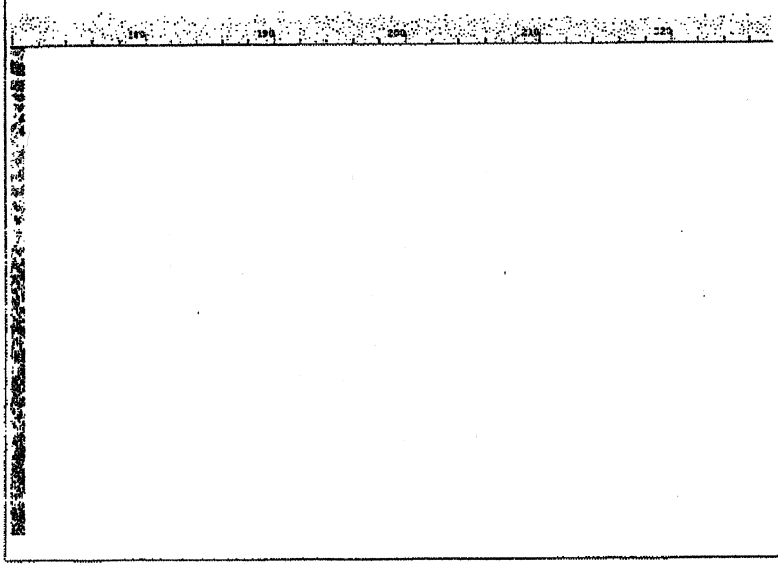
AS144 Jul, 14 2005, 08:34:18 Page 2 of 5



AS144 Jul, 14 2005, 08:34:18 Page 3 of 5







AR159

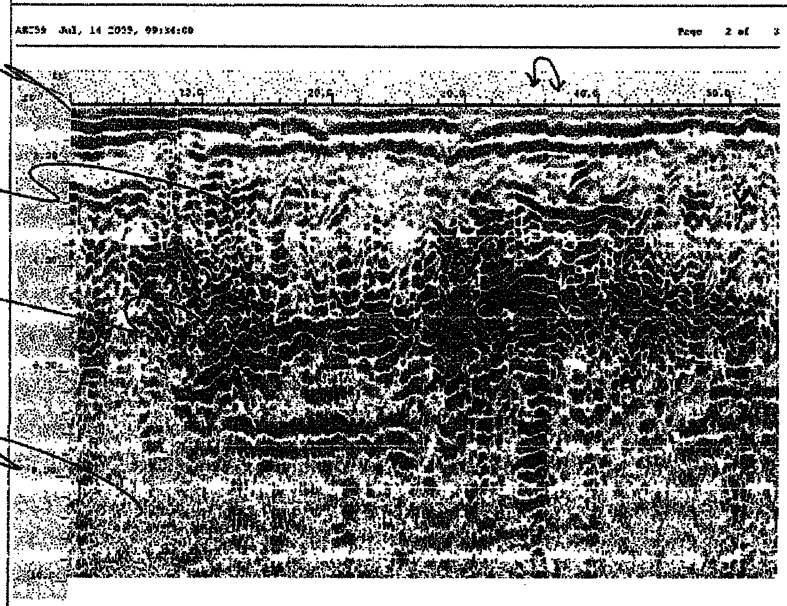
Continuous gpr data taken in AOC #2 showing no hyperbolic features to indicate tanks.

Created Jul, 14 2005, 09:27:50 Modified Jul, 14 2005, 09:34:00
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 50.035' Meters/Vert 2.4384
Dial Constant 8

CHANNEL 1 400MHZ
Position 5.12 mS Range 57 mS
Vert TIR LP N -1 F -800 MHz
Vert TIR HP N -1 F -100 MHz
Position Correction -0.35 mS
Range Gain (dB) -20.0 41.0 46.0
Position Correction 5.12 mS

⇩ = 180° CHANGE IN DIRECTION

AR159 Jul, 14 2005, 09:34:00 Page 2 of 3



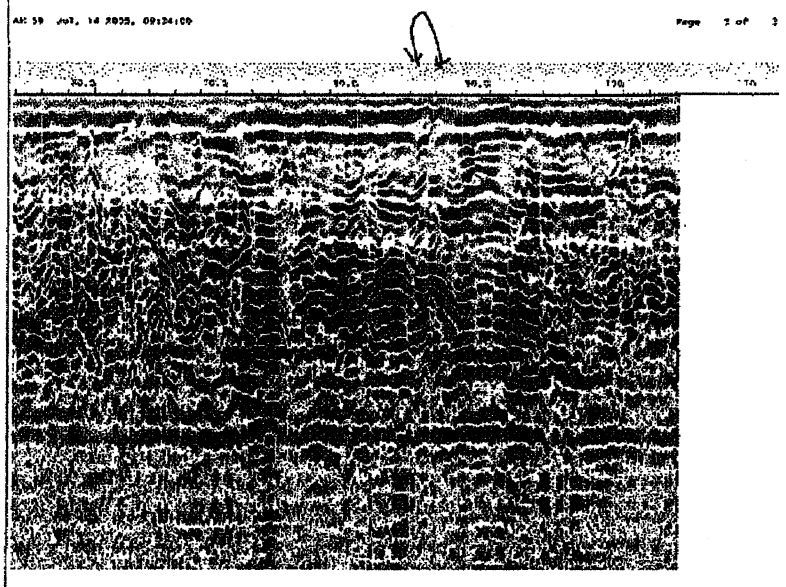
Sugar

Upper soils

Native interface ??

Moisture

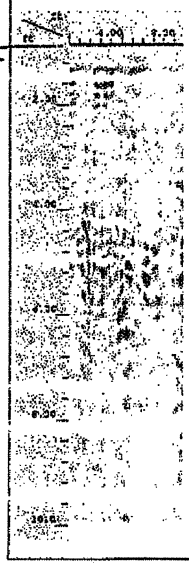
AR 59 Jul, 14 2005, 09:34:00 Page 2 of 3



A8163 - No unusual arguments

Created Jul. 14 2005, 09:[illegible] Modified Jul. 14 2005, 09:43:24
Channel(s) 1 Samples/Scan 512 Site/Sample 10
Scans/Ground 100 Scans/Meter 59.0551 Meters/Xcel 2.4384
Dial Constant 0

CHANNEL 1 400MHz
Position 4.79 nS Range 57 nS
Range Gain (dB) -20.0 41.5 46.9
Position Correction -9.35 nS
Vert [illegible] N =1 T =800 MHz
Vert [illegible] N =1 T =700 MHz
Position Correction 4.79 nS



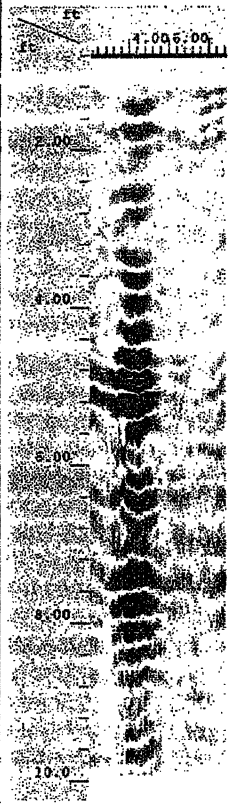
Sky 9/26

AEI68

AOC#4 - No hyperbolic features.

Created Jul, 14 2005, 09:49:48 Modified Jul, 14 2005, 09:50:06
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 59.0551 Meters/Mark 2.4384
Diel Constant 8

CHANNEL 1 400MHZ
Position 4.56 nS Range 57 nS
Range Gain (dB) -20.0 41.0 46.0
Position Correction -0.35 nS
Vert IIR LP N =1 F =800 MHz
Vert IIR HP N =1 F =100 MHz
Position Correction 4.56 nS

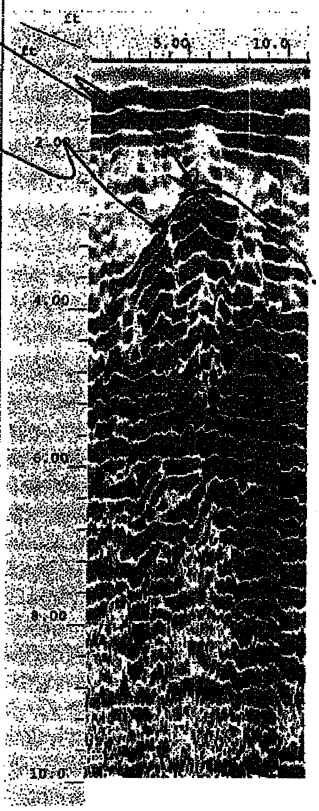


AEI70

Waste water tank parabolic feature.

Created Jul, 14 2005, 10:07:52 Modified Jul, 14 2005, 10:08:20
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 59.0551 Meters/Mark 2.4384
Dial Constant 8

CHANNEL 1 400MHZ
Position 4.79 nS Range 57 nS
Range Gain (dB) -20.0 41.0 45.0
Position Correction -0.35 nS
Vert IIR LP N =1 F =800 MHz
Vert IIR HP N =1 F =100 MHz
Position Correction 4.79 nS

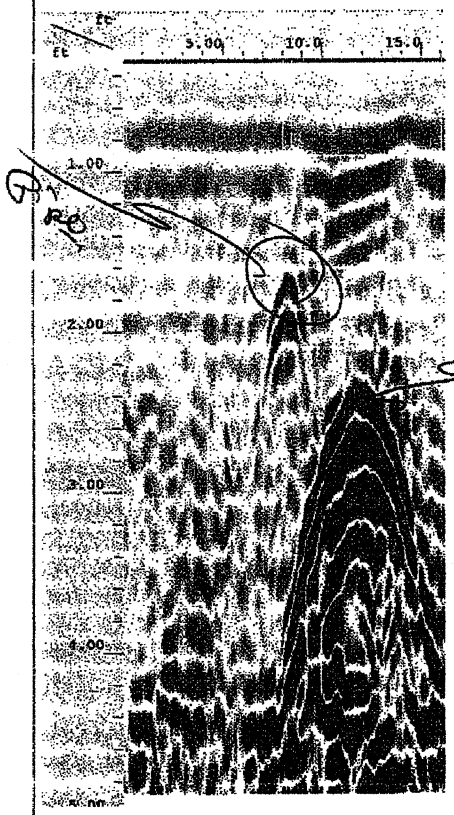


AEI72

Waste water tank and exiting pipe painted on site on the day of the survey.

Created Jul, 14 2005, 10:14:56 Modified Jul, 14 2005, 10:16:10
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 59.0551 Meters/Mark 2.4384
Diel Constant 8

CHANNEL 1 400MHZ
Position 1.75 nS Range 28 nS
Range Gain (dB) -18.0 22.0 47.0
Position Correction 2.675 nS
Vert IIR LP N =1 F =800 MHz
Vert IIR HP N =1 F =100 MHz
Position Correction 1.75 nS



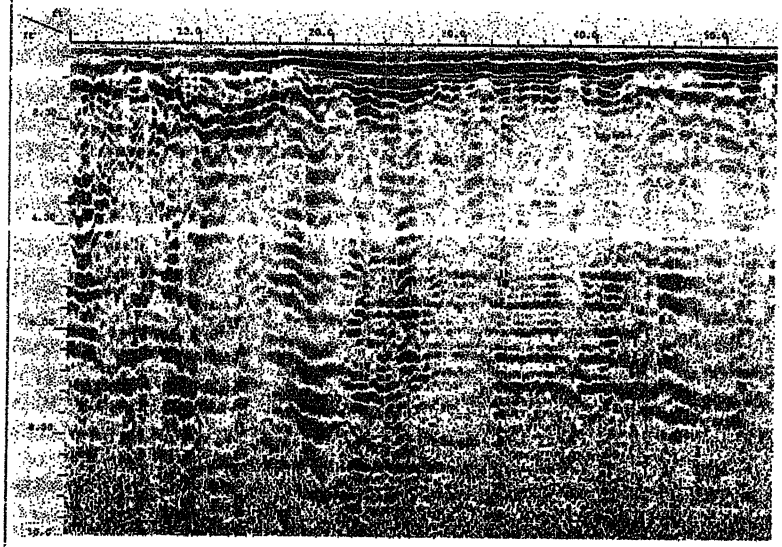
AE143

Parallel data to AE145 at 4.5' intervals showing no changes in the subsurface topography. No cultural anomalies.

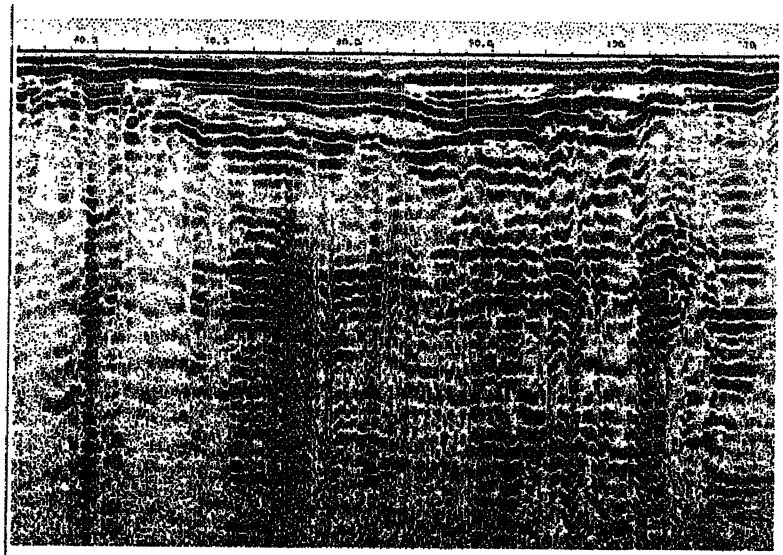
Created Jul, 14 2005, 08:34:25 Modified Jul, 14 2005, 08:35:46
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 300 Scans/Meter 59.035 Meters/Mark 1.4334
Dial Constant 8

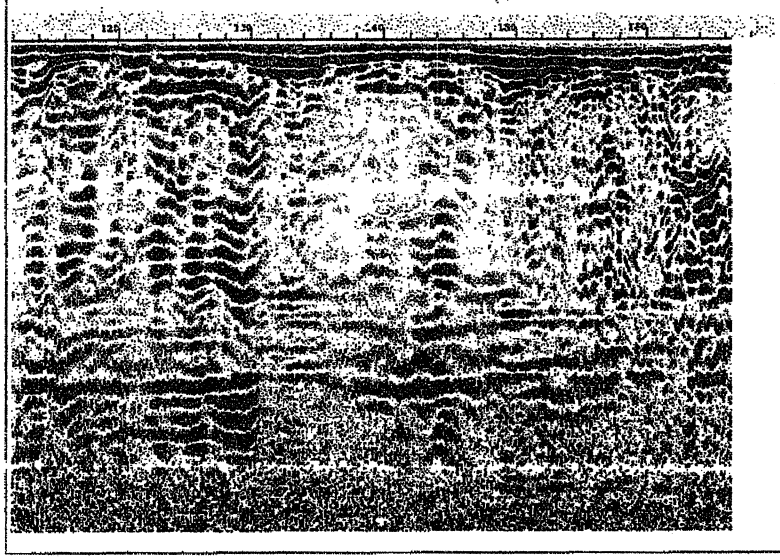
CHANNEL 1 400MHz
Position 3.01 mS Range 57 nS
Range Gain (dB) -18.0 20.0 47.0
Position Correction 1.525 nS
Vert (14 nS H +1 F =800 MHz
Vert IFR NP H -1 F =100 MHz
Position Correction 3.01 nS

AE145 Jul, 14 2005, 08:35:46 Page 2 of 4



AE 45 Jul, 14 2005, 08:35:46 Page 3 of 4





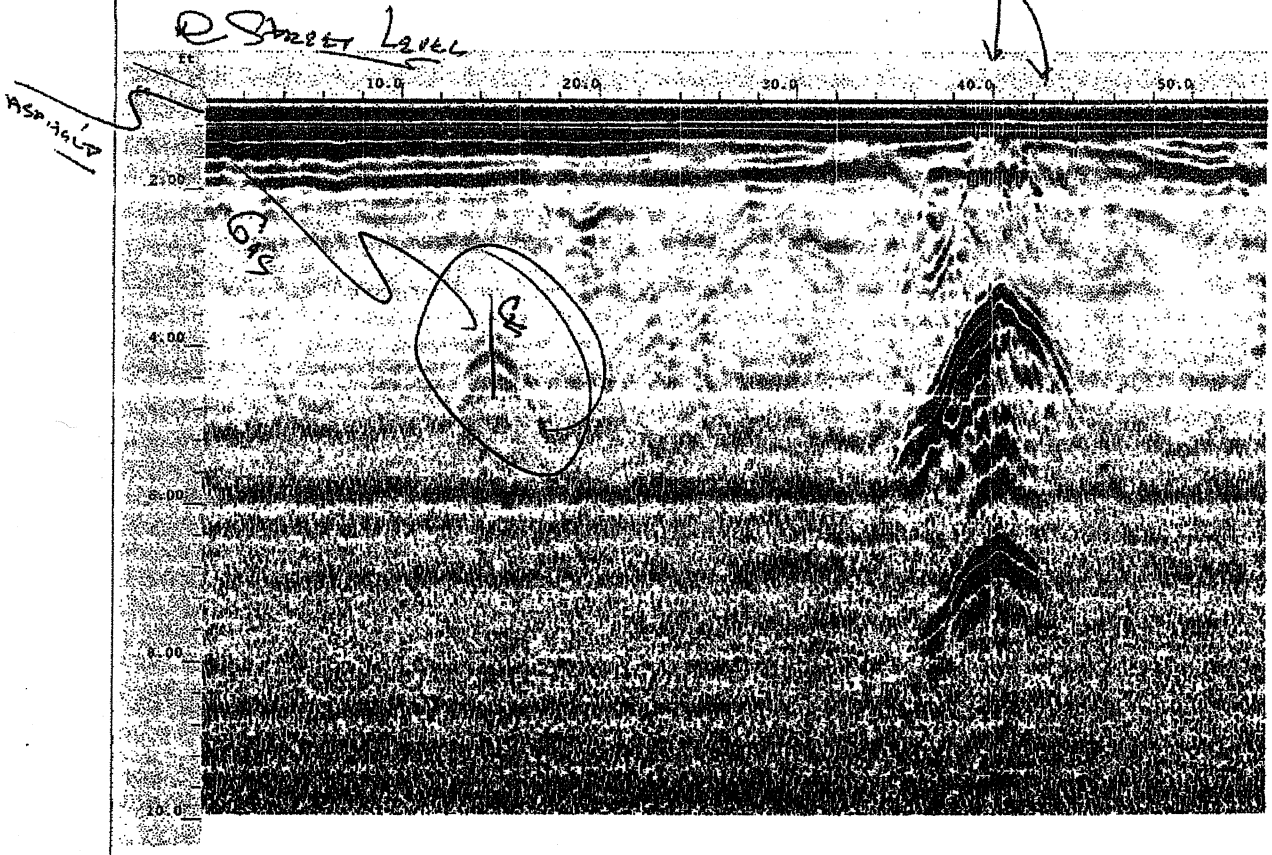
AEI77

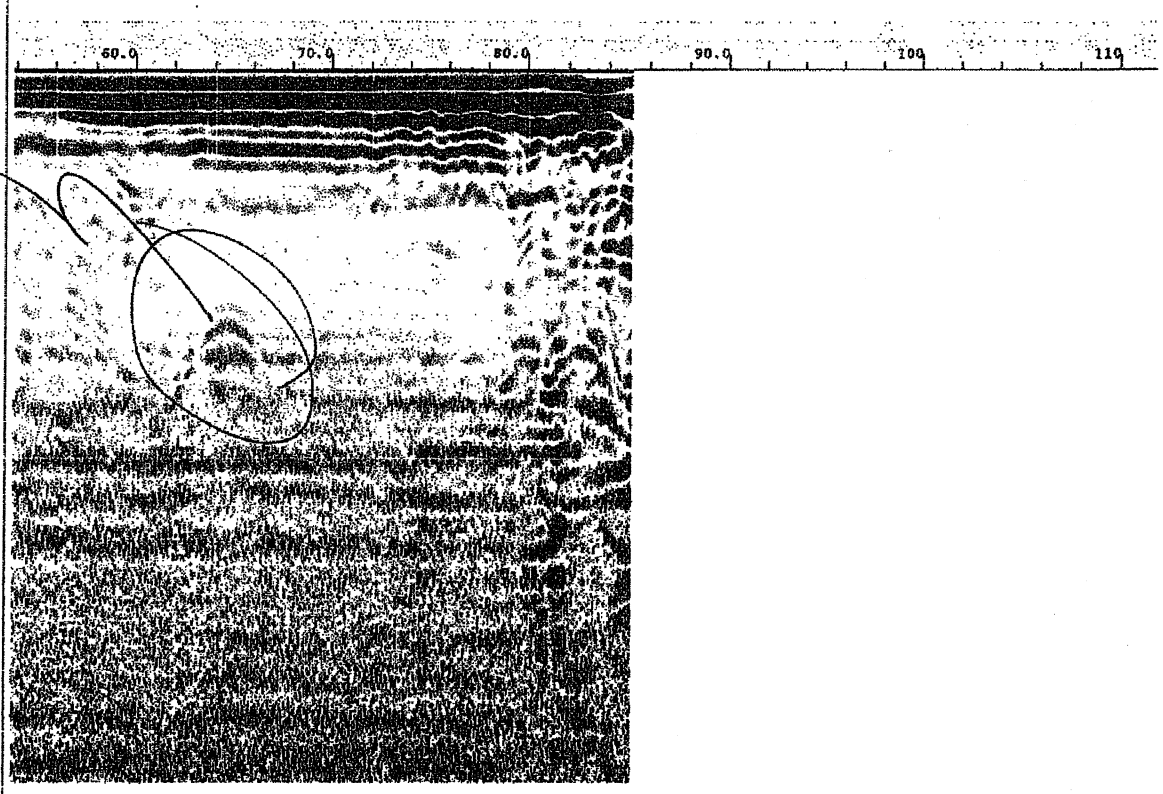
85' of continuous data over the suspect gas line along Cooper Street. Painted on site.

Created Jul, 14 2005, 10:40:04 Modified Jul, 14 2005, 10:41:32
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 59.0551 Meters/Mark 2.4384
Diel Constant 8

CHANNEL 1 400MHZ
Position 5.01 nS Range 57 nS
Range Gain (dB) -20.0 35.0 48.0
Position Correction -0.35 nS
Vert IIR LP N =1 F =800 MHz
Vert IIR HP N =1 F =100 MHz
Position Correction 5.01 nS

AEI77 Jul, 14 2005, 10:41:32 Page 2 of 3



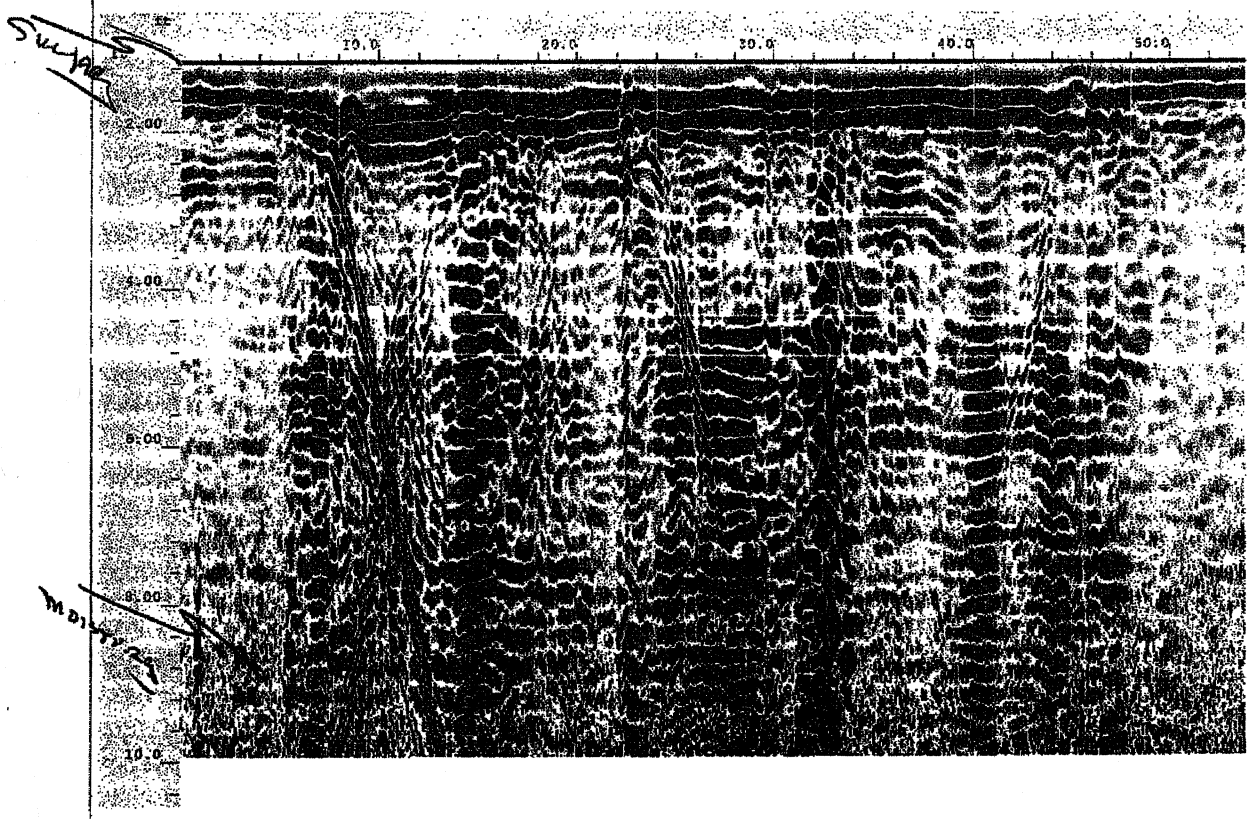

60.0
70.0
80.0
90.0
100
110

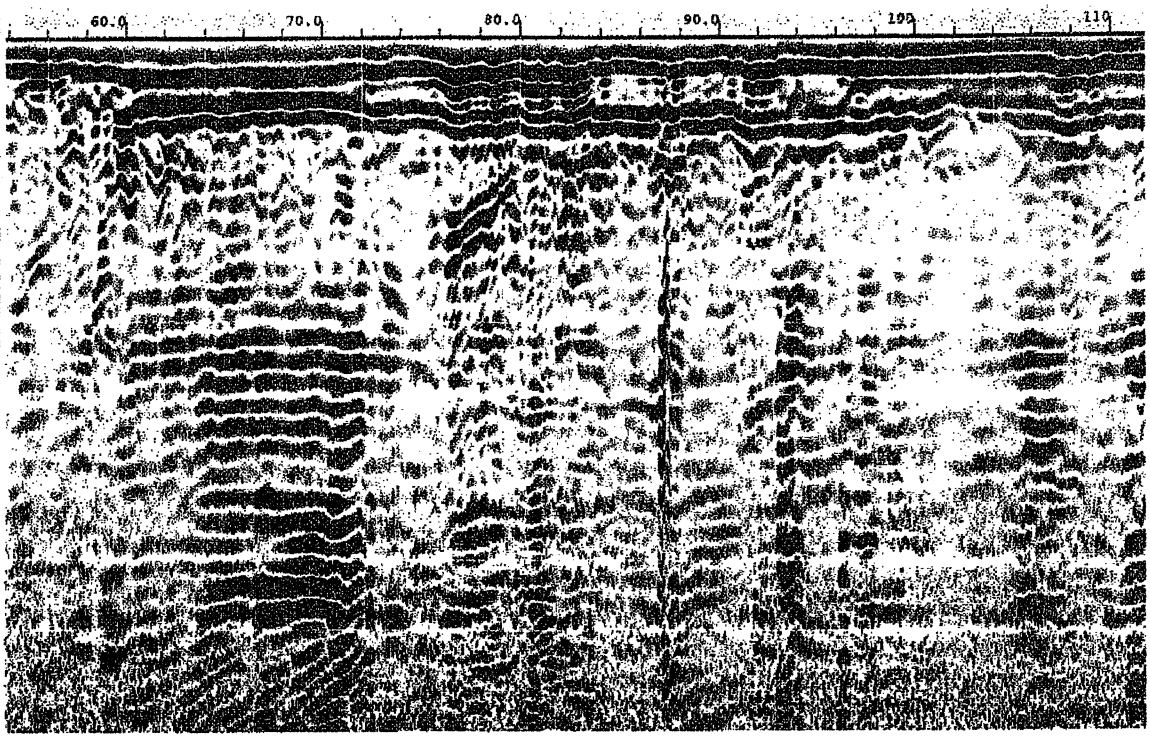
AEI87

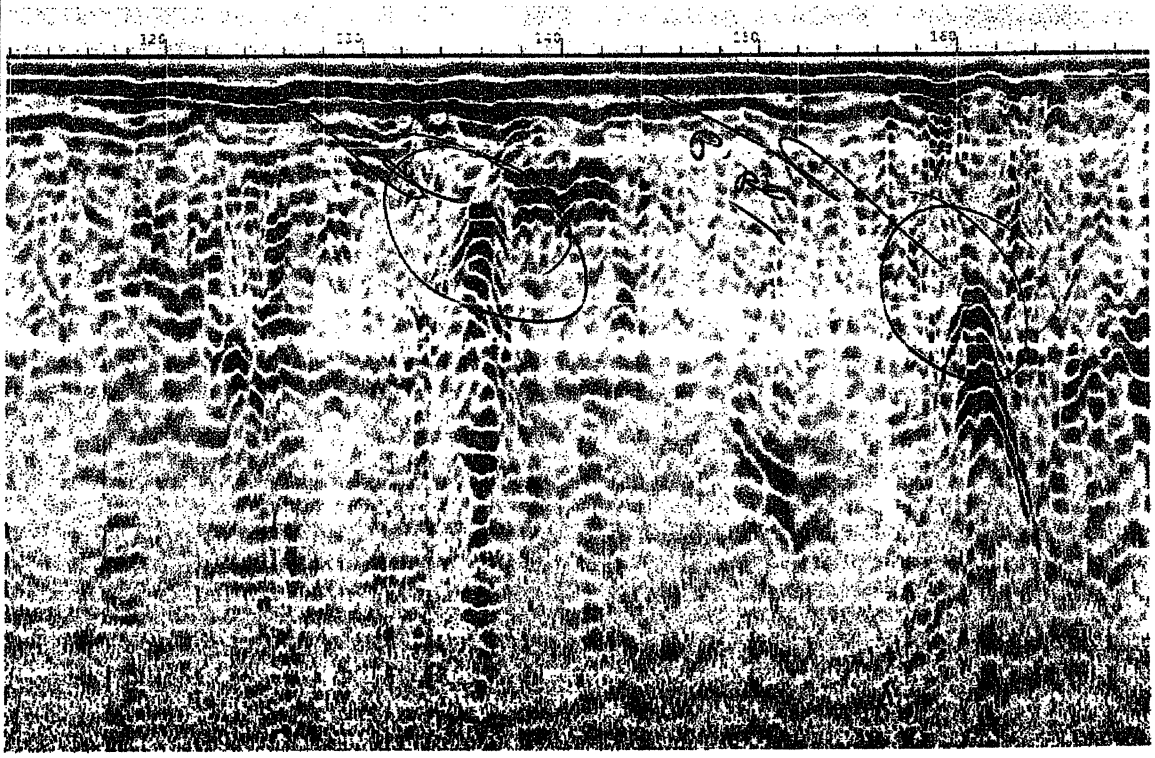
340' of continuous northerly data collected down the corridor east of Building A. The parabolic features [circled] are that of pipes which were painted on site on the day of the survey.

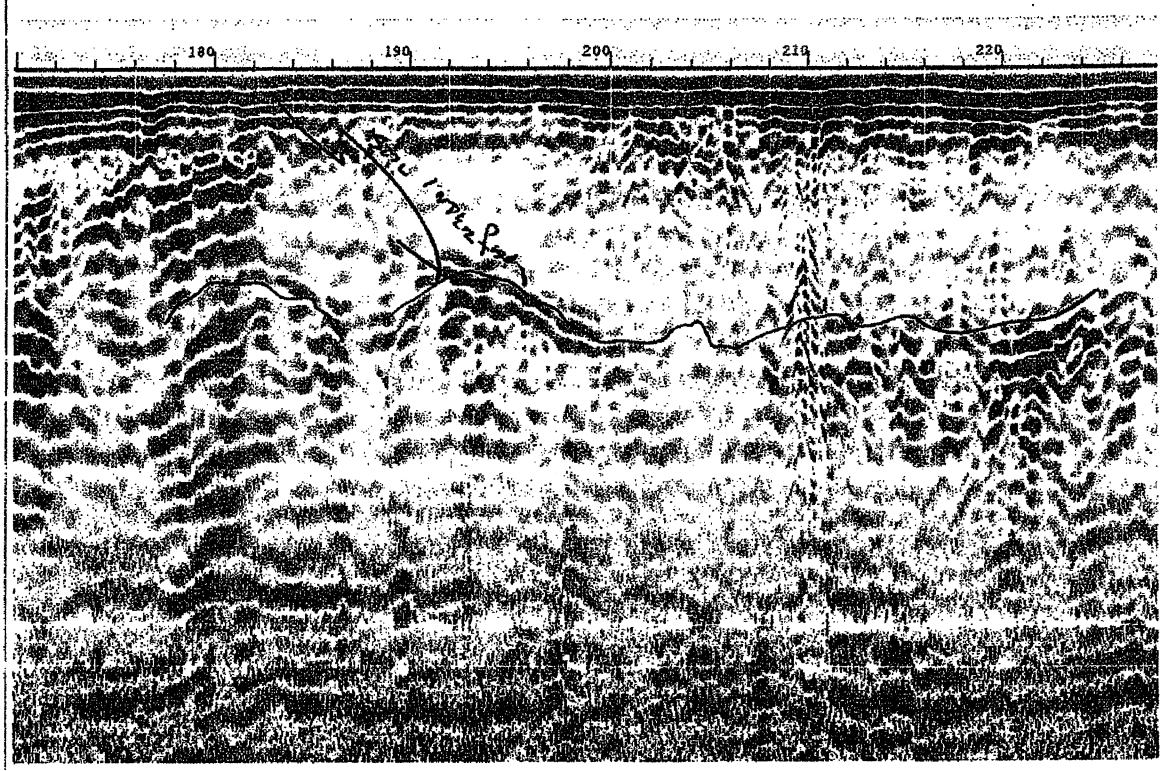
Created Jul, 14 2005, 11:45:52 Modified Jul, 14 2005, 11:50:32
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 100 Scans/Meter 59.0551 Meters/Mark 2.4384
Diel Constant 8

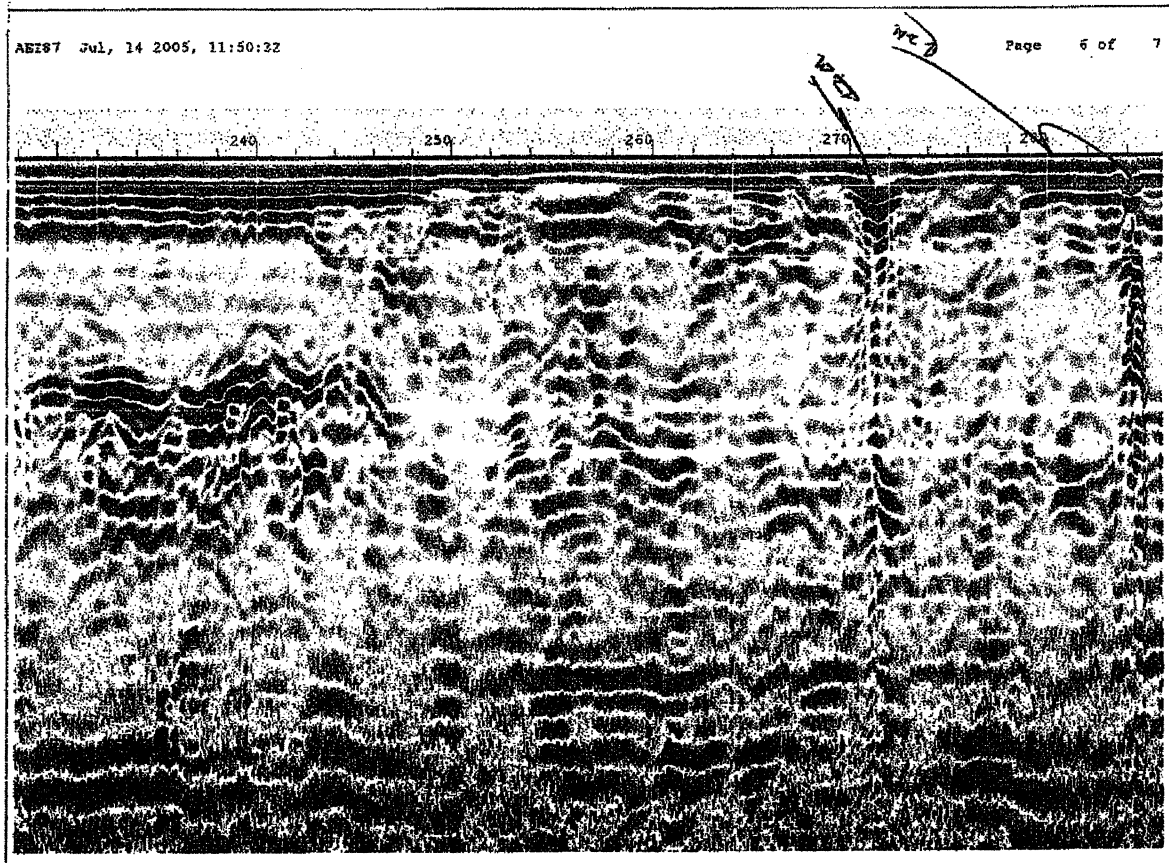
CHANNEL 1 400MHZ
Position 6.35 nS Range 57 nS
Range Gain (dB) -19.0 31.0 51.0
Position Correction -1.725 nS
Vert IIR LP N =1 F =800 MHz
Vert IIR HP N =1 F =100 MHz
Position Correction 6.35 nS

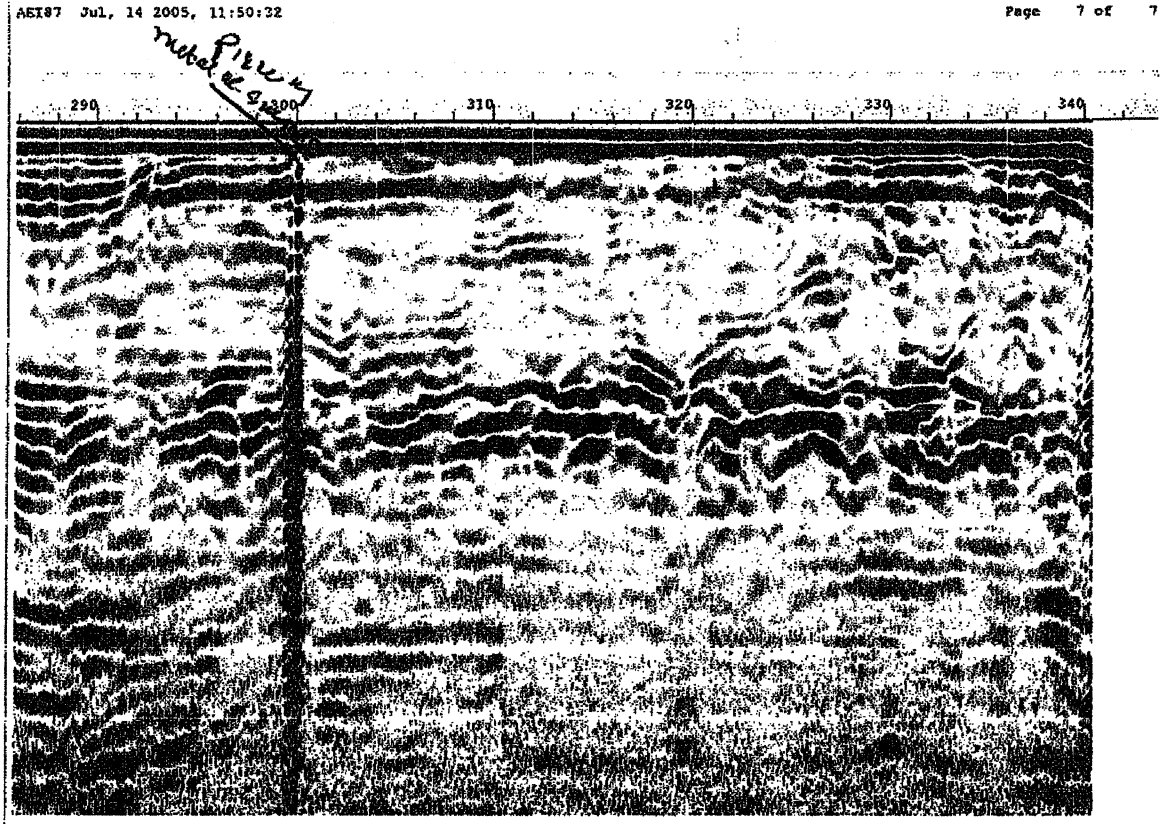



60.0
70.0
80.0
90.0
100
110


120
130
140
150
160


180
190
200
210
220


240
250
260
270


290
300
310
320
330
340

5.0 ACQUIRING PROCEDURES

The acquiring of data from the field for the location and orientation of underground storage tanks, utilities, conduits w/in slab, rebar location, grave sites and other specific anomalies has been established by the *ground penetrating radar* for many years. Since *1988*, Sub-Surface Informational Surveys, Inc. has completed a multitude of successful investigations covering most phases of the *ground penetrating radar* profession. During an investigation, a cross-section of the project will be recorded on the hard drive of our computer. The data is then transferred, copied and duplicated to be made part of this report.

We do not necessarily record every traverse in most of our investigation since most of the information viewed on our monitor is related to the previous traverse. Traverses (I.e., profiles) are monitored on a constant basis. When a traverse is collected on the hard drive, it is also played back in the field for a second look. Where there is an *out-of-place characteristic*, it may be played back a number of times to determine its location and origin. This is recorded on the hard drive for further analyzing at our office. When specific anomalies are located, *all* are documented for reporting. Anomalies are marked in the field if requested to do so. Measurements are taken to identify the exact location such as a tank or utility.

During the start of all surveys, site characteristics and features must be documented to set the standard for that particular site such as soil conditions, conductive features, etc. While the survey is being conducted, there are periodic documentations which are used as a permanent visual comparison to confirm the standard of that site.

After the completion of our survey, it must be reasonably assured that the information is a true cross-section of the project and the information obtained is accurate according to our best professional efforts.

REPORT NOTES

DATE _____

DATE: _____

DATE: _____

DATE: _____

DATE: _____

"LET US SEEK AND FIND"

GPR PRINCIPLES
DIELECTRIC CONSTANTS
TWO-WAY SLOWNESS

GROUND PENETRATING RADAR (GPR)...Looks like an X-Ray picture of the ground which is the typical initial impression of the graphic results obtained by radar. GPR, unlike sonic or seismic uses an electromagnetic (radio wave) antenna turned to a frequency, which can penetrate most soils, rock, concrete, ice and other common natural and manmade materials. Such capabilities make GPR a prime technique to a multitude of tasks.

GPR determines subsurface conditions by sending pulses of high frequency radio waves into the ground from a transmitter antenna located on the surface. Subsurface structures and interfaces cause some of the wave energy to be reflected back to the surface, while the rest of the energy continues to penetrate deeper. A receiver antenna on the surface picks up the reflected wave energy. These signals are then processed and plotted in a distance versus time-depth display. Thus, as the radar antenna is slowly towed across the surface, a continuous cross-section picture of the subsurface is generated. The reflections are cause by wave responses a t interfaces of materials having different electrical properties. These interfaces include many natural conditions such as bedding, cementation, changes in moisture and clay content, voids etc., as well as man-made objects.

PENETRATION of the radar signal is dependent on the conditions found at each site. Radar waves are attenuated (absorbed or scattered) by certain properties of the site's soil; the most important of which is the ***electrical conductivity*** of the material. Generally, better overall penetration is achieved in dry sandy soils; reduced penetration is achieved in moist, clayey or conductive soils. Radar penetration is excellent in massive dry materials such as granite, limestone and concrete. The following is a partial list of the approximate ***dielectric constants*** of certain materials:

MATERIAL	DIELECTRIC/C	TSm (ns/ft) *	TSm (ns/m)*
AIR	1	2	6.5
FRESH WATER	81	18	59
SEA WATER	81	18	59
SAND-DRY	4-6	4.5	15
SAND-SATURATED	30	11	36
SILT-SATURATED	10	6	20
CLAY-SATURATED	8-12	6	20
DRY SANDY COASTAL LAND	10	6	20
MARSHY FORESTED FLAT LAND	12	7	23
RICH AGRICULTURAL LAND	15	8	26
PASTORAL LAND, HILLY	13	7	23
FRESH WATER ICE	4	4	23
PERMAFROST	4-8	5	16
GRANITE (DRY)	5	4.5	15
LIMESTONE (DRY)	7-9	5	16
DOLOMITE	7-8	2.5	8
QUARTZ	4	4	13
COAL	4-5	4	13
CONCRETE	6	5	16
ASPHALT	3-5	4-5	13-16
SEA ICE	4-12	4-7	13-23
PVC, EPOXY, VINYL			
POLYESTERS, RUBBER	3	4	13

** TSm = Two Way Slowness

Compliments of
Sub-Surface Informational Surveys, Inc.
E. Longmeadow, MA 01028
413-525-4666 Fax 413-525-2887

GPR PRINCIPLES
DIELECTRIC CONSTANTS
TWO-WAY SLOWNESS

Dielectric Constant = This parameter is the value of the dielectric constant used to convert two-way travel time to depth. The value ranges from 1 to 81 and depends upon the dielectric properties of the subsurface materials being profiled. *WARNING*: Dielectric constants for various materials, and thus the resulting depth scales, are only approximations. Additional approximates of various materials are as follows:

MATERIAL	D/C	MATERIAL	D/C
Air	1	Wet Granite	6.5
Snow Firm	1.5	Travertine	8
Dry Loamy/Clayey Soils	2.5	West Limestone	8
Dry Clay	4	West Basalt	8.5
Ice	4	Tills	11
Coal	4.5	Volcanic Ash	13
Asphalt	5	Wet Sands	15
Dry Granite	5	Wet Sandy Soils	23.5
Frozen Sand & Gravel	5	Dry Bauxite	25
Dry Concrete	5.5	Saturated Sands	25
Dry Sand & Gravel	5.5	Wet Clay	27
Potash Ore	5.5	Peats	61.5
Dry Mineral/Sandy Soils	6	Organic Soils	64
Dry Salt	6	Sea Water	81
Frozen Soil/Permafrost	6	Water	81
Wet Sandstone	5	Syenite Porphyry	6
MATERIAL	**T/ns/meters/ft**	**MATERIAL**	**T/ns/meters/ft**
Snow	8/2.5	Water	59/18
Asphalt	14/4.5	Dry Concrete	15/4.5
Wet Concrete	23/7	Dry Sands	13/4
Wet Sands	25.5/7.5	Saturated Sands	33/10
Dry Sand & Gravel	15.5/4.5	Frozen Sand & Gravel	14.5/4.5
Dry Loamy/Clayey Soils	10.5/3	Dry Mineral/Sandy Soils	16/5
Organic Soils	52.5/16	Wet Sandy Soils	32/9.5
Frozen Soil/Permafrost	16/5	Tills	22/6.5
Peats	51.5/15.5	Wet Clay	34/10.5
Dry Clay	13/4	Dry Granite	14.5/4.5
Wet Granite	16.5/5	Wet Basalt	19/6
Volcanic Ash	23.5/7	Potash Ore	15/4.5
Dry Bauxite	33/10	Syenite Porphyry	16/5
Travertine	18.5/5.5	Coal	14/4
Dry Limestone	15.5/4.5	Wet Limestone	18.5/5.5
Wet Sandstone	16/5	Dry Salt	16/5

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