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SURFACE GEOPHYSICAL SURVEYS
BOOTH OIL SITE
NORTH TONAWANDA
NIAGARA COUNTY, NEW YORK

HAGER-RICHTER
GEOSCIENCE, INC.

SURFACE GEOPHYSICAL SURVEYS
BOOTH OIL SITE
NORTH TONAWANDA
NIAGARA COUNTY, NEW YORK

Prepared for:

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File 89D37
June, 1990

Surface Geophysical Surveys
Booth Oil Site
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0. EXECUTIVE SUMMARY

Hager-Richter Geoscience, Inc. conducted surface geophysical surveys at the Booth Oil Site, North Tonawanda, Niagara County, New York on May 31 and June 1, 1990 for Dvirka and Bartilucci Consulting Engineers of Syosset, New York. The Site, the location of a former waste oil collection, storage, and reclamation facility, is approximately 3.9 acres in area.

The geophysical surveys are part of a larger RI/FS of the Site conducted by Dvirka and Bartilucci for the New York State Department of Environmental Conservation. The objectives were to determine whether additional, previously unknown, underground storage tanks and recognizable plumes are present at the Site, and if any were detected, to locate them for further evaluation. A terrain conductivity survey was conducted over the Site. Ground penetrating radar profiling was conducted over anomalous areas of terrain conductivity.

On the basis of the geophysical surveys conducted at the Booth Oil Site, we conclude that:

1. The measured terrain conductivity of the Site is highly variable and apparently strongly influenced by both visible and buried cultural features.

2. Steep apparent conductivity gradients due to such features mask the presence, if any, of contaminant plumes. No plume was identified in this survey.

3. Regions of the Site with apparent negative terrain conductivity are interpreted to contain buried metal and reinforced concrete. The GPR records confirm the presence of pipes in four such areas and probable reinforced concrete pads in other areas. However, there is no evidence for the presence of underground storage tanks in the GPR data for the areas surveyed.

4. Several regions of the Site exhibit apparent conductivity two to five times higher than elsewhere on Site. The precise nature of the material causing the increase in conductivity is not known.

5. The northeast corner of the Site contains a small area of relatively low terrain conductivity that may represent a concentration of hydrocarbon contamination.

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1. INTRODUCTION

Hager-Richter Geoscience, Inc. conducted surface geophysical surveys at the Booth Oil Site, North Tonawanda, Niagara County, New York, for Dvirka & Bartilucci Consulting Engineers (D&B) of Syosset, New York on May 31 and June 1, 1990. The geophysical surveys are part of a larger RI/FS undertaken by D&B for the New York State Department of Environmental Conservation. The objectives of the surveys were: (1) to determine whether previously unknown underground storage tanks are present at the Site and, if any were detected, to locate them; and (2) to determine whether recognizable patterns (plumes) of contaminant concentration are present.

The general location of the Site is shown in Figure 1. The Site is located on Robinson Street approximately 1/8 mile east of the Little River, a sidestream of the Niagara River. The neighborhood of the site is mixed industrial and residential. A waste oil collection, storage and reclamation facility was operated for more than 50 years at the Site. During plant operations prior to the early 1980s, spillage reportedly occurred throughout the site, according to information supplied by D&B. Pools of oily material and oil-stained ground are visible at various locations on the Site.

The Site consists of two parcels separated by actively used railroad tracks. The western parcel is 1.3 acres and is owned by ConRail; the eastern parcel is 2.6 acres and is owned by Booth Oil. At the time of survey, both parcels were relatively flat, mowed grass lots, with dirt and gravel parking areas. Scattered metallic debris, including unused rails, was stockpiled along active portions of the ConRail tracks. Remnants of concrete structures that supported above-ground storage tanks and concrete slabs possibly used as loading docks were partially visible. Figure 2 is a copy of a Facility Location Map provided by D&B showing structures and other features that were once present at the Site.

Hager-Richter personnel were on Site May 31, and June 1, 1990. George Fields and David Petroy of Hager-Richter conducted the geophysical surveys. The fieldwork was coordinated by Mr. Gerald DeGaetano of Dvirka and Bartilucci. Mr. Joseph Zollo and Mr. Brian Stalters, also of D&B, observed the fieldwork in part and established the surveyed grid on the Site.

Fieldwork was conducted under Level D personal protection. Data analysis and interpretation were completed at the Hager-Richter offices. Original data and field notes reside in the Hager-Richter files and will be retained for a minimum of five years.

Dvirka and Bartilucci Consulting Engineers established a 50-foot by 50-foot orthogonal grid on the Site. Locations referred to in this document and shown on the plates are based upon the conventions established by D&B.

2. EQUIPMENT AND PROCEDURES

2.1 General

Two geophysical techniques were used for this project: (1) a terrain conductivity survey of the entire Site on a 10-foot by 10-foot grid; and (2) ground penetrating radar profiling in areas of anomalous terrain conductivity, determined from preliminary processing in the field. Time limitations did not permit GPR investigation of every conductivity anomaly.

Data for the terrain conductivity survey were collected at approximately 1540 stations. Ground penetrating radar profiles were oriented with the site grid.

2.2 Terrain Conductivity Survey

Terrain conductivity data were collected with a Geonics Model EM31-DL terrain conductivity meter. The EM31-DL is an induction type unit that measures terrain conductivity without ground electrodes or contact. The EM31-DL is calibrated to read ground conductivity directly in millimhos per meter (mmho/m) with a resolution of 2% of full scale and an accuracy of 1 mmho/meter. The nominal depth of earth sampled by the EM31-DL is about 18 feet. The data are recorded on a digital data logger and transferred to a computer at the end of each field day.

Two components of the induced magnetic field measured by the EM31-DL were recorded at this Site: (1) the quadrature-phase component and, (2) the in-phase component. The quadrature-phase component is a measure of the average terrain conductivity of the subsurface materials located between the receiver and transmitter of the EM31-DL and includes the soil, rock, contaminants, and buried metallic objects. The in-phase component is a very sensitive indicator of the presence of metal objects.

At sites free of metal objects and other cultural interference, the terrain conductivity measured at a particular location is controlled by the subsurface fluid. The instrument response is more affected by near surface material than by deeper material. In cases where the terrain conductivity meter is directly over a buried metal target, the apparent conductivity reading may be a strong negative number.

Background terrain conductivity data were collected with the EM31-DL in Pine Woods Park approximately 3/4 mile east of the Site. The values obtained in this area were between 13 and 15.5 mmhos/meter.

2.3 Ground Penetrating Radar (GPR) Survey

For this investigation, we used a Geophysical Survey Systems, Inc. Model SIR-3:VDU-38 ground penetrating radar system. The system consists of an electronics unit, power supply, graphic recorder, color video display unit, and transmitting/receiving antenna. Figure 3 is a sketch that shows the basic operation of the GPR system.

The GPR transmit/receive antenna is housed in a box that is moved across the surface. The data for this survey were collected with a 300 MHz antenna, after determining that signal penetration with the 500 MHz antenna was inadequate. The transmitted signal is directed into the ground, and reflected signals are output in real-time to a graphic recorder and a color video display unit. The data are also recorded on a tape recorder for later detailed interpretation in the office. The horizontal axis of the output is distance across the surface and the vertical axis is round-trip travel time of the radar signal. The round-trip travel time can be converted to approximate depth by correlating with reflections from targets of known depth or by using handbook values of velocities for materials in the subsurface. For those sites where the subsurface is electrically inhomogeneous, the travel times of the radar signal may be different in the various materials, and the vertical scale for the radar records is not necessarily uniform with depth.

GPR is similar to other radar systems (for example, weather radar) in that it transmits electromagnetic signals and then detects, amplifies, and displays reflections of the signals. The reflections are produced by spatial changes in the electrical properties (complex dielectric constant) of the materials in the path of the signals. For GPR, changes in electrical conductivity, permittivity, density, and/or rock or sediment type can produce reflections of the radar signal. Buried metal objects such as pipes and tanks have electrical properties very different from the ground in which they are buried and typically produce very strong reflections of the radar signal, with characteristic signatures.

GPR can detect metal tanks buried in soil with a high degree of reliability. Fiberglas tanks can also be detected, but the reflected signals are weaker. Buried cylindrical tanks are recognized by the distinctive hyperbolic images they produce in GPR records when the survey lines are oriented perpendicular to the long axis of a tank. The highest point of the hyperbolic curve occurs where the antenna is nearest the tank.

Pipes and sewer lines can also be detected by GPR if there is sufficient electrical contrast with the surrounding material. When GPR survey lines are acquired perpendicular to pipes and sewer lines, they produce hyperbolas that are similar to, but smaller than, those produced by tanks.

3. RESULTS

3.1 Terrain Conductivity Survey

Plate 1 is a station map showing the locations at which terrain conductivity data were collected. A 10-foot station spacing was used. This method and grid spacing is adequate to locate buried tanks and plumes with a relatively high degree of assurance.

The data for some terrain conductivity stations were significantly affected by certain visible objects (such as reinforced concrete pads, power lines, etc.) Because such objects have large associated terrain conductivity effects that can "mask" the effects due to a nearby subsurface object and the method cannot discriminate between surface and subsurface objects, it is possible that buried metal objects may occur near observed surface metal objects.

Plate 2 shows the terrain conductivity (quadrature-phase component) plotted with a contour interval of 20 mmhos/meter and an inset of the northeast corner of the Site contoured at 2 mmhos/meter. The Booth Oil Site is characterized by terrain conductivity that is highly variable over very short distances. The apparent terrain conductivity at the Booth Oil Site is strongly affected by the cultural features of the Site.

There are several areas of the Site with terrain conductivity higher than 100 mmhos/meter. The cause of such high conductivity anomalies is uncertain. Many of the anomalies are near features such as the railroad tracks, but the anomalies are too high and wide to be caused by the metal in the rails alone. There is an overhead power line located along the railroad tracks along the southwestern edge of the eastern parcel, approximate coordinates (W2+20, N0+00) to (W2+50, N1+50), which probably contributes to the apparent high terrain conductivity in that region. We do not know if there are additional power cables underground or other utilities that are present along the tracks. We regard all such areas with high terrain conductivity as areas to be investigated further.

A high conductivity anomaly located near (N0+90, W0+50) correlates with a sewer discharge noted on the Facility Location Plan provided by D&B (Figure 2). A north-south high between it and the street is probably caused by a connecting sewer pipe.

The inset map on Plate 2 is the approximate area of the earthen containment for a 500,000 gallon and other above ground storage tanks shown in Figure 2. This area has lower values of terrain conductivity than most of the Site, and may be due to fill material. A distinct E-W low is present in an area immediately north of the location of tanks numbered 48 to 50; this area may contain concentrated hydrocarbons in the subsurface. The increasing contours at the southwestern corner of the inset map are "edge effects" from anomalies due to reinforced concrete and the large terrain conductivity high located near the railroad tracks.

Plate 2 also shows several areas of the Site with apparently negative terrain conductivity values. Such areas are interpreted to contain buried metal and are further defined in Plate 3, a contour map of the in-phase component of the terrain conductivity contoured at an interval of 10 parts per thousand. The in-phase component of the terrain conductivity is very sensitive to both ferrous and non-ferrous subsurface metal objects. An example of such an anomaly is located from (N1+50, W0+70) to (N1+10, W1+60). We interpret this negative in-phase component anomaly, as well as the anomaly between (N1+00, W3+90) to (N2+00, W3+60), to be caused by reinforced concrete slabs that are partially exposed in those areas.

Another negative anomaly extends from (N0+50, W3+25) to (N0+40, W4+20). We interpret this linear feature to be a shallow buried pipe that correlates closely with one shown on the D&B Facility Location Map. We attribute the negative anomaly centered at (N2+60, W4+15) to be the result of the loose stockpile of railroad tracks and other metallic debris on the surface.

Plumes of hydrocarbons or other contamination commonly affect the measured terrain conductivity by 2 to 30 mmhos/m. The very steep gradients in terrain conductivity exhibited at the Booth Oil Site prevent the recognition of such subtle features, if present, at this Site.

3.2 Ground Penetrating Radar Survey

The GPR survey at this Site consisted of about 2200 feet of GPR profiling obtained on 58 traverses. Plate 4 shows the locations of the GPR survey lines. Profiles were obtained in six areas of anomalous terrain conductivity using an orthogonal grid with a spacing of ten feet between lines.

GPR signal penetration at the Site was generally 20 nanoseconds round-trip travel time. Assuming a velocity of 5 to 7 nanoseconds/foot, typical values for concrete, sand and fill material, the effective depth of penetration of the radar signal was approximately 3 to 4 feet.

Time limitations did not permit GPR investigation of every terrain conductivity anomaly at the Site. The GPR profiles were focused mainly in areas of apparent negative terrain conductivity, which are produced by metal objects, in order to determine whether the causative objects include an underground storage tank. GPR profiles were not obtained over locations of previously known underground storage tanks because they were reportedly removed prior to this survey and there is no indication of the presence of buried metal in the terrain conductivity data for those areas.

There is no evidence for the presence of underground storage tanks in the GPR data acquired in the six areas of the Site. Four buried pipes and a sewer line were identified on the basis of the GPR records. The approximate depth of burial for the pipes is 2 to 3 feet. A typical signature from one of the possible buried pipes is shown in Figure 4.

Several of the areas surveyed by GPR exhibited reverberations from a strong, apparently continuous reflector at 7 to 10 nanoseconds, masking any deeper reflections, if present. The reverberations may be due to reinforced concrete pads, partially exposed at the surface or buried at shallow depth. An example is shown in Figure 5.

3.3 Interpretation

Plate 5 is a sketch map showing the locations of features identified in the geophysical surveys at the Booth Oil Site and their interpretation, where the causative object has been identified on the basis of either type of method used. In addition, three types of anomalies in the terrain conductivity data are outlined: high conductivity anomalies of uncertain origin; low conductivity anomalies that may be related to concentrations of hydrocarbons in the subsurface; and apparent negative conductivity anomalies indicating the presence of metal. The apparent negative conductivity anomalies outlined in Plate 5 were taken from the in-phase component data, which are more sensitive to the presence of metal than the quadrature-phase component.

4. CONCLUSIONS

On the basis of the geophysical surveys conducted at the Booth Oil Site, we conclude that:

1. The measured terrain conductivity of the Site is highly variable and apparently strongly influenced by both visible and buried cultural features.

2. Steep apparent conductivity gradients due to such features mask the presence, if any, of contaminant plumes. No plume was detected in this survey.

3. Regions of the Site with apparent negative terrain conductivity are interpreted to contain buried metal and reinforced concrete. The GPR records confirm the presence of pipes in four such areas and probable reinforced concrete pads in other areas. However, there is no evidence for the presence of underground storage tanks in the GPR data for the areas surveyed.

4. Several regions of the Site exhibit very high conductivity, two to five times the conductivity measured elsewhere on Site. The nature of the materials causing the increase in conductivity is unknown.

5. The northeast corner of the Site contains a small area of relatively low terrain conductivity that may represent a concentration of hydrocarbon contamination.

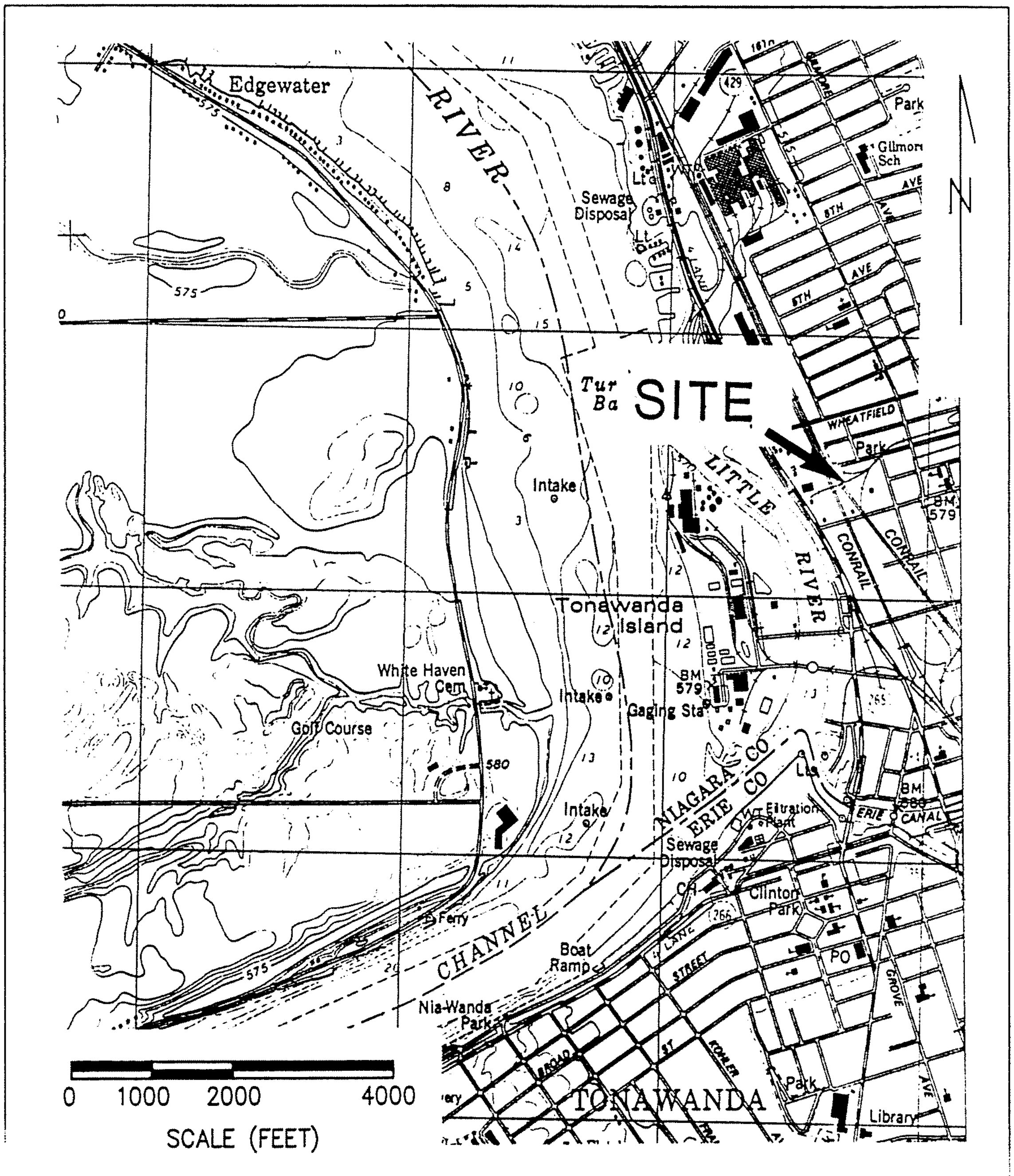
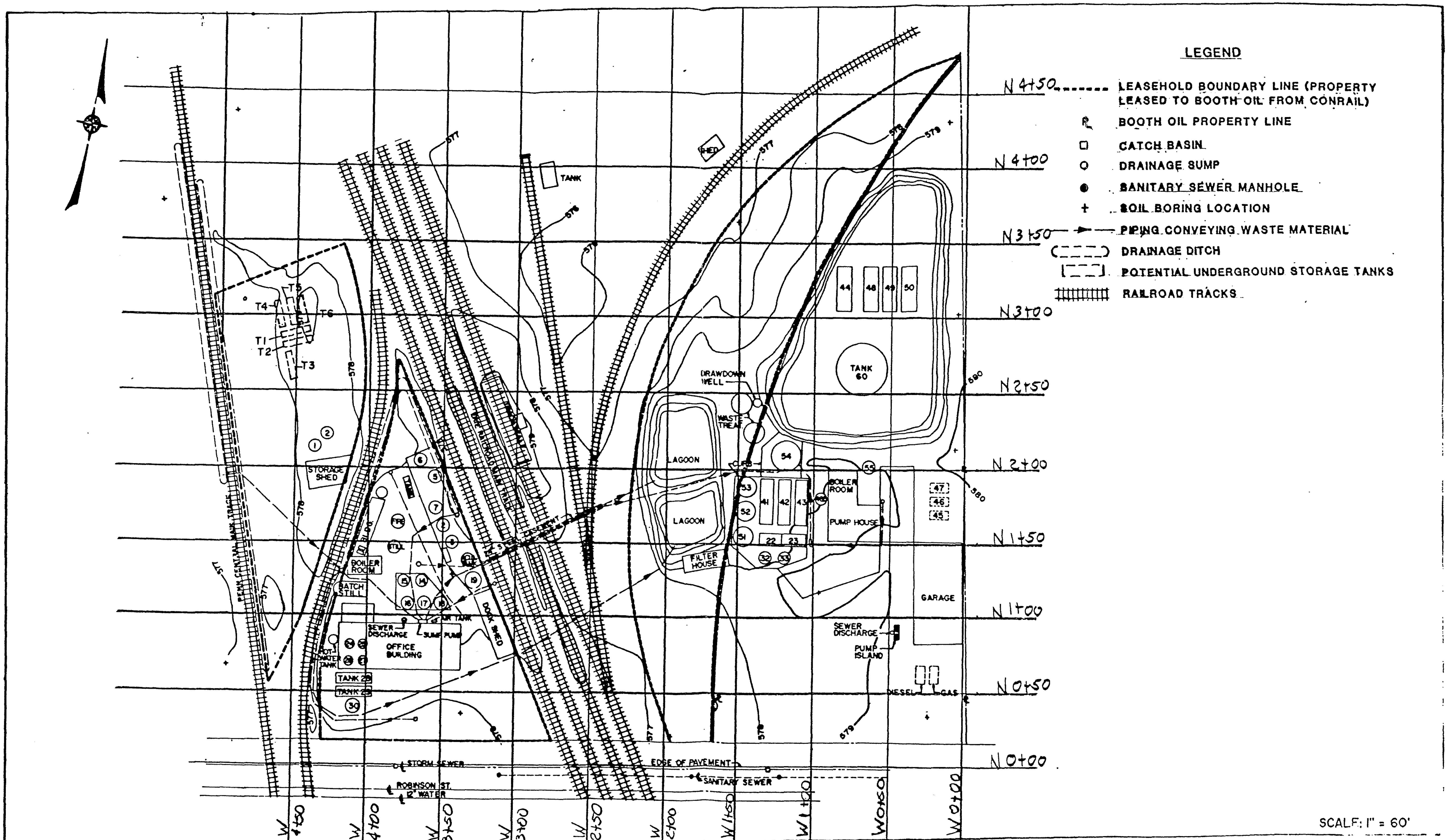


Figure 1. General location of the Booth Oil Site.



BOOTH OIL SITE
NORTH TONAWANDA, NIAGARA COUNTY, NEW YORK

Dvirka and Bartilucci CONSULTING ENGINEERS

FACILITY LOCATION MAP

FIGURE NO. 2-2

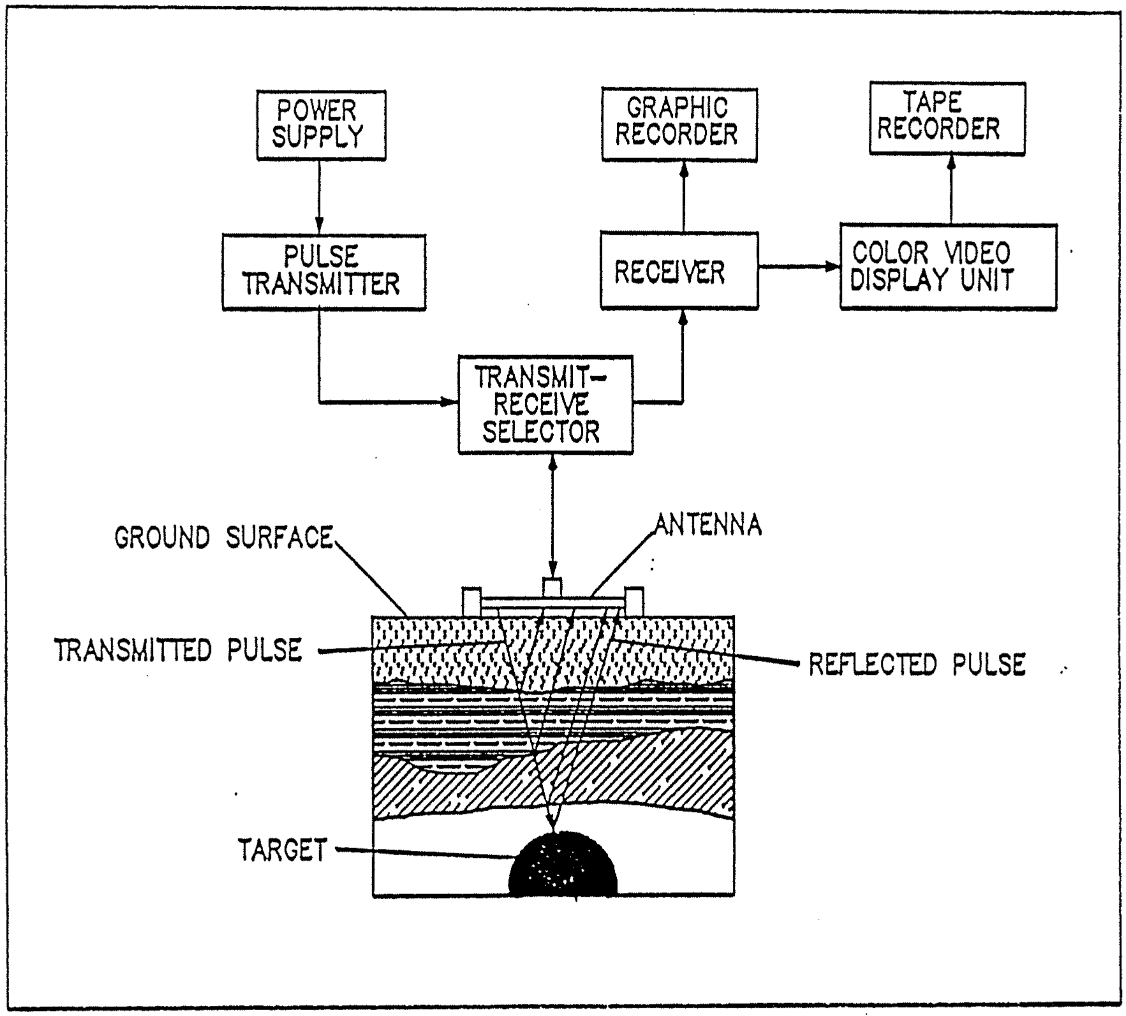


Figure 3. Basic operation of the GPR system.

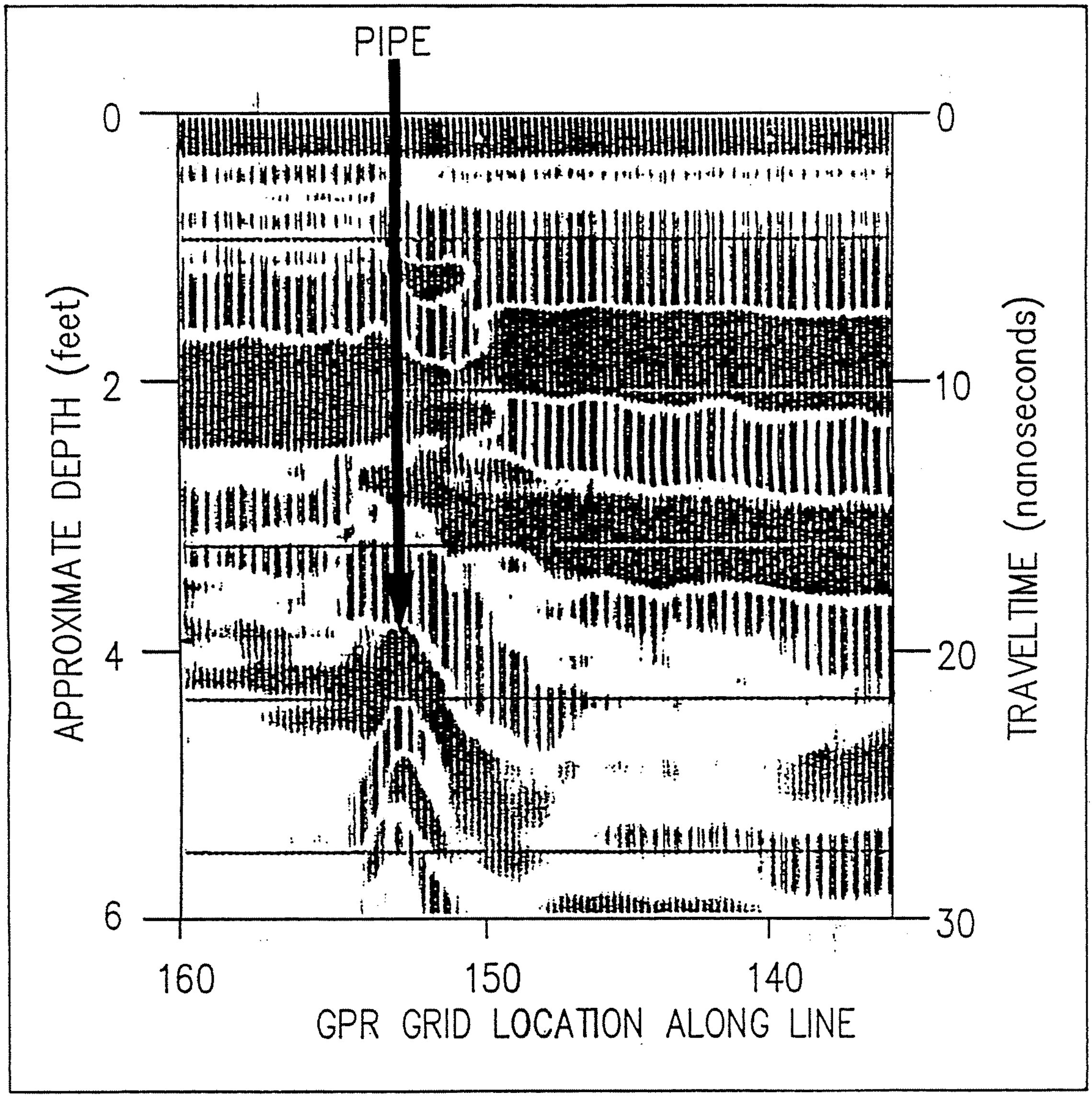


Figure 4. GPR signature of a possible pipe. Survey Line DDD.

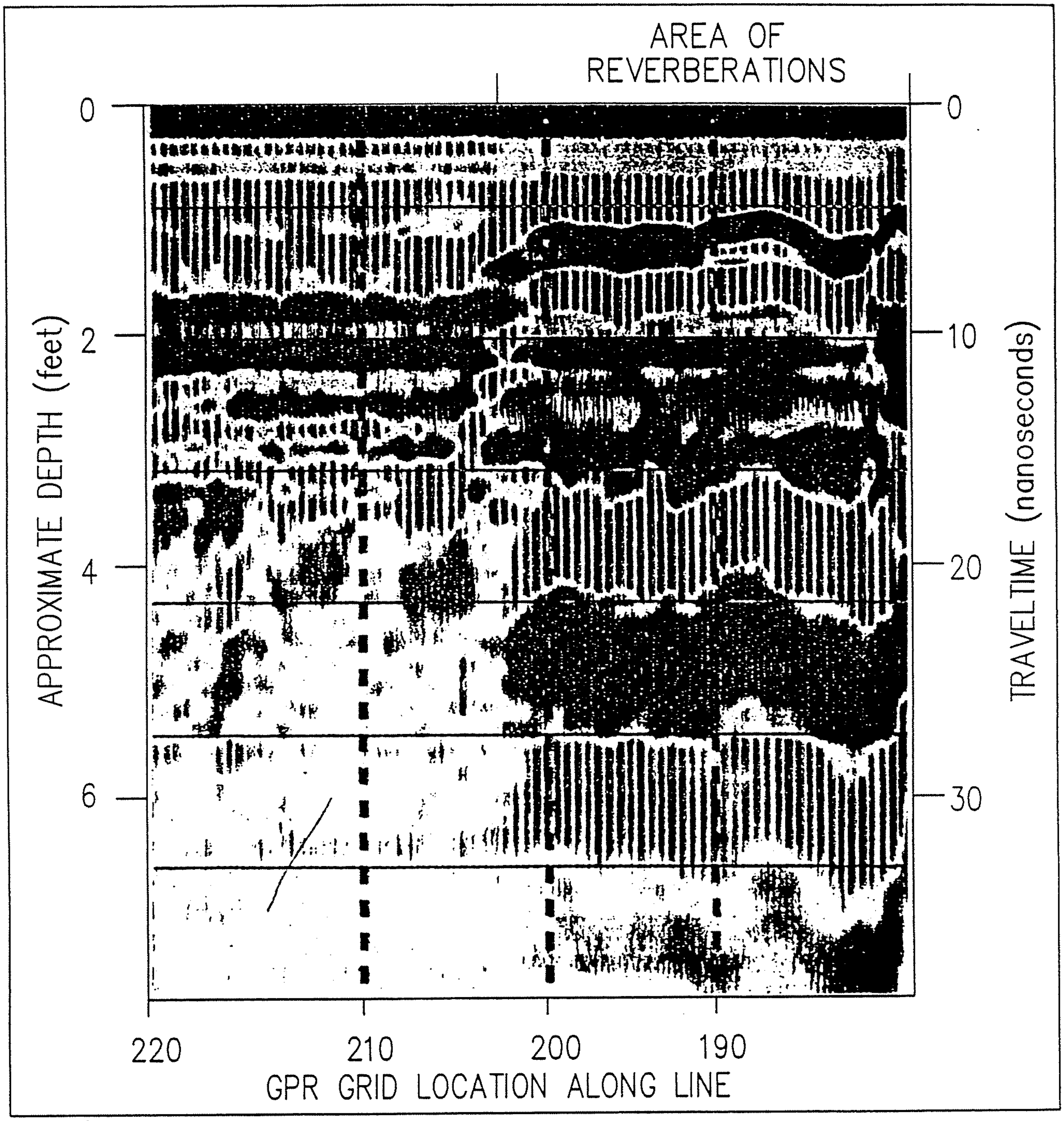


Figure 5. GPR signature of reverberations attributed to reinforced concrete slabs. Survey Line E.

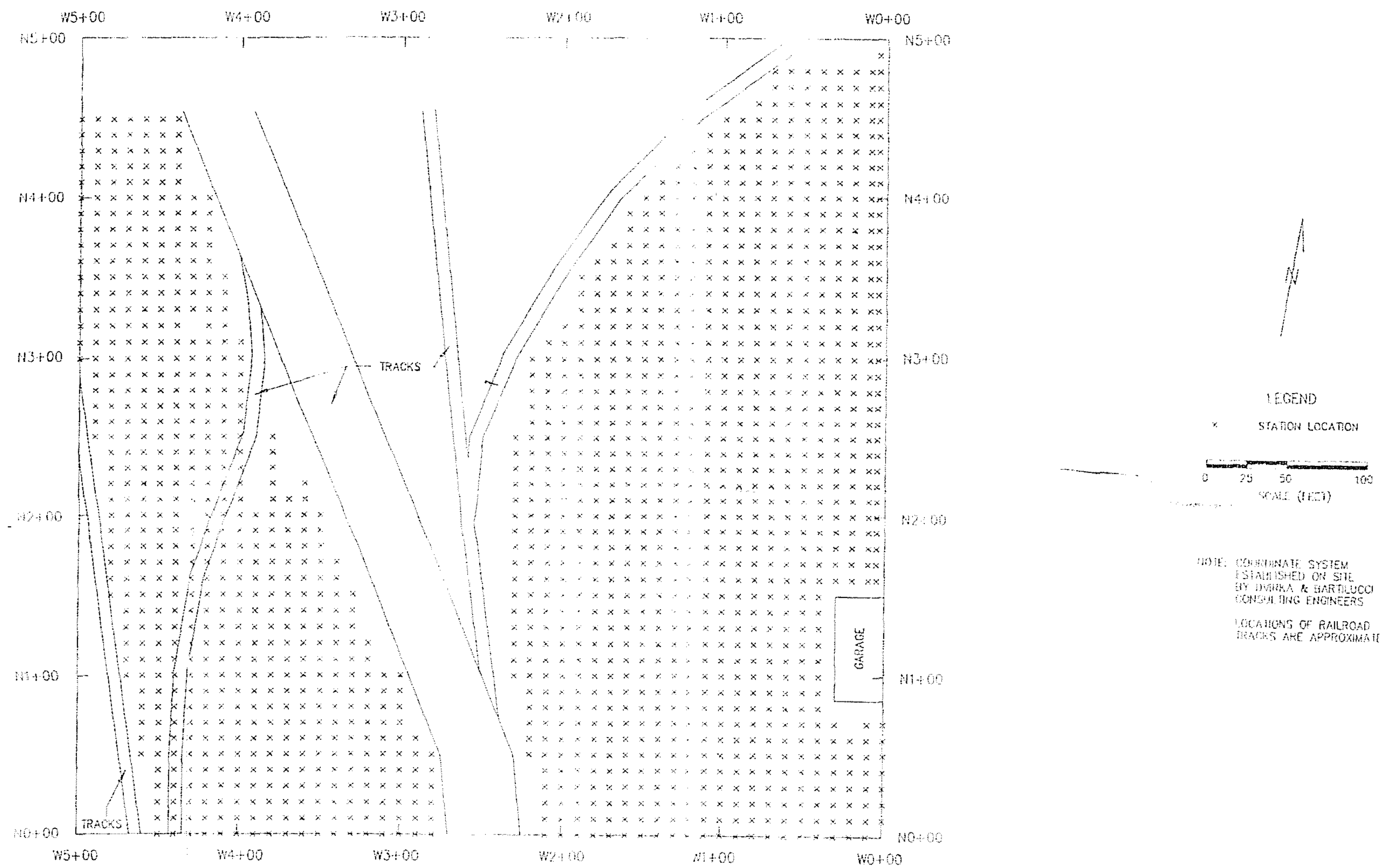


PLATE 1
TERRAIN CONDUCTIVITY STATIONS
BOOTH OIL SITE
NORTH TONAWANDA, NEW YORK

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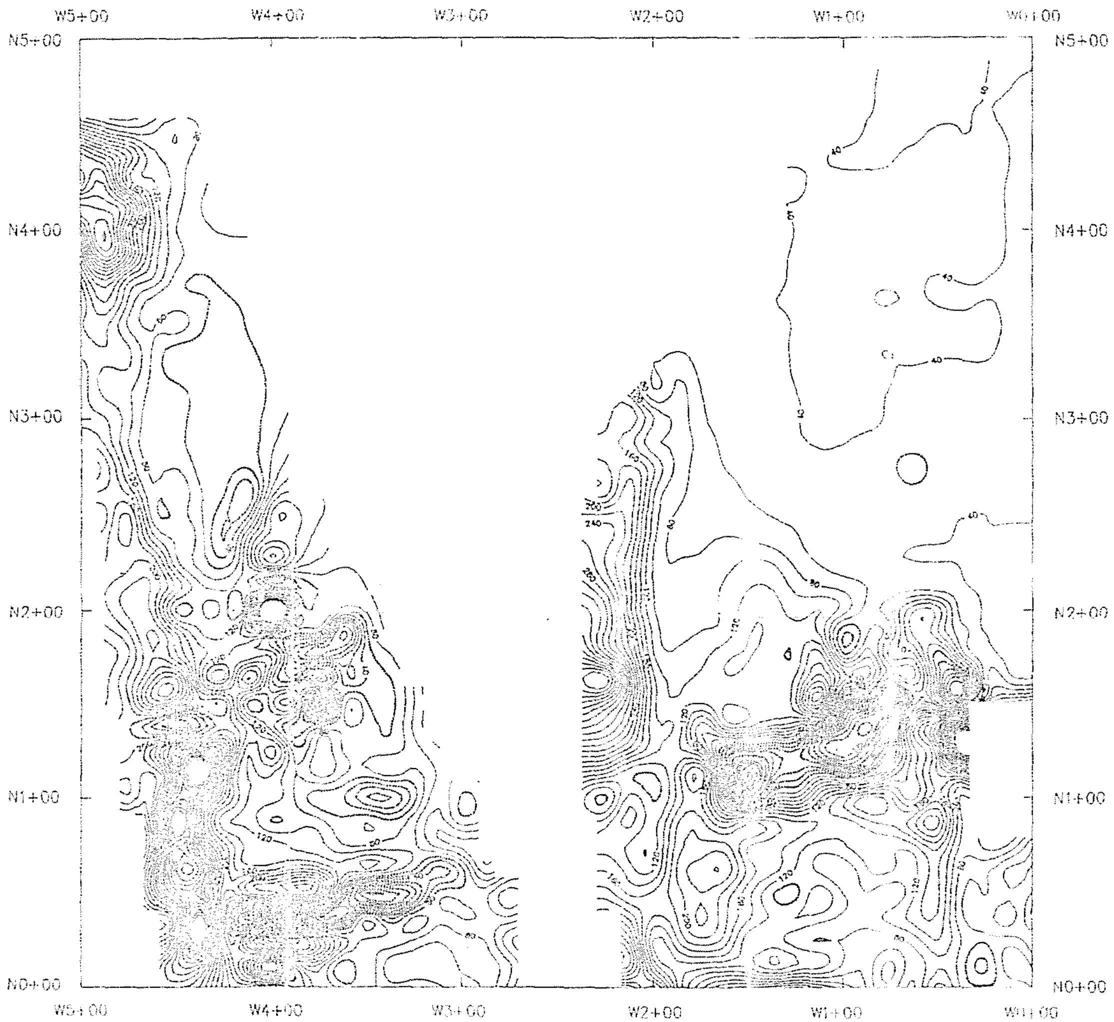
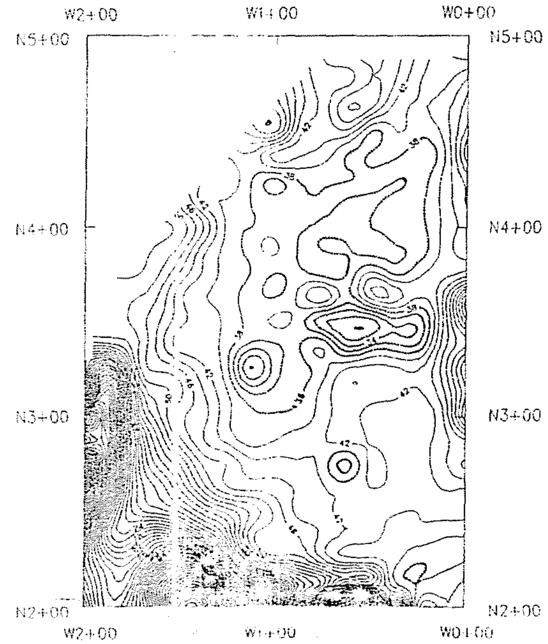




Inset Map

CONTOUR INTERVAL = 2 mmhos/meter

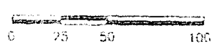
NOTE: COORDINATE SYSTEM ESTABLISHED ON SITE BY DVIRKA & BARTILUCCI CONSULTING ENGINEERS

CONTOURS GREATER THAN 460 mmhos/meter HAVE BEEN OMITTED.

LEGEND

CONTOUR LINE SHOWING TERRAIN CONDUCTIVITY (mmhos/meter)

CONTOUR INTERVAL = 20 mmhos/meter



SCALE (FEET)

PLATE 2
SHALLOW TERRAIN CONDUCTIVITY
QUADRATURE-PHASE COMPONENT
BOOTH OIL SITE
NORTH TONAWANDA, NEW YORK

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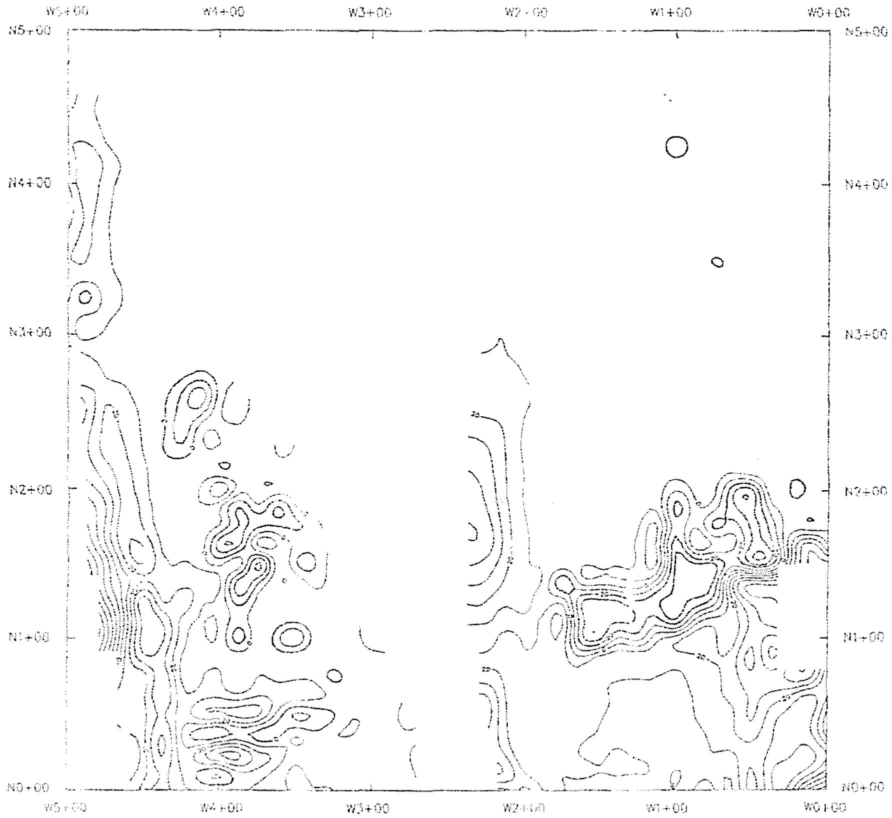

LEGEND

CONTOUR LINE SHOWING
TERRAIN CONDUCTIVITY
IN-PHASE COMPONENT
(mmhos/meter)

CONTOUR INTERVAL = 10 ppt.

0 25 50 100
SCALE (FEET)

NOTE: COORDINATE SYSTEM
ESTABLISHED ON SITE
BY DVIRKA & BARTILUCCI
CONSULTING ENGINEERS

PLATE 3
SHALLOW TERRAIN CONDUCTIVITY
IN-PHASE COMPONENT
BOOTH OIL SITE
NORTH TONAWANDA, NEW YORK

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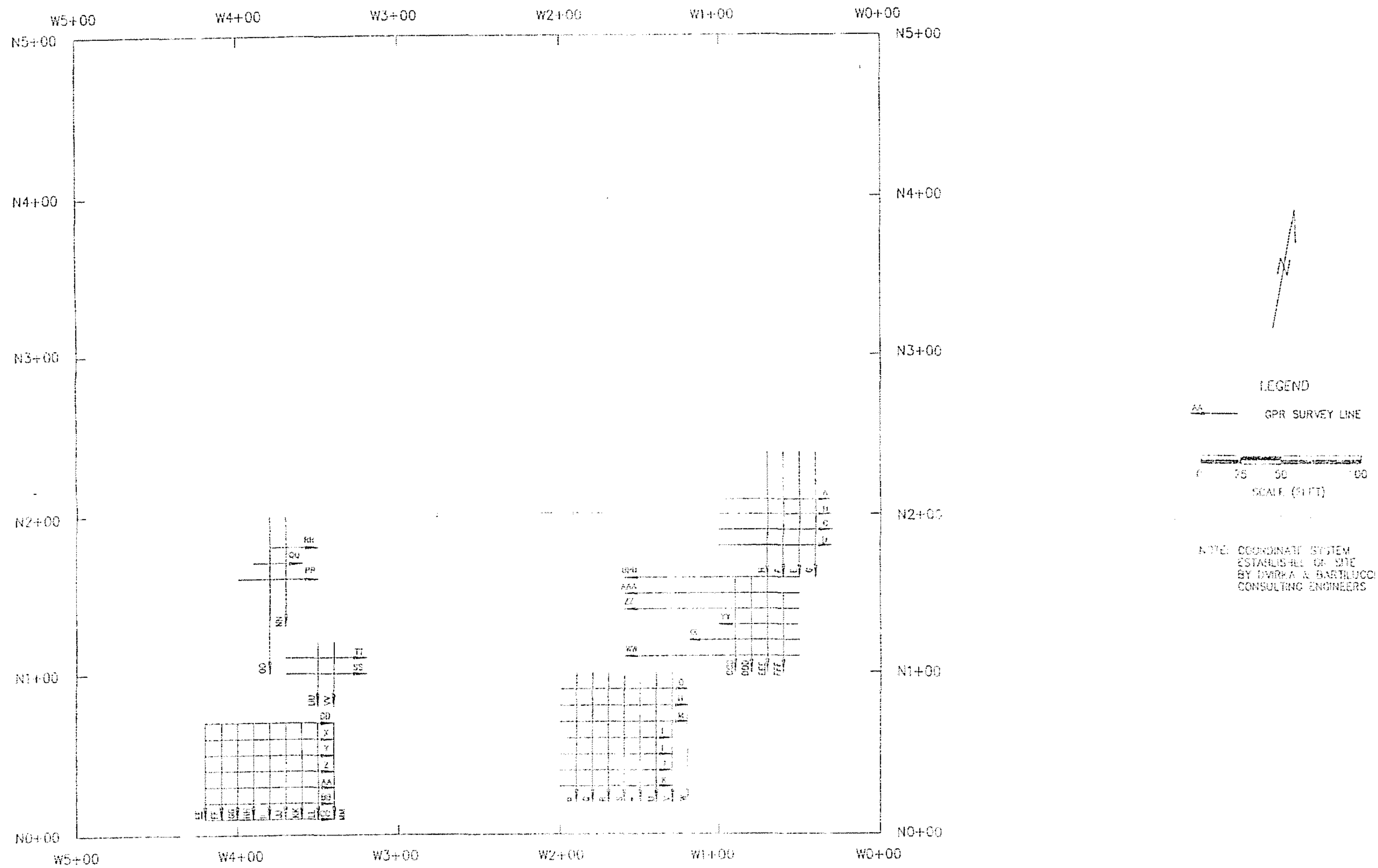

PLATE 4
GPR SURVEY LINES
BOOTH OIL SITE
NORTH TONAWANDA, NEW YORK

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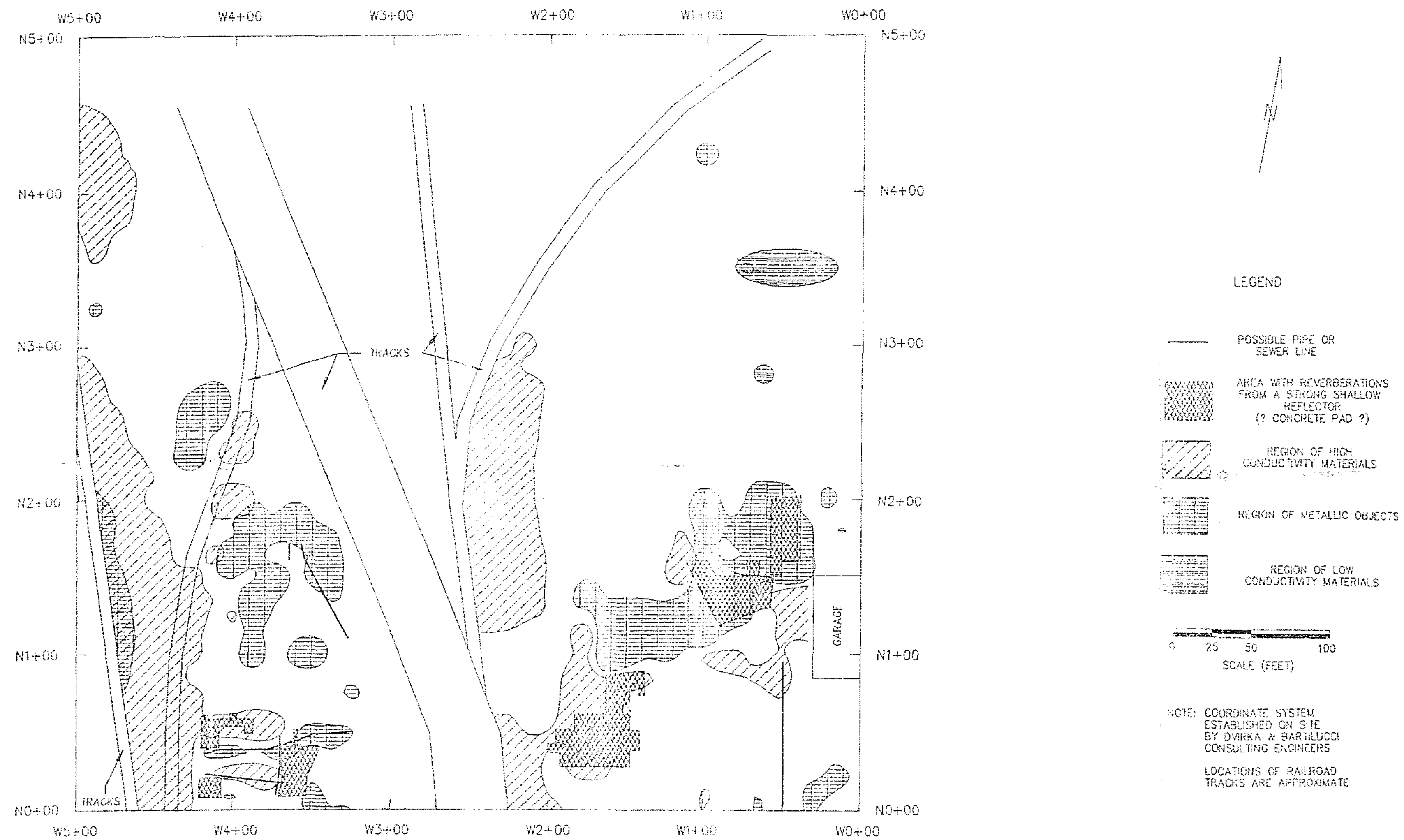

PLATE 5
INTERPRETATION MAP
BOOTH OIL SITE
NORTH TONAWANDA, NEW YORK

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