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TECHNICAL MEMORANDUM I
TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

April 10, 1992

Prepared for

The Tutu Environmental Investigation Committee
St. Thomas, U.S. Virgin Islands

Prepared by

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TECHNICAL MEMORANDUM I
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Geraghty & Miller, Inc. is submitting this report on behalf of the Tutu Environmental Investigation Committee for work performed at the Tutu Wells Site, St. Thomas, U.S. Virgin Islands. The report was prepared in conformance with Geraghty & Miller's strict quality assurance/quality control procedures to ensure that the report meets the highest standards in terms of the methods used and the information presented. If you have any questions or comments concerning this report, please contact one of the individuals listed below.

Sincerely,

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INTRODUCTION

In March 1992, Geraghty & Miller, Inc. revised and submitted the Tutu Service Station Investigation Work Plan (Geraghty & Miller, Inc. 1992) to the United States Environmental Protection Agency (USEPA) on behalf of the Tutu Environmental Investigation Committee (TEIC), which is comprised of Texaco Caribbean Inc. (Texaco) and Esso Virgin Islands, Inc. (Esso). The Tutu Wells Site is located in the east-central portion of St. Thomas (see Figure 1). The work plan was to be incorporated as part of the Administrative Order by Consent (No. II-RCRA-7003 and 9003-92-0401) issued to Texaco and Esso by the USEPA Region II, pursuant to Subtitle I of the Resource Conservation and Recovery Act (RCRA). As indicated in the work plan, the purpose of Technical Memorandum I is to provide the results of the preliminary reconnaissance activities which will determine the final recommendations for the soil boring and monitoring well locations. The drilling program as proposed in the work plan will consist of twelve soil borings (B-1 through B-12), ten shallow monitoring wells (MW-1 through MW-10), and seven deep monitoring wells (MW-1D, MW-4D, MW-6D, MW-10D through MW-13D). Figure 2 presents the drilling locations as originally proposed in the work plan (Geraghty & Miller, Inc. 1992).

The reconnaissance activities were performed to increase the current knowledge of the site conditions, to ensure that final well locations are selected to maximize hydrogeologic characterization of the site, and to prevent interference with subsurface and overhead utilities during field work. The reconnaissance activities included the following:

- Preparation of an accurate base map of the area.
- Review of existing geologic and hydrogeologic data for the area.

- Review of previous investigations performed by the USEPA, the U.S. Virgin Islands Department of Planning and Natural Resources (DPNR), or previous site owners and operators.
- An inventory of existing wells in the area.
- Identification of human-constructed structures in the area.
- Fracture trace analysis of aerial photographs.
- Implementation and interpretation of magnetometer surveys at selected boring locations.

BASE MAP PREPARATION

For the purposes of the Tutu Service Station Investigation, a more accurate map depicting the study area than Figure 2 will be needed. A more accurate site plan is presented on Figure 3. This site plan was based on a map of the water distribution system prepared for the Virgin Islands Water and Power Authority (WAPA) at an approximate scale of 200 feet (CH_2M Hill 1990). Figure 3 provides the necessary accuracy to depict the proposed drilling locations relative to overall site features. More detailed base maps were prepared for the Esso Service Station (see Figure 4) and the Texaco Service Station (see Figure 5) using compass and tape measure readings. A licensed surveyor is in the process of preparing a topographic base map of the study area, which will be used during the investigation.

HYDROGEOLOGIC SETTING

St. Thomas has an area of 32 square miles. The island is mainly comprised of volcanic rocks of Cretaceous age. The Tutu Wells Site is located within the Turpentine Run surface drainage basin, which covers approximately 3.4 square miles. Turpentine Run flows from northwest to southeast. The Turpentine Run basin is separated into an upper and lower basin. The upper basin includes 2.3 square miles upstream of the historical stream gaging station near Mt. Zion, and the lower basin includes 1.1 square miles downstream of this station. Turpentine Run at the Tutu Wells Site has been channelized into storm sewer culverts (see Figure 6). Figure 6 presents the general layout and dimensions of the storm sewer culverts. Flow rates are highly variable in the storm sewer, depending predominantly on rainfall. There have been occasions when no flow was observed in the channel.

The geology of the Turpentine Run basin is comprised of two volcanic formations, the Water Island Formation and the younger Louisenhoj Formation (Donnelly 1959). The Water Island Formation is composed primarily of basaltic flows and breccias. It is unconformably overlain by the Louisenhoj Formation. This formation consists of pyroclastic to epiclastic augite-andesite. Locally, the base of the Louisenhoj consists of the Cabes Point Conglomerate which is composed of well rounded and well sorted pebbles and cobbles of the older Water Island Formation.

Both the Water Island and Louisenhoj Formations are present in the upper basin. By mapping the offset of formation contacts, Donnelly (1959) identified two major strike-slip faults striking northwest-southeast, with right lateral separation. One of these faults occurs approximately 2500 feet northeast of the Tutu Wells Site. Geologic logs of wells drilled in the upper basin do not differentiate between the Water Island and the Louisenhoj Formations. In the lower basin, only the Water Island Formation is found and it is overlain by as much as 40 feet of alluvial deposits (Jordan and Costner 1973).

Ground water in the Turpentine Run basin occurs in two aquifers (Jordan and Costner 1973). The primary aquifer consists of fractured volcanic rock of the Water Island and Louisenhoj Formations, and locally, the Cabes Point Conglomerate. A more limited aquifer occurs in the alluvial deposits in the lower basin. Very thin alluvial deposits are present in the upper basin with thicknesses ranging from 0 to 2 feet in most locations, to perhaps 10 to 20 feet along the axis of the valley. The alluvial deposits in the Upper Turpentine Run basin are not considered an aquifer capable of supplying a useable amount of water because of the limited extent and saturated thickness of these deposits. Where saturated, the alluvial deposits are considered to be hydraulically connected with the fractured volcanic rock aquifer. Ground water in alluvial deposits and the fractured bedrock generally exists under water-table conditions. Localized low permeability (i.e., fine-grained) layers in the alluvial deposits can result in localized confined conditions in the bedrock.

The bedrock aquifer in the Turpentine Run basin is the most intensely developed ground-water resource in St. Thomas. As of 1982, over 45 wells had been drilled in the upper and lower Turpentine Run basin for domestic, commercial, and public housing supply (Geraghty & Miller 1983). In the upper basin, the ground-water supply is derived from the fractured volcanic rock. Well depths in the upper basin range from 73 to 325 feet below land surface (Stevens et. al. 1981). The depth to these wells does not correlate with yield, but rather is an indication of where a zone of water-bearing fractures was penetrated. Short-term well yields in the upper basin as high as 100 gallons per minute (gpm) have been reported; however, sustained yields typically range only between 2 to 21 gpm (Jordan and Costner 1973).

A potentiometric surface map of the Turpentine River basin aquifer was prepared by the U.S. Geological Survey (USGS) (Graves and Gonzales 1988) using water-level data collected on September 11, 1987. A generalized adaption of this map is shown on Figure 7, which indicates that ground-water flow is generally to the southwest through the Tutu area, parallel to the axis of the valley. At the southern portion of the Tutu area, ground-water flow is to the south and southeast. The September 11, 1987 water levels for the Demitri, Eglin II, Eglin III, and Steele wells were qualified by the USGS study (Graves and Gonzalez 1988) as non-static (i.e., pumping or recovery) water levels. Table 1 presents ground-water levels and estimated supply well pumping rates for September 1987.

Although accurate ground-water withdrawal rates were not known, it was estimated that in 1978 withdrawals probably exceeded the estimated safe yield of 300,000 gallons per day (gpd) that was calculated by the USGS in 1973 (Griggs pers. comm. 1978). As of 1982, the Virgin Island Department of Public Works (VIDPW) had granted ground-water withdrawal appropriations totaling approximately 1,000,000 gpd (Geraghty & Miller, Inc. 1983).

Recharge to the fractured volcanic rock in the upper basin is from the occasional major rainstorm, and is dependent not only on rainfall frequency, but also on the volume of a particular rainfall event (Jordan and Costner 1973). Because of surface runoff and evapotranspiration, at least 2 inches of rainfall within a 24-hour period is necessary for recharge to occur. Annual recharge to the upper basin due to rainfall is estimated to be 130 million gallons. Of this amount, about 10 million gallons is lost to base flow in Turpentine Run and 25 million gallons by subsurface ground-water discharge to the lower basin under natural conditions. The sum of 35 million gallons per year represents the estimated maximum ground-water yield, if all of the ground-water could be effectively captured by ground-water withdrawal. The remainder, about 95 million gallons, is lost to evapotranspiration. Few data exist to characterize the hydraulic characteristics of the Turpentine Run basin aquifers. Of six pump tests reported in the basin prior to 1982 only one well had a specific capacity greater than 1 gallon per minute per foot (gpm/ft) of drawdown but it was less than 2 gpm/ft (Stevens et. al. 1981). Due to the general lack of scientific pumping test data and the complexity of ground-water flow in fractured rock, more data are needed for an accurate determination of aquifer hydraulic characteristics.

INVENTORY OF EXISTING WELLS

Using information obtained from the Virgin Islands Department of Planning and Natural Resources (DPNR) and the USGS, information pertaining to existing wells was compiled; this is summarized in Tables 1 and 2. The locations of these wells are shown on Figure 7. In addition to the supply wells listed in Table 2, monitoring wells are known to exist in the study area; however, construction data for these monitoring wells was not readily available. Two monitoring wells were installed approximately 20 feet east of Route 38 at the north and south edges of the O'Henry property. The northern (upgradient) well at the O'Henry property has been damaged, apparently by a vehicle. The protective casing is bent over, making the well inaccessible. Underground storage tank leak detection compliance monitoring wells are present near the underground storage tanks at the Texaco Service Station and at the Esso Service Station. An apparent monitoring well is present on Four Winds property between the car wash and the Esso property. As of February 1992, a new supply well has been installed at the Four Winds Plaza, near the proposed location of monitoring wells MW-6 and MW-6D.

UNDERGROUND STRUCTURES

Prior to initiation of a selection of final drilling locations, information was gathered regarding subsurface utilities. The files of the VIDPW were reviewed to ascertain the position of sanitary and storm sewer lines, however no maps were available. Therefore, storm sewer and sanitary sewer lines were mapped in the field by Geraghty & Miller personnel. A map of the Four Winds Plaza and Esso Station prepared by Alvarez-Diaz Associates of San Juan, Puerto Rico presented in a soil gas report (Belogodere and Associates 1988) was also used to delineate sewer lines. Most of the electrical and telephone lines are above-ground. Figures 4 and 5 show the underground and above-ground structures identified during the reconnaisance activities at the Esso Service Station and the Texaco Service Station, respectively. The location of the storm sewer drainage is shown on Figure 6.

FRACTURE TRACE ANALYSIS

Because the aquifer underlying the Tutu study area consists of fractured bedrock, a fracture trace analysis was included in the scope of the work plan (Geraghty & Miller, Inc. 1992). The results of the fracture trace analysis have been considered when selecting the final monitoring well locations.

METHODS AND OBJECTIVES

A fracture trace analysis was conducted in an effort to identify features of the underlying bedrock (such as fractures, joints, and faults) which may influence the rate and direction of ground-water flow at the Tutu Wells Site. Fracture traces are linear trends that can be discerned in topographic features, soil tone, and vegetation, and are often surface manifestations of underlying bedrock fractures. The Tutu fracture trace study consisted of the detailed analysis of aerial photographs and topographic maps of the area. The aerial photographs examined were pairs of black and white stereographic prints. Aerial photographs from January 29, 1954 at a scale of approximately 1:28,000 (1 inch = 2,333 feet) and February 7, 1971 at a scale of approximately 1:20,000 (1 inch = 1,667 feet) were analyzed. The USGS (1954) topographic map for the eastern St. Thomas quadrangle, at a scale of 1:24,000 (1 inch = 2,000 feet), was also used to plot the linear trends identified in the Tutu area.

RESULTS OF FRACTURE TRACE ANALYSIS

The analysis identified 47 linear traces representing a total of 73,400 linear feet (13.89 miles) of observable features within the study area (Figure 8). The average length of the linear features was 1,560 feet. Some of the linear trends were identified at the Tutu Wells Site area.

An azimuth frequency diagram, commonly known as a rose diagram, was prepared using the fracture traces identified. The rose diagram, prepared by plotting the azimuth of each trace, is useful in identifying trends and groupings of traces. The rose diagram for fracture trace results is presented in Figure 9. As shown by the rose diagram, the mean trace orientation was 58.8 degrees (238.8 degrees). However, the predominant trace orientation is 103 degrees (283 degrees), and a secondary set is orientated 48 degrees (228 degrees).

The most significant results of the fracture trace analysis of the Tutu Wells Site include the identification of two fracture lineaments within the study area. A northeast-southwest lineament is located north of the Curriculum Center Building (former Laga Building) and intersects the existing supply wells at the Virgin Island Housing Authority (VIHA) and Ramsay properties (see Figure 8). A second fracture trace with a north-south trend, near Route 38, intersects the northeast-southwest lineament within the Ramsay property (see Figure 8). The presence of these two intersecting fracture lineaments may allow for preferential ground-water flow. Under natural conditions, ground water may flow more readily from the vicinity of VIHA in a southwest direction along the first fracture trace until intersecting the north-south fracture lineament on the Ramsay property. Preferential ground-water flow may continue southward along the fracture system which coincides with the axis of the Turpentine Run valley (see Figure 8). The water supply line located in the vicinity of the northeast-southwest lineament identified north of VIHA and the Curriculum Center, prevents the installation of monitoring wells in the immediate vicinity of the lineament. However, proposed Monitoring Wells MW-13D, MW-1, and MW-1D will be located within approximately 100 feet south of the northeast-southwest lineament. Proposed Monitoring Wells MW-2, MW-6, and MW-6D will be located in the vicinity of the north-south lineament (see Figure 3).

MAGNETOMETER SURVEY

A magnetometer survey was performed at three specific areas within the study area for the Tutu Service Station Investigation from December 16, 1991 through December 21, 1991. The aim of the survey was to further characterize the site and determine if the proposed boring and monitoring well locations were free from underground obstructions. If there was any doubt from a safety standpoint, alternate locations for the borings and monitoring wells would be recommended.

METHODS AND OBJECTIVES

Geraghty & Miller personnel utilized a GEM GSM-19 proton precession magnetometer/gradiometer equipped with a data logger for the magnetic survey. The magnetometer measures the intensity of the earth's magnetic field. The presence of ferrous metal creates local variations in the strength of the earth's magnetic field, permitting detection of the metallic object. The following areas were surveyed with 5-foot interval spacing:

- North of the Curriculum Center Building (Former Laga Building)
- Southwest portion of the Texaco Service Station
- Northern portion of the Esso Service Station

These areas and the proposed boring and monitoring well locations are illustrated on Figure 3.

A 5-foot grid was established at each survey area with a measuring tape, compass, and spray paint. Not all of the nodes were marked; rather sufficient reference points were marked to allow the instrument operator and his guide to cover the survey grid, ensuring that each reading was correctly entered into the data logger at the correct grid coordinate.

The magnetometer was calibrated to the inclination of the magnetic field, which is about 50 degrees in the Virgin Islands. The grid coordinate system was keyed into the data logger and successive readings were taken along each transect line. At each node of the grid, values of total magnetic field and vertical gradient were simultaneously measured and digitally recorded by the instrument operator using a data logger. The second member of the survey team documented each line and made a sketch map of the grid. All known metallic surface features relevant to the interpretation of the survey data were plotted on the grid map.

Base station readings were obtained to check for diurnal drift in the earth's magnetic field as an indication of any localized magnetic storms which may affect the integrity of the survey data that were collected between successive base station data sets. The survey areas were relatively small; hence, base station readings were taken at the beginning and at the end of each survey. This resulted in only a few hours difference in base station data sets. The base station data set consisted of ten readings taken concurrently at 4-second intervals.

To select an area suitable for a base station, readings were obtained over a 20-square foot area in order to determine if the area contained any anomalies. If the readings varied by more than plus or minus a few gammas, the area was rejected for use as a potential base station. Once the base station had been selected, it was staked out so the base station readings could be taken at exactly the same location each time. A base station was established on the Joseph Gomez School property immediately north of the Curriculum Center property. A second potential base station located south of the Four Winds Plaza was rejected due to unacceptable readings.

Both the total magnetic field and the vertical gradient of the total field were recorded during the survey. During processing a regional component of 40500 gammas was removed from the total field leaving the anomalous total field. These values were plotted and used for the data interpretation. The removal of this constant field from the data does not influence the interpretation since it does not alter the magnitude of the anomalies nor does it change their shape. The advantage of this processing is that anomaly sizes are more easily observed on the contour maps.

Interpretation of the magnetic data was carried out in two parts. First, the most significant anomalies were selected and lines of anomalous total field data passing through these anomalies were obtained. These were computer modelled allowing estimates of the depth to the top of the sources along with an interpretation of their depth extent. It is important to note that the interpretation is designed only to present approximate solutions and has not been carried out in detail. In all of the cases modelled, the interpreted depths to the top of the sources was less than 5 feet. The second part of the interpretation was to draw, on the individual total field contour maps, an interpretation of the location of the source of the anomalies. In the Virgin Islands, the inclination of the magnetic field is about 50 degrees. This means that the induced anomaly over a buried piece of iron will have a positive anomaly and a fairly strong negative anomaly to the north of the metallic object. However, some of the negative anomalies could not be properly accounted for during the interpretation. Such anomalies are frequently caused by local buildings where metal is at an elevation greater than that of the sensor. Negative anomalies can be very strong in such cases. This may be the case for many of the negative anomalies at these sites.

RESULTS OF THE MAGNETOMETER SURVEY

One survey grid map, one total field contour map, and one vertical gradient contour map are presented for each survey area (see Figures 10 through 18). The interpreted source locations are plotted on the total field maps. Because of the complexity of the survey areas, the vertical gradient data shows rapid variations and has been used only to check the anomalies.

The effectiveness of the magnetometer surveys was partially limited by the interference or noise associated with known metallic objects (i.e., fences, buildings, vehicles, metal debris, etc.). To the extent possible, computer modelling of the known metallic objects was performed to predict and cancel the expected influence of the known objects.

Magnetometer Survey North of Curriculum Center Building

The survey grid for the area north of the Curriculum Center Building (former Laga Building) is presented in Figure 10. The magnetometer survey was performed in an unpaved area north of a chain-link fence which trends east-west, approximately 60 feet north of the Curriculum Center Building. Sixteen 55-gallon steel drums are present in the survey area. The objective of the magnetometer survey was to identify any subsurface magnetic anomalies which would jeopardize the safety and effectiveness of the proposed drilling program in this area.

A gate in the fence extends from grid coordinates 3N, 60E eastward beyond the survey area. The gate allows access to an unpaved area east of the survey grid which is used for employee parking and storage of various building materials. The magnetometer survey area includes sixteen 55-gallon steel drums which are partially corroded and strewn on the ground in grassy areas along the north and west boundaries of the survey grid. A brown gray viscous sludge with a plastic or rubber consistency is present in some of the corroded drums. Black-colored stained soil is present immediately east of the largest accumulation of drums.

The total magnetic field intensity contour plot (Figure 11) indicates a linear anomaly along the north portion of the grid. The known presence of a 12-inch diameter steel water supply pipe running east to west is not the sole cause of this linear anomaly because the magnitude of the anomaly is too large. The contour plot of the vertical magnetic gradient (Figure 12) which is more sensitive to shallow metallic objects supports two distinct anomalies in this area. Computer modeling across the anomaly indicates that the interpreted depth to the top of the source is less than 5 feet. Based on field observations of metallic debris at this location, the influence of the drums and the metal pole combined with the steel water line are interpreted as the source of the anomaly. Based on the magnetometer survey it is proposed to locate B-1 at grid coordinates 25E, 24N (see Figure 10).

The surface soil in the area east of the larger accumulation of drums is stained and a magnetic anomaly is also present in this area. Based on the magnetometer survey data and the observed stained soil at this location, it is proposed that surface soil samples be collected at this location rather than drilling into the subsurface. The magnetometer survey results indicate Soil Boring B-1 cannot be safety located in the stained soil area or adjacent to the drums, as desired. The proposed location for Boring B-1 has been relocated south and east of the two areas of drums. The revised soil boring location is shown on Figures 3 and 10. This drilling location will provide data on the depth to bedrock, but soil quality data for samples from this boring may not provide an adequate assessment of the impact of the drum disposal. Therefore, Geraghty & Miller proposes that two samples of the sludge remaining in the drums and two surficial soil samples in areas of stained soil be collected to characterize the potential impact of the drum disposal.

Magnetometer Survey at Texaco Service Station

The southwest portion of the Texaco Service Station was selected for a magnetometer survey because underground storage tanks and associated piping needed to be delineated prior to final selection of drilling locations for proposed Monitoring Wells MW-4 and MW-4D. Two anomalous magnetic areas were identified along the 50N and 60N lines on the Texaco Station grid. Underground storage tanks are located in this area.

A negative anomaly with center at (75E, 35N) possibly results from metallic objects above the sensor. Further interpretations of this anomaly is difficult without more data points. One possible cause could be magnetism that was induced into the tanks when they were first manufactured. The most likely explanation is an erroneous data point which has been extrapolated by the contouring program.

Magnetometer Survey at Esso Service Station

The northern portion of the Esso Service Station property was selected for a magnetometer survey to identify any underground utilities, tanks or other metallic anomalies. The reinforced concrete wall at the perimeter of the Esso property contains steel reinforcement. This magnetic feature was modelled and removed from the result. Magnetometer survey results for the Esso Service Station do not require modification of the proposed boring locations.

RECOMMENDED DRILLING LOCATIONS

Soil boring and monitoring well locations (see Figure 2) presented in the work plan (Geraghty & Miller, Inc. 1992) were selected to delineate the horizontal and vertical extent and the possible migration pathways of petroleum hydrocarbon products and volatile organic compounds in soil and ground water at the study area. The proposed locations shown in Figure 2 were selected based on preliminary visual observations. As a result of the reconnaissance activities, three soil boring and five monitoring well locations are recommended for relocation. The revised drilling locations are presented in Figure 3.

Proposed Boring B-1 and Monitoring Wells MW-1 and MW-1D were relocated at the north area of the Curriculum Building. Discarded drums and metal debris was observed at this area during survey activities. Monitoring Wells MW-1 and MW-1D have been located southwest of the drum disposal area and west of the loading dock at the Curriculum Center (see Figure 3). Proposed Monitoring Wells MW-4 and MW-4D were relocated at the Texaco service station. Due to numerous physical access limitations at the Texaco service station (i.e., underground piping, overhead power lines, vehicular traffic) the proposed location for Monitoring Well MW-5 has been moved south of Route 38 to the Tillett property (see Figures 3 and 5).

The locations for Soil Borings B-11 and B-12 are proposed at the rear of the O'Henry facility near the drum storage area (see Figure 3). An additional Soil Boring B-13 is proposed south of the O'Henry facility to characterize soil quality near a soil pile. The currently proposed soil boring and monitoring well locations are shown on Figures 3 through 5. Table 3 provides a summary of the anticipated total depth of the soil borings. The purpose of the soil borings is to collect soil samples for geologic and chemical analysis. The soil borings will also provide information regarding depth to bedrock. Table 4 provides a summary of the anticipated monitoring well construction details and the purpose of each monitoring well. Geraghty & Miller recommends that two sludge samples and two surface soil samples from the drum disposal area at the Curriculum Center be collected and analyzed for volatile organic compounds.

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Table 1. Ground–Water Levels and Pumping Rate Estimates for September 1987, Tutu Area, St. Thomas, U.S. Virgin Islands.

Well Identification	Depth to Ground Water* (feet)	Elevation* (feet) MSL	Ground–Water Elevation* (feet) MSL	Estimated** Pumping Rates (gpd)	Hours** Operating per Day
A – Bryan	---	215	---	72,000	6
B – Dede	26	27	1	---	---
C – Demitri	80	231	151	---	---
D – Dench	---	---	---	15,000	---
E1 – Devcon I, II, III	---	---	---	---	---
F1 – Eglin I	12	144	132	25,000	24
F2 – Eglin II	37	149	112	25,000	24
F3 – Eglin III	66	152	86	25,000	24
G – Four Winds I	13	166	153	500	16
H – Four Winds II	9	165	156	500	16
I1 – New Gassett	26	130	104	---	---
I2 – Hartman II	32	140	108	10,000	24
I3 – Hartman III	---	---	---	---	---
J – Harvey	30	138	108	500	variable
K – LaPlace	28	111	83	---	---
L – Leonard	---	---	---	---	---
M – Lockhart	11	220	209	80,000	6
N – Matthias	10	90	80	---	---
O – Ramsay	---	---	---	500	8
P – Rodrigues	16	125	109	500	6
Q – Smith	10	90	80	---	---
R – Steele	76	175	99	---	---
S – Tillett	21	186	165	40,000	24
T1 – VIHA I	56	231	175	500	24
T2 – VIHA II	60	235	175	500	---
T3 – VIHA III	17	239	222	44	---
T4 – VIHA IV	39	278	239	500	---

MSL Denotes elevations referenced to Mean Sea Level.
--- Denotes that relevant information was not available or was not found.
gpd Gallons per day.
Sources: *Graves, R.P. and Gonzalez, R. 1988, Potentiometric Survey of the Turpentine Run Basin in the Tutu Area, eastern St, Thomas, U. S. Virgin Islands: United States Geological Survey. Water Resources Investigations Report 88–4131.
**DPNR report: Well Inventory Tutu/Turpentine Run Site, St. Thomas, U.S. Virgin Islands September, 1987– unpublished.
***Field measurement by Geraghty & Miller in June 1991.

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Table 2. Inventory of Well Data, Tutu Service Station Investigation, St. Thomas, U.S. Virgin Islands.

Well Identification	Year** Constructed	Type of Casing	Reported** Depth (feet)	Alternate Well Designations USGS	DPNR
A – Bryan	1978	6" PVC	140	10–12	---
B – Dede	1964	6" ---	60	15–34	USVI–WAPA
C – Demitri	---	6" PVC	300	10–6	---
D – Dench	---	6" PVC	140	15–28	---
E1 – Devcon I	1981	6" PVC	160	15–29	POLY CARIB
E2 – Devcon II	1980	6" Steel	250	15–30	POLY CARIB
E3 – Devcon III	1982	8" PVC	250	15–31	POLY CARIB
F1 – Eglin I	1965	6" Steel	225	10–38	---
F2 – Eglin II	---	6" Steel	225	10–40	---
F3 – Eglin III	---	6" Steel	325	10–39	---
G – Four Winds I	1981	6" Steel	305	10–45	---
H – Four Winds II	1981	6" Steel	285	10–46	---
I1 – Gassett (New)	---	PVC **	203 ***	10–36	---
Gassett (Old)	1978	PVC	325	10–36	Harthman–Bakery
I2 – Hartman II	1978	6" PVC *	210	10–37	Harthman–Crusher
I3 – Hartman III	1965	6" Steel	210	10–43	Harthman–Estate
J – Harvey	1978	6" Steel	160	10–35	---
K – LaPlace	1967	6" Steel	80	10–33	C. Hodge
L – Leonard	1977	6" PVC	70	10–7	---
M – Lockhart (A)	1978	6" PVC *	140	10–10	M. Bryan 2
N – Mattias	1966	8" Steel	50	10–31	---
O – Ramsay	1978	6" PVC *	105	10–48	Ramsey Motors
P – Rodrigues	1978*	6" Steel	80	10–26	E&A's Corp.
Q – Smith	1960	6" Steel	---	10–32	---
R – Steele	1965	6" Steel	150	10–34	---
S – Tillett	1963	6" Steel	100	10–47	---
T1 – VIHA I	1978	6" Steel	175	10–49	---
T2 – VIHA II	1977	Steel *	150	10–50	---
T3 – VIHA III	1978	6" Steel	142	10–51	---
T4 – VIHA IV	1978	Galvan * Steel	140	10–52	---

--- Denotes that relevant information was not available or was not found.

* DPNR report: Well Inventory Tutu/Turpentine Run Site, St. Thomas, U.S. Virgin Islands September, 1987– unpublished.

** Denotes that data is from an unpublished report by the U.S. Geological Survey (USGS) office in the U.S. Virgin Island and is tentative.

*** Field measurements by Geraghty & Miller during sampling.

PR01301–wp3\wsyveic.wk3

TUT 002 1118

Table 3. Anticipated Soil Boring Total Depths, Tutu Service Station Investigation, St. Thomas, U.S. Virgin Islands.

Soil Boring	Estimated Depth to Bedrock (feet)	Purpose
B-1	12	Soil sampling.
B-2	10	Soil sampling.
B-3	18	Soil sampling.
B-4	15	Soil sampling.
B-5	10	Soil sampling.
B-6	12	Soil sampling.
B-7	12	Soil sampling.
B-8	12	Soil sampling.
B-9	12	Soil sampling.
B-10	12	Soil sampling.
B-11	12	Soil sampling.
B-12	12	Soil sampling.
B-13	12	Soil sampling.

#PR01301-wp3/boring.wk3

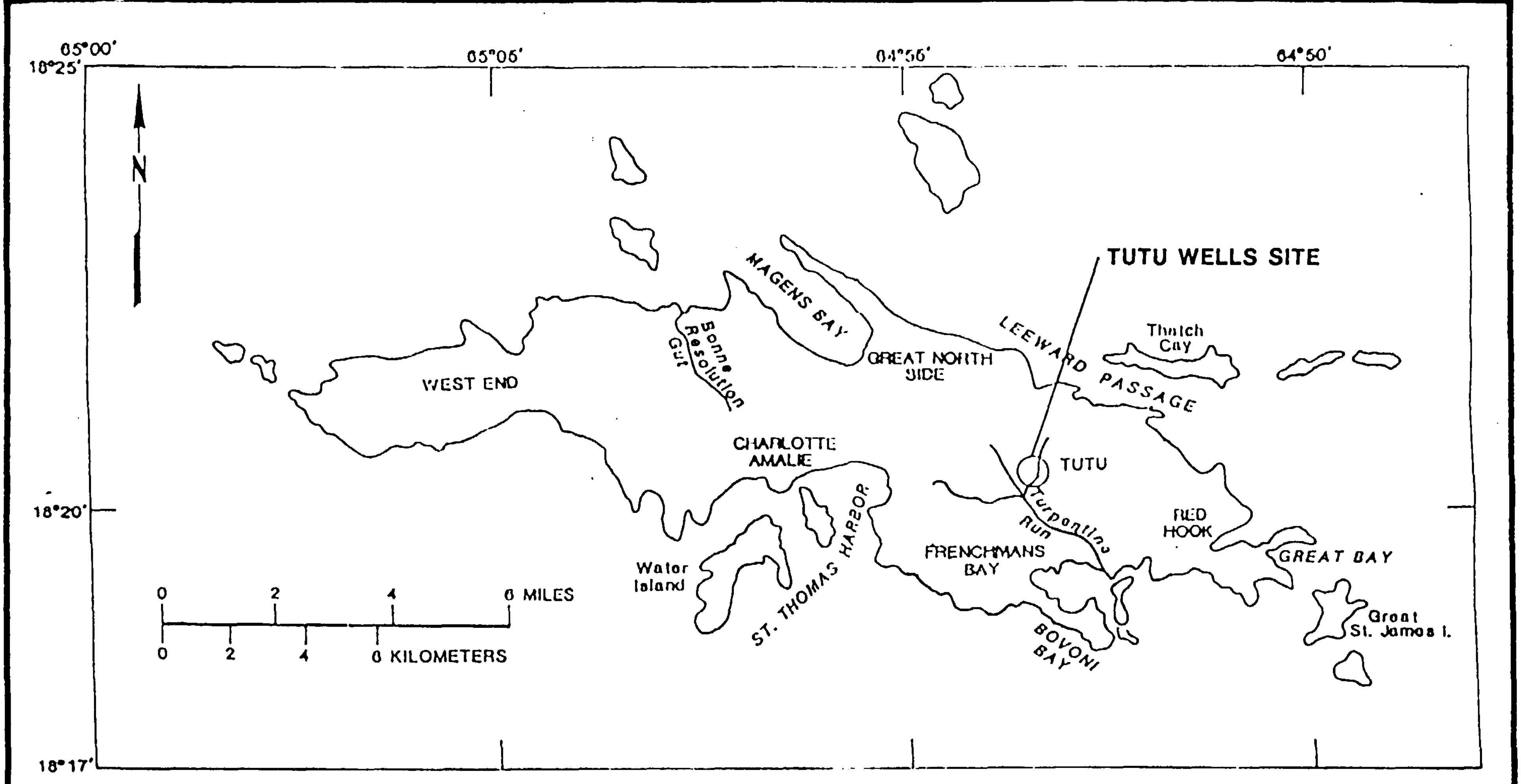
Table 4. Proposed Monitoring Well Construction, Tutu Service Station Investigation, St. Thomas, U.S. Virgin Islands.

Location	Estimated Depth to Bedrock (feet)	Estimated Total Depth of Boring (feet)	Estimated Depth to Ground Water (feet)	Proposed Screened Interval	Purpose
MW-1	12	53	40	32-52	Downgradient ground-water quality of drum disposal area at Curriculum Center property.
MW-1D	12	93	40	72-92	Downgradient ground-water quality of drum disposal area at Curriculum Center property.
MW-2	15	28	15	7-27	Upgradient ground-water quality at Four Winds Plaza.
MW-3	8	23	10	2-22	Upgradient ground-water quality of Texaco property.
MW-4	15	23	7	2-22	Downgradient ground-water quality of Texaco property.
MW-4D	15	63	7	42-62	Downgradient water quality of Texaco property.
MW-5	12	33	20	12-32	Downgradient ground-water quality of Texaco property; upgradient ground-water quality of Tillett property.
MW-6	15	23	5	2-22	Upgradient ground-water quality of Esso property.
MW-6D	15	63	5	42-62	Upgradient ground-water quality of Esso property.

Table 4. Proposed Monitoring Well Construction, Tutu Service Station Investigation, St. Thomas, U.S. Virgin Islands.

Location	Estimated Depth to Bedrock (feet)	Estimated Total Depth of Boring (feet)	Estimated Depth to Ground Water (feet)	Proposed Screened Interval	Purpose
MW-7	8	28	15	7-27	Downgradient ground-water quality of Tillett property and paint store.
MW-8	12	23	7	2-22	Upgradient ground-water quality of Esso property.
MW-9	12	23	7	2-22	Downgradient ground-water quality of Esso property.
MW-10	12	23	10	2-22	Downgradient ground-water quality of Esso property.
MW-10D	12	63	10	42-62	Downgradient ground-water quality of Esso property.
MW-11D	10	63	10	42-62	Downgradient ground-water quality of study area.
MW-12D	10	68	15	47-67	Downgradient ground-water quality of study area.
MW-13D	10	113	60	92-112	Upgradient ground-water quality of curriculum center.

#PR01301-wp3/WellCons.wk3



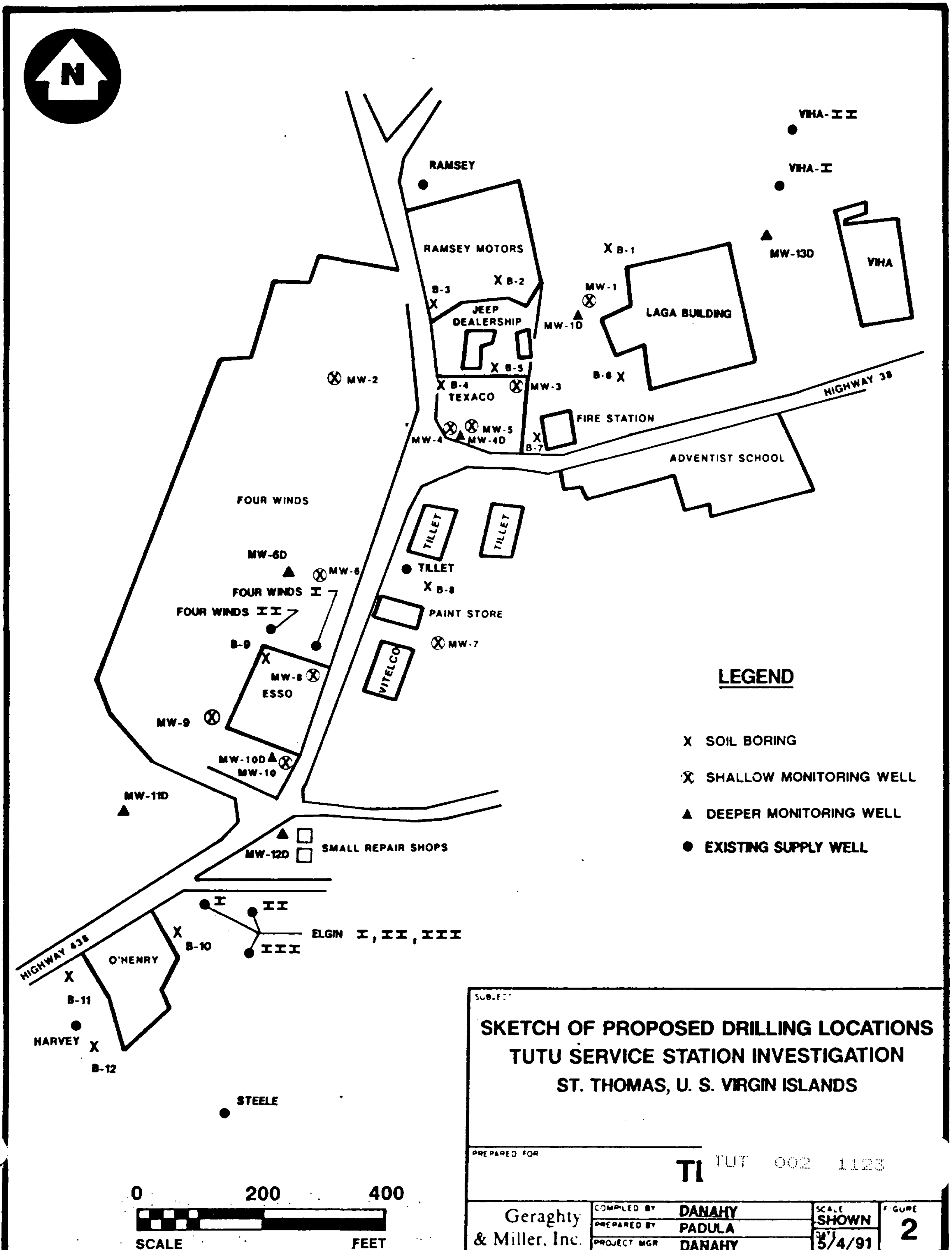
SUBJECT

TUTU WELLS SITE
TUTU SERVICE STATION INVESTIGATION,
ST. THOMAS, U. S. VIRGIN ISLANDS

PREPARED FOR

TEIC

Geraghty & Miller, Inc.	COMPILED BY NACHMAN PREPARED BY MESSINGER PROJECT MGR DANAHY	SCALE SHOWN DATE	FIGURE 1



SUBJECT

SKETCH OF PROPOSED DRILLING LOCATIONS
TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U. S. VIRGIN ISLANDS

PREPARED FOR TI

TUT 002 1123

Geraghty & Miller, Inc.	COMPILED BY DANAHY	SCALE SHOWN	FIGURE 2
	PREPARED BY PADULA	DATE 5/4/91	
	PROJECT MGR DANAHY		

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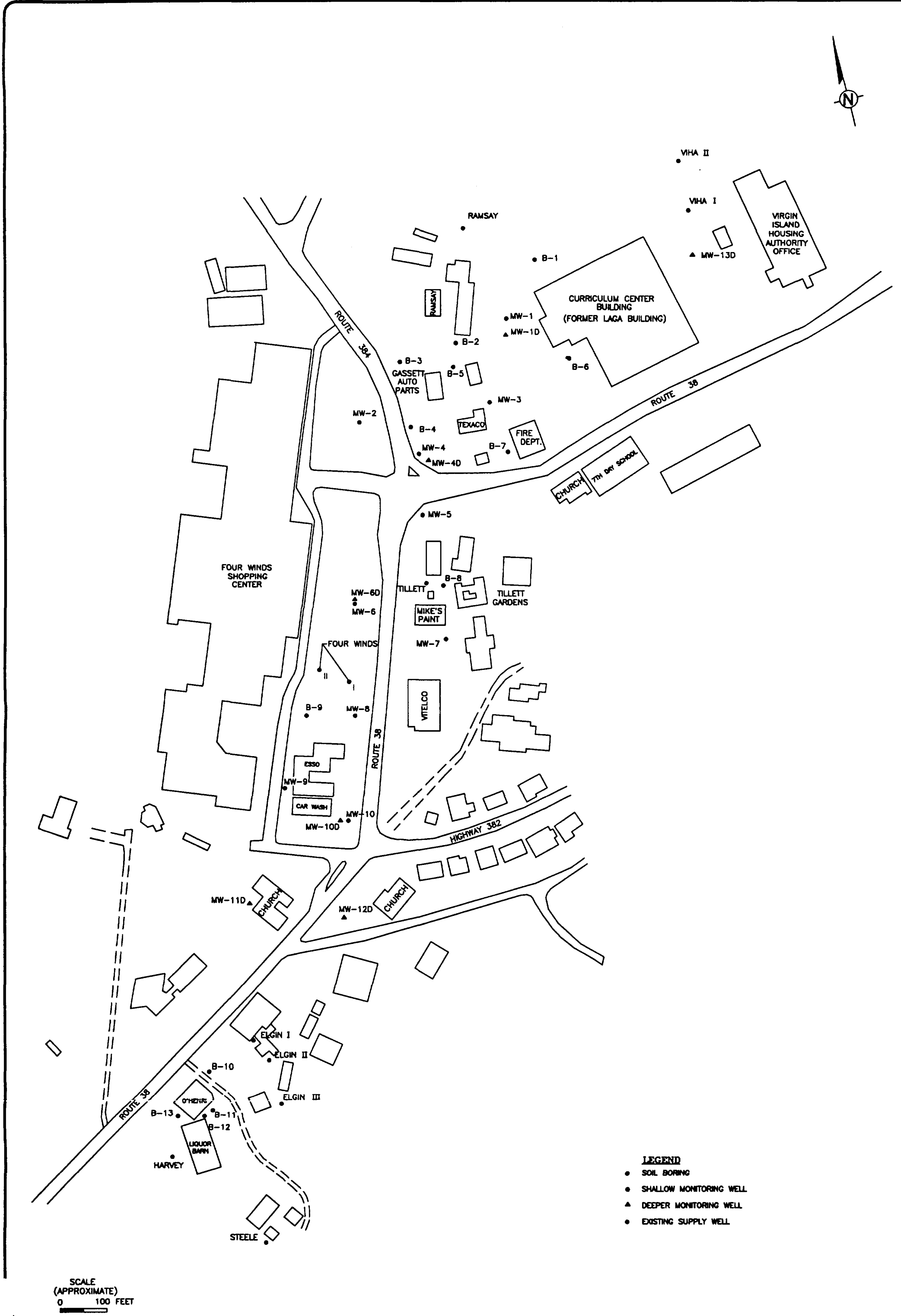


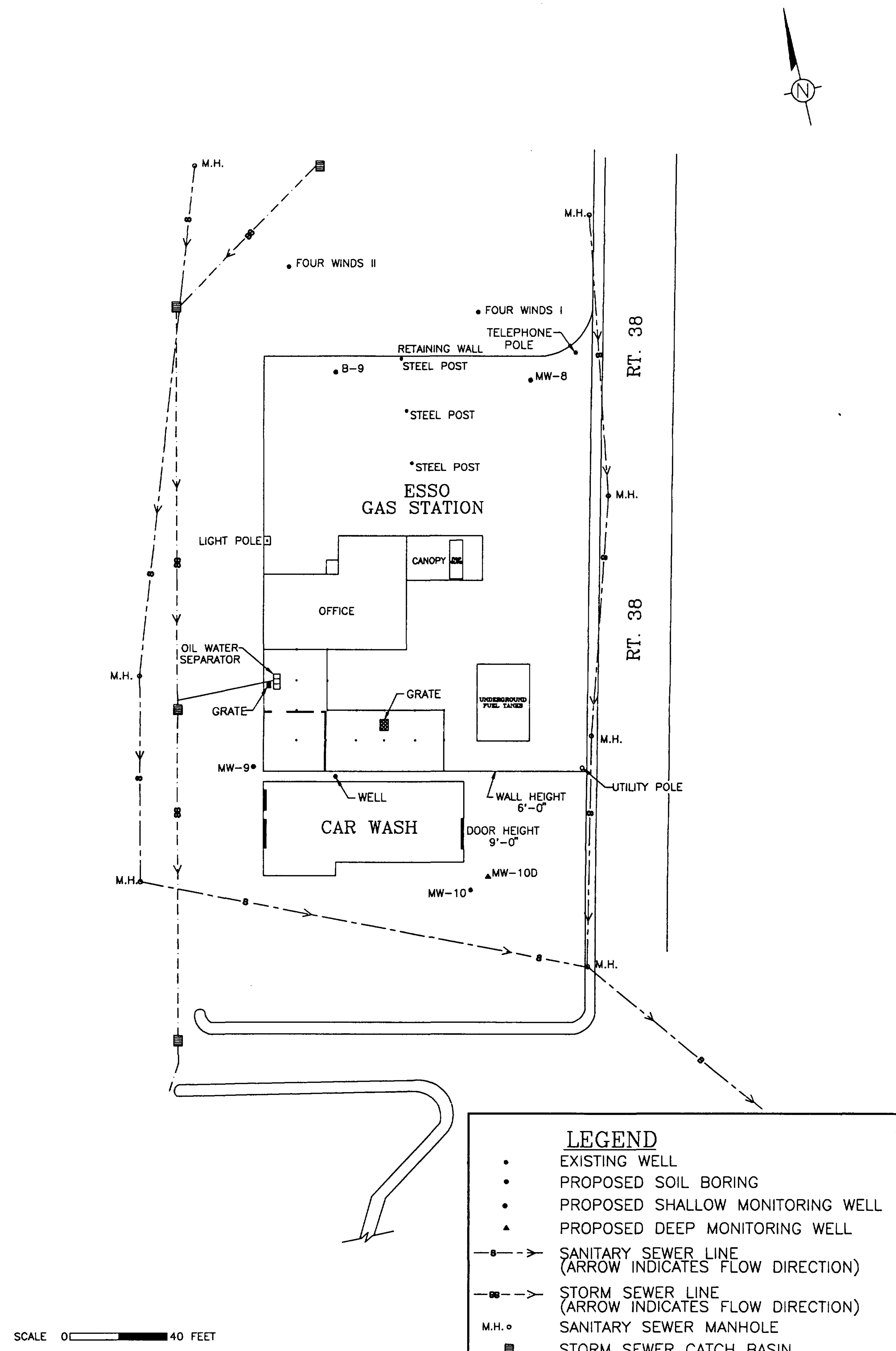
TUT 002 1124

GERAGHTY & MILLER, INC.
Environmental Services

SITE PLAN

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 3



TUT 002 1125

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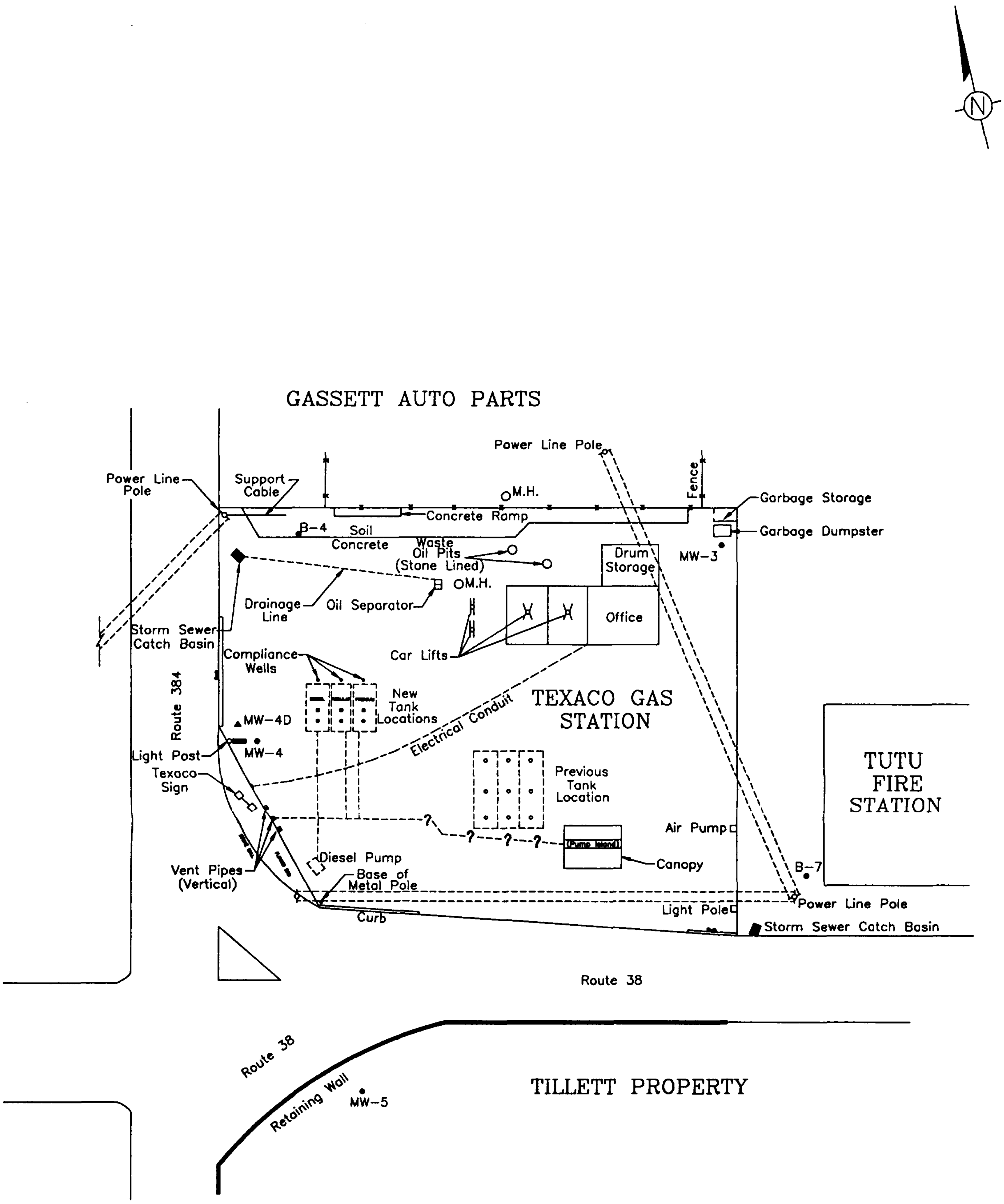
APPROVED BY: -DANAHY	DATE: -

ESSO SERVICE STATION SITE PLAN
TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 4



LEGEND

- ● SOIL BORING
- ▲ DEEPER MONITORING WELL
- ● SHALLOW MONITORING WELL
- M.H.○ MANHOLE FOR SANITARY SEWER

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TEXACO SERVICE STATION SITE PLAN

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 5

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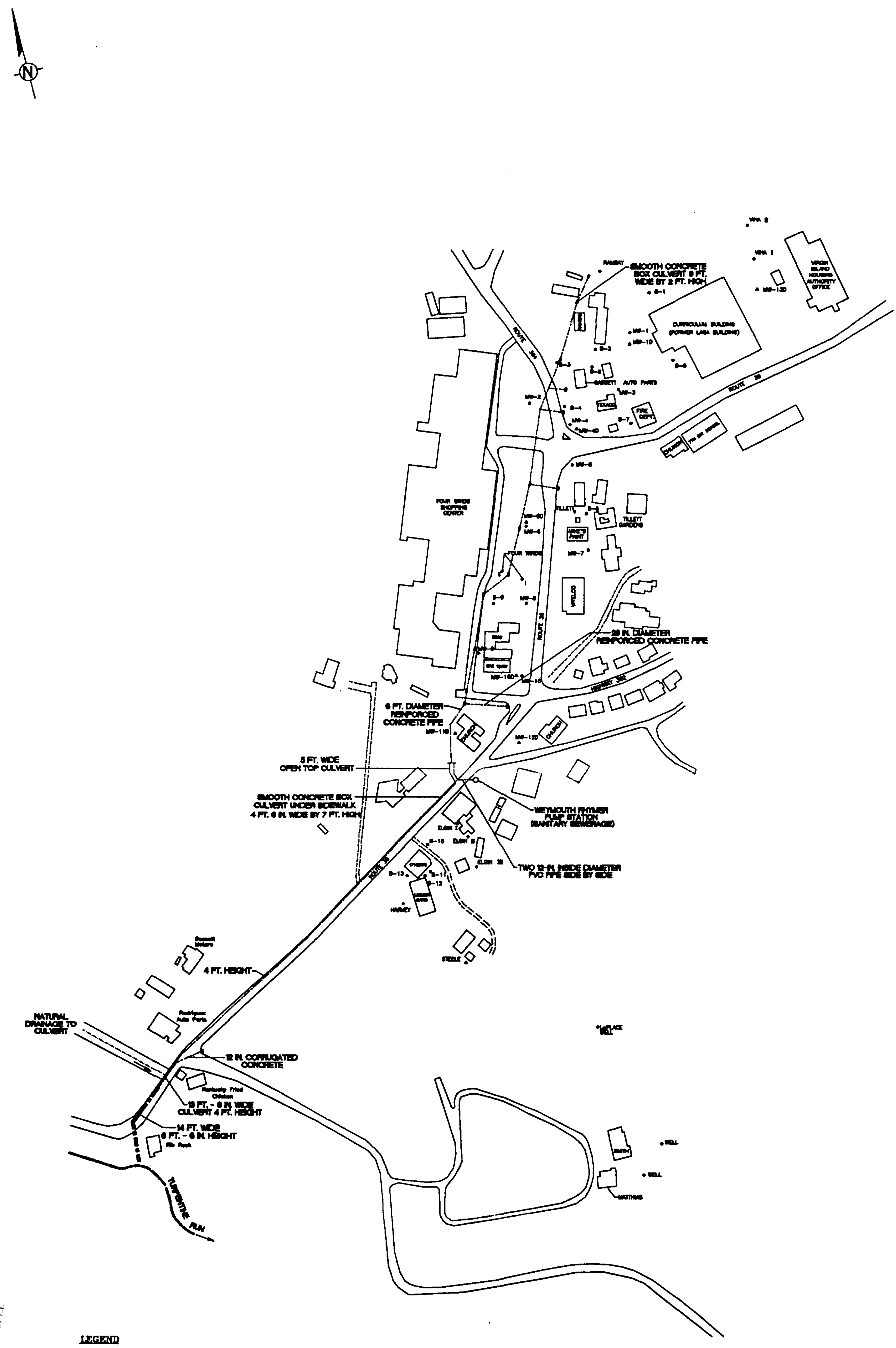


LEGEND

- PROPOSED SOIL BORING
- PROPOSED SHALLOW MONITORING WELL
- ▲ PROPOSED DEEPER MONITORING WELL
- EXISTING SUPPLY WELL

FT. FEET

IN. INCH

SCALE (APPROXIMATE)
0 200 FEET

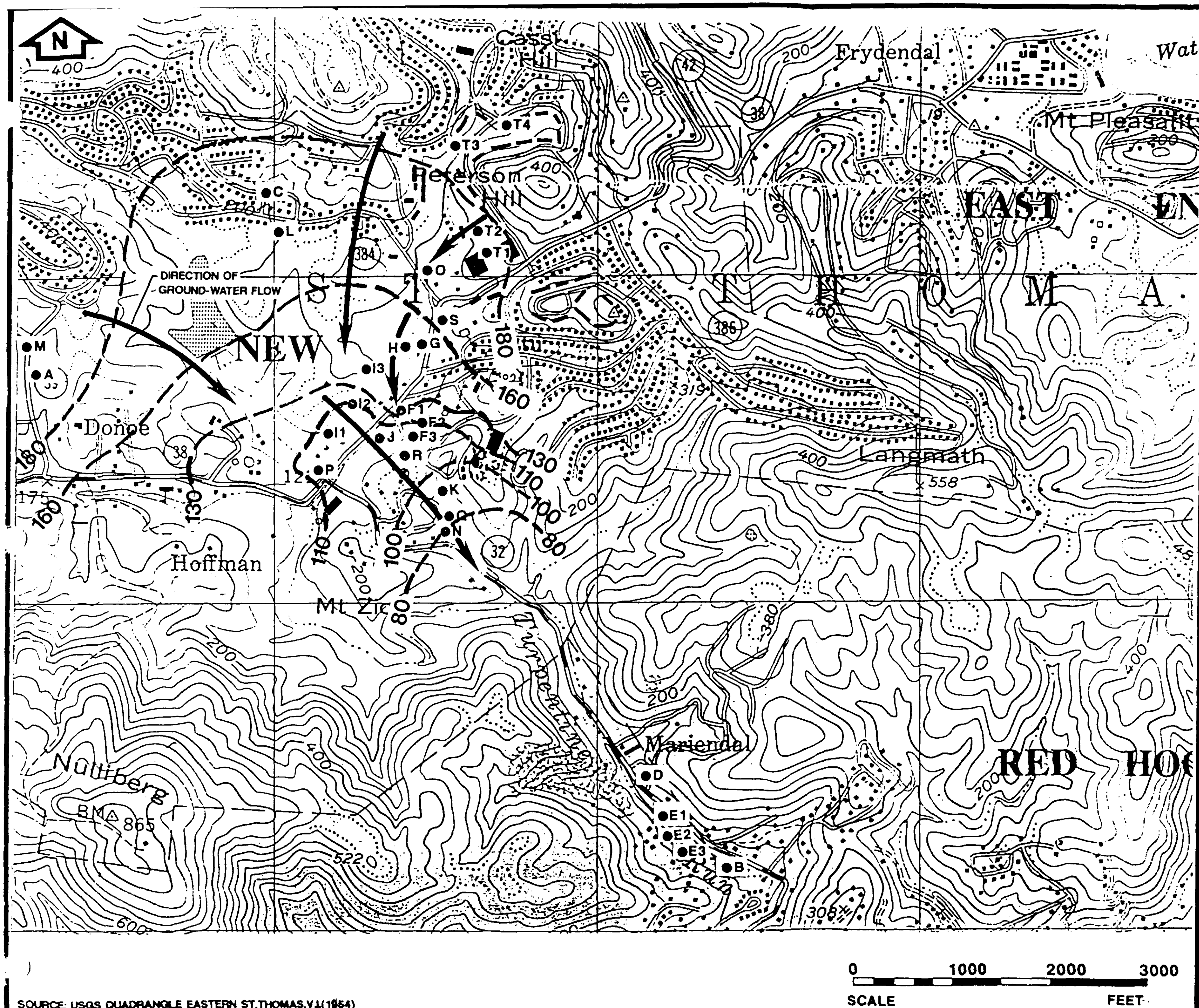
TUT 002 1127

GERAGHTY & MILLER, INC.
Environmental Services

STORM SEWER LAYOUT

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 6



SOURCE: USGS QUADRANGLE EASTERN ST.THOMAS,V.I.(1954)

LEGEND

●	RESIDENTIAL WELL
A	BRYAN
B	DEDE
C	DEMITRI
D	DENCH
E1	DEVCON I
E2	DEVCON II (ALTERNATE)
E3	DEVCON III
F1	EGLIN I
F2	EGLIN II
F3	EGLIN III
G	FOUR WINDS I
H	FOUR WINDS II
I1	GASSETT
I2	HARTMAN II (CRUSHER)
I3	HARTMAN III (ESTATE)
J	HARVEY
K	LaPLACE
L	LEONARD
M	LOCKHART (ALTERNATE)
N	MATTHIAS
O	RAMSEY
P	RODRIGUES
Q	SMITH
R	STEELE
S	TILLETT
T1	VIHA I
T2	VIHA II (ALTERNATE)
T3	VIHA III
T4	VIHA IV (ALTERNATE)
160	LINE OF EQUAL GROUND-WATER LEVEL ELEVATION (FEET ABOVE MEAN SEA LEVEL)

(MODIFIED AFTER GRAVES AND GONZALEZ 1988)

SUBJECT

GENERALIZED POTENTIOMETRIC SURFACE (9/11/87) TUTU AREA, ST. THOMAS, U. S. VIRGIN ISLANDS

PREPARED FOR

TEIC

Geraghty & Miller

TUT 002 1128

SCALE SHOWN

DATE 5/90

FIGURE 7

7/-/33

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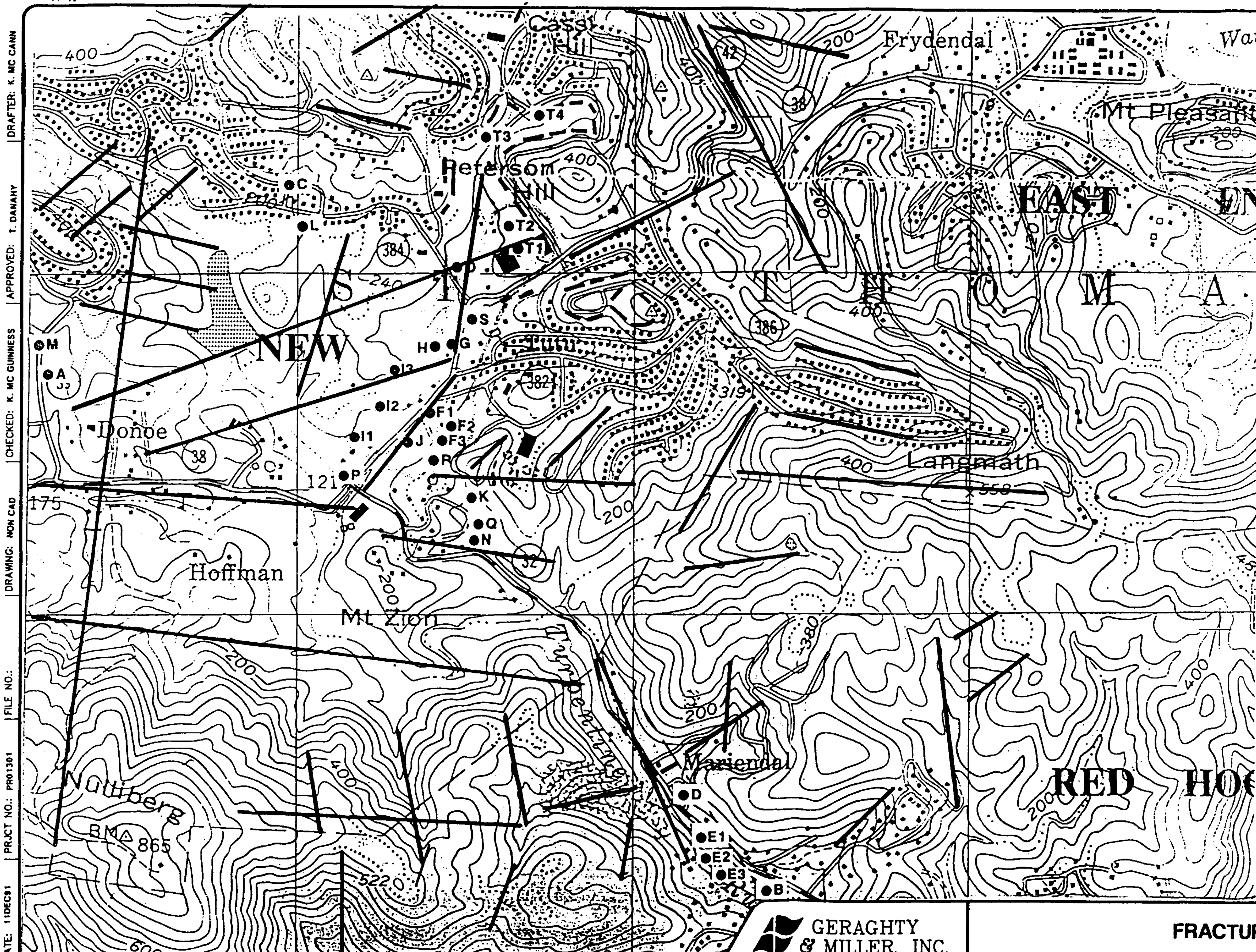


LEGEND

●	RESIDENTIAL WELL
A	BRYAN
B	DEDE
C	DEMITRI
D	DENCH
E1	DEVCON I
E2	DEVCON II (ALTERNATE)
E3	DEVCON III
F1	EGLIN I
F2	EGLIN II
F3	EGLIN III
G	FOUR WINDS I
H	FOUR WINDS II
I1	GASSETT
I2	HARTMAN II (CRUSHER)
I3	HARTMAN III (ESTATE)
J	HARVEY
K	LaPLACE
L	LEONARD
M	LOCKHART (ALTERNATE)
N	MATTHIAS
O	RAMSEY
P	RODRIGUES
Q	SMITH
R	STEELE
S	TILLETT
T1	VIHA I
T2	VIHA II (ALTERNATE)
T3	VIHA III
T4	VIHA IV (ALTERNATE)
―	FRACTURE TRACE

SOURCE: USGS QUADRANGLE EASTERN ST. THOMAS, V.I. (1954)

SCALE 0 1000 2000 3000 FEET

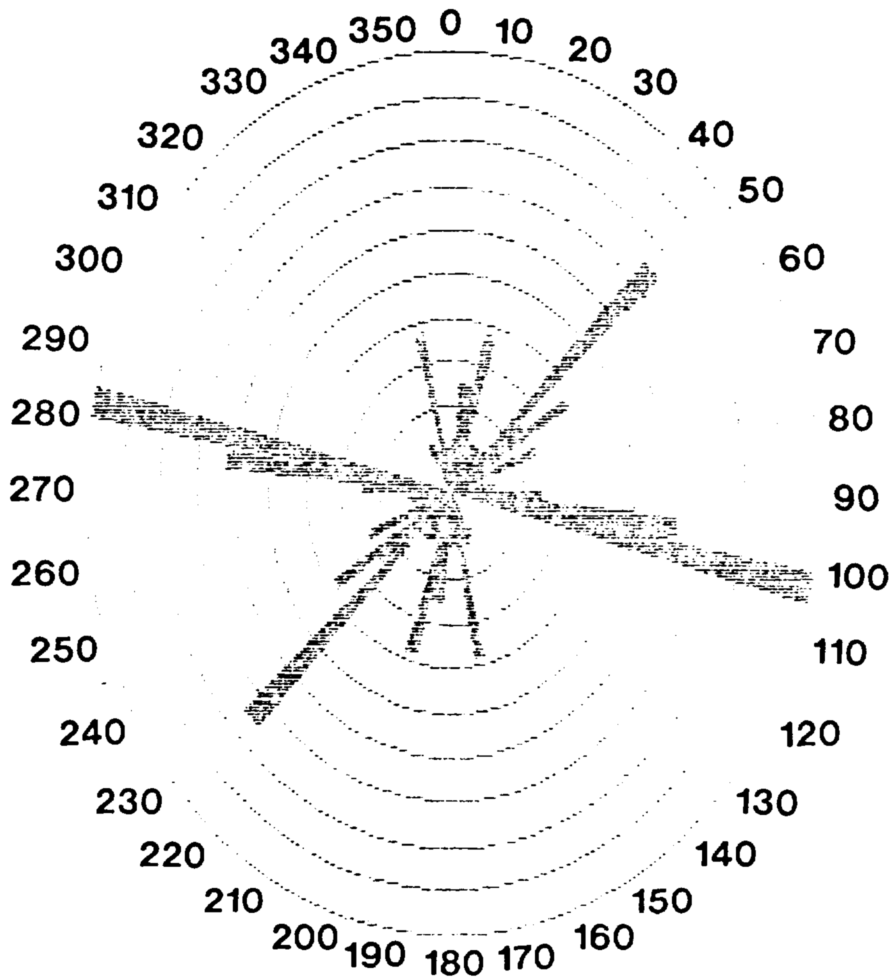
GERAGHTY & MILLER, INC. *Environmental Services*

FRACTURE TRACES

TUTU SERVICE STATION INVESTIGATION, ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 8

163135



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Environmental Services

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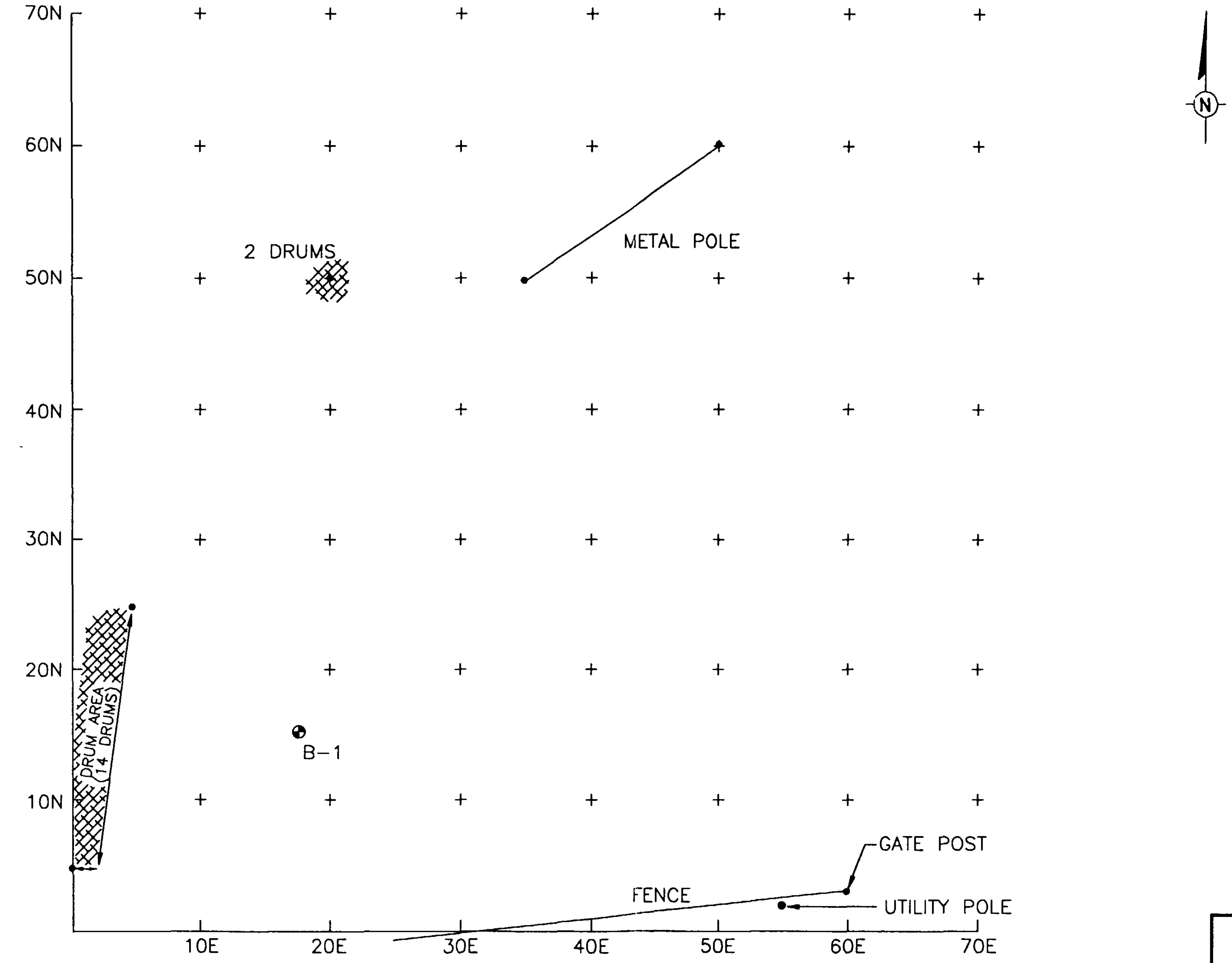
FRACTURE TRACE ROSE DIAGRAM

TUTU SERVICE STATION INVESTIGATION
ST.THOMAS, U.S. VIRGIN ISLANDS

FIGURE 9



LEGEND

⊕ PROPOSED BORING

SCALE
0 10 FT

GERAGHTY & MILLER, INC.
Environmental Services

MAGNETOMETER SURVEY GRID
NORTH OF CURRICULUM CENTER BUILDING

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE
10

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PRJCT NO.: PR013.01
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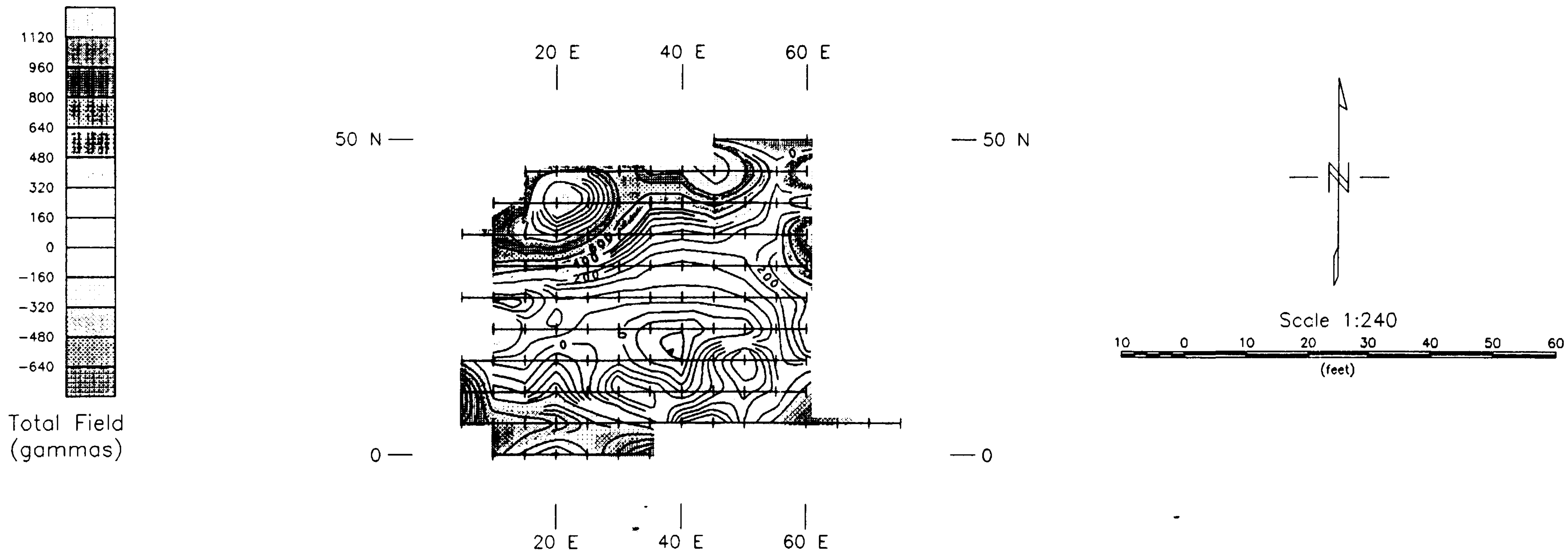


LEGEND

200 — CONTOUR OF TOTAL MAGNETIC FIELD IN GAMMAS

AREA OF INTERPRETED SOURCE (DASHED WHERE INFERRED)

AREA OF POSSIBLE SECONDARY SOURCE (DASHED WHERE INFERRED)

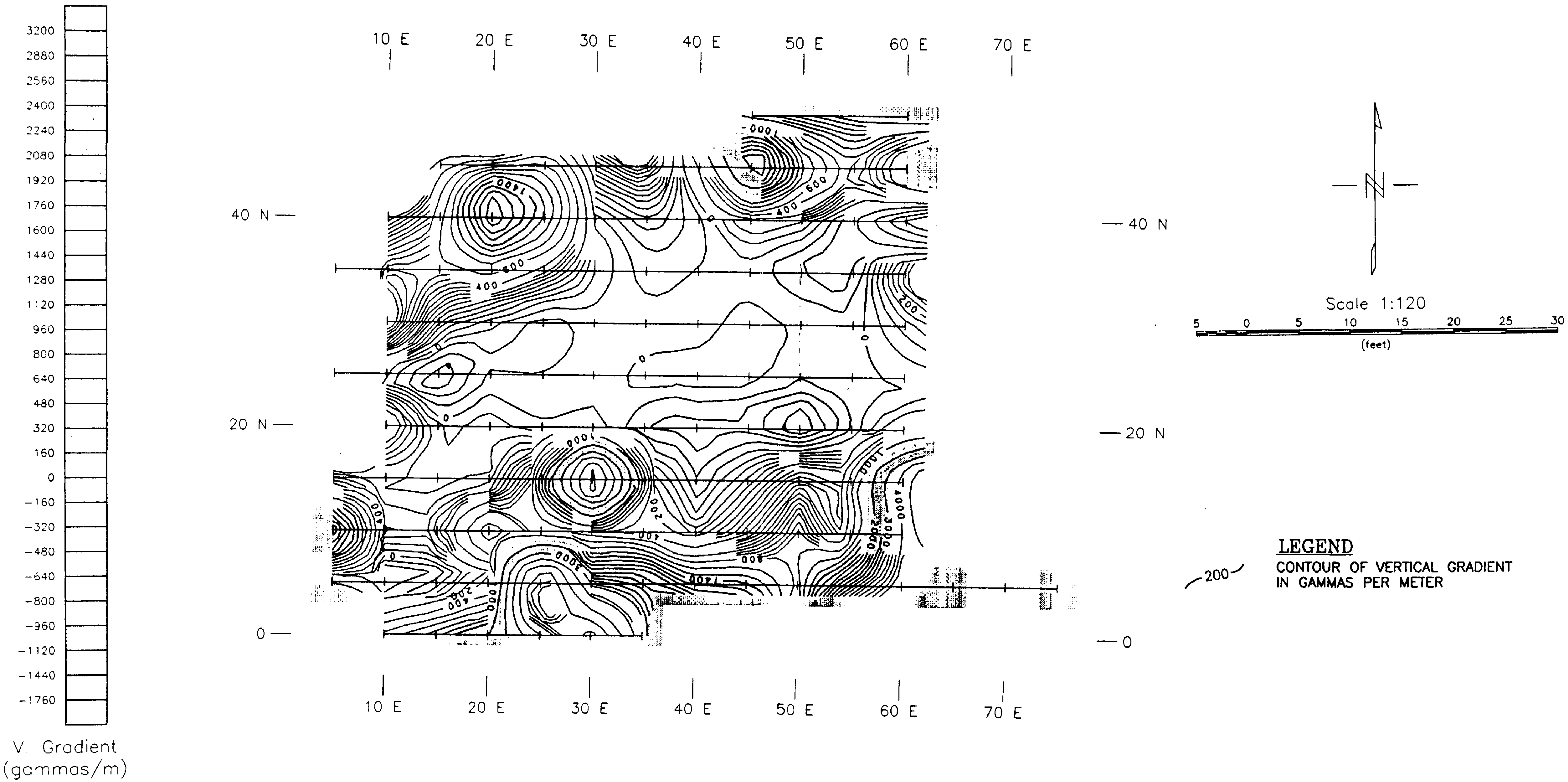
GERAGHTY & MILLER, INC.
Environmental Services

TOTAL MAGNETIC FIELD INTENSITY NORTH OF CURRICULUM CENTER BUILDING

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE
11

DRAFTER: NIXON | APPROVED: DANAHY | CHECKED: MOFFATT | DRAWING: | FILE NO.: | PRJCT NO.: PR01301 | DWG DATE: 10APR92



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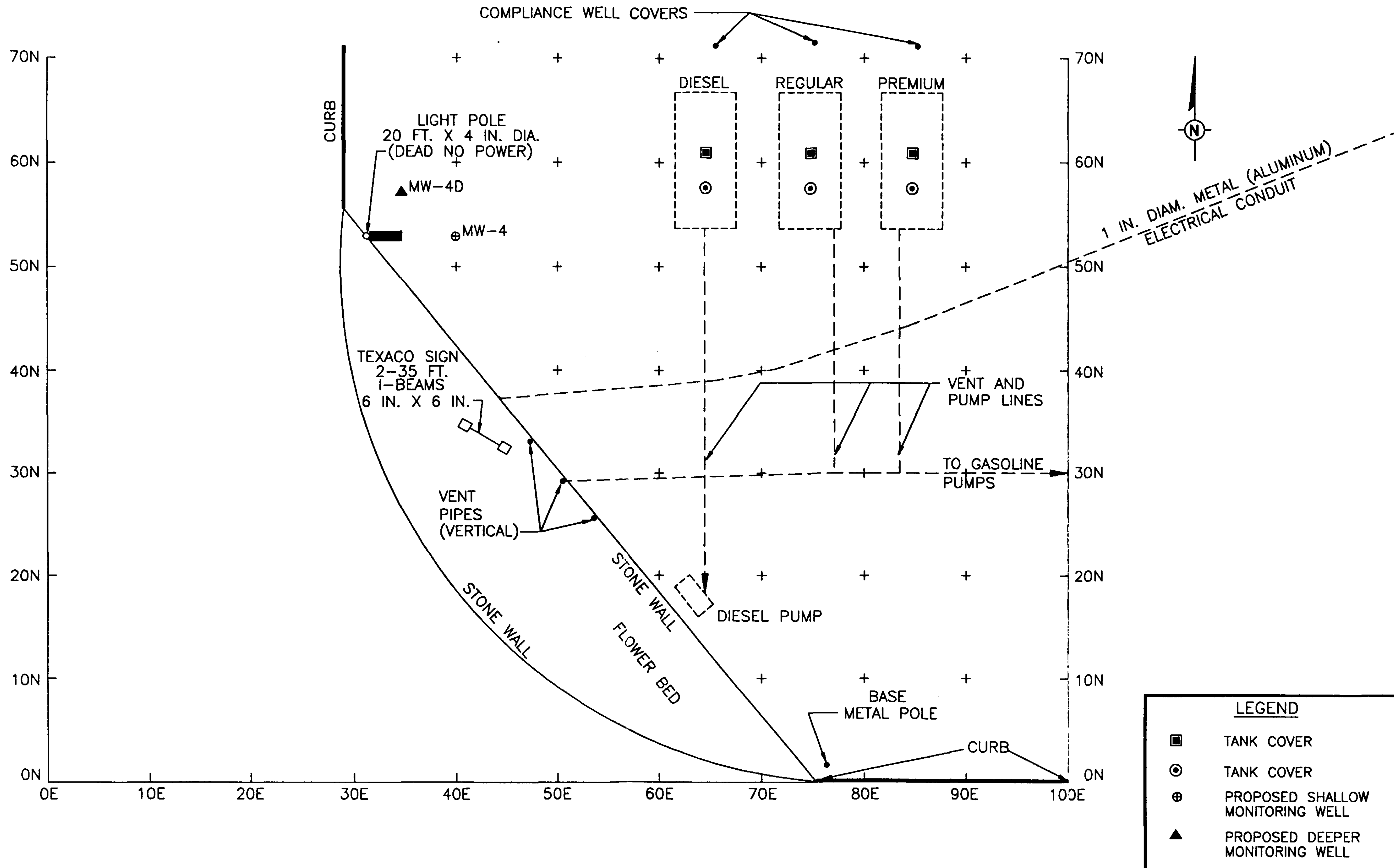
VERTICAL MAGNETIC GRADIENT NORTH OF CURRICULUM CENTER BUILDING

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 12



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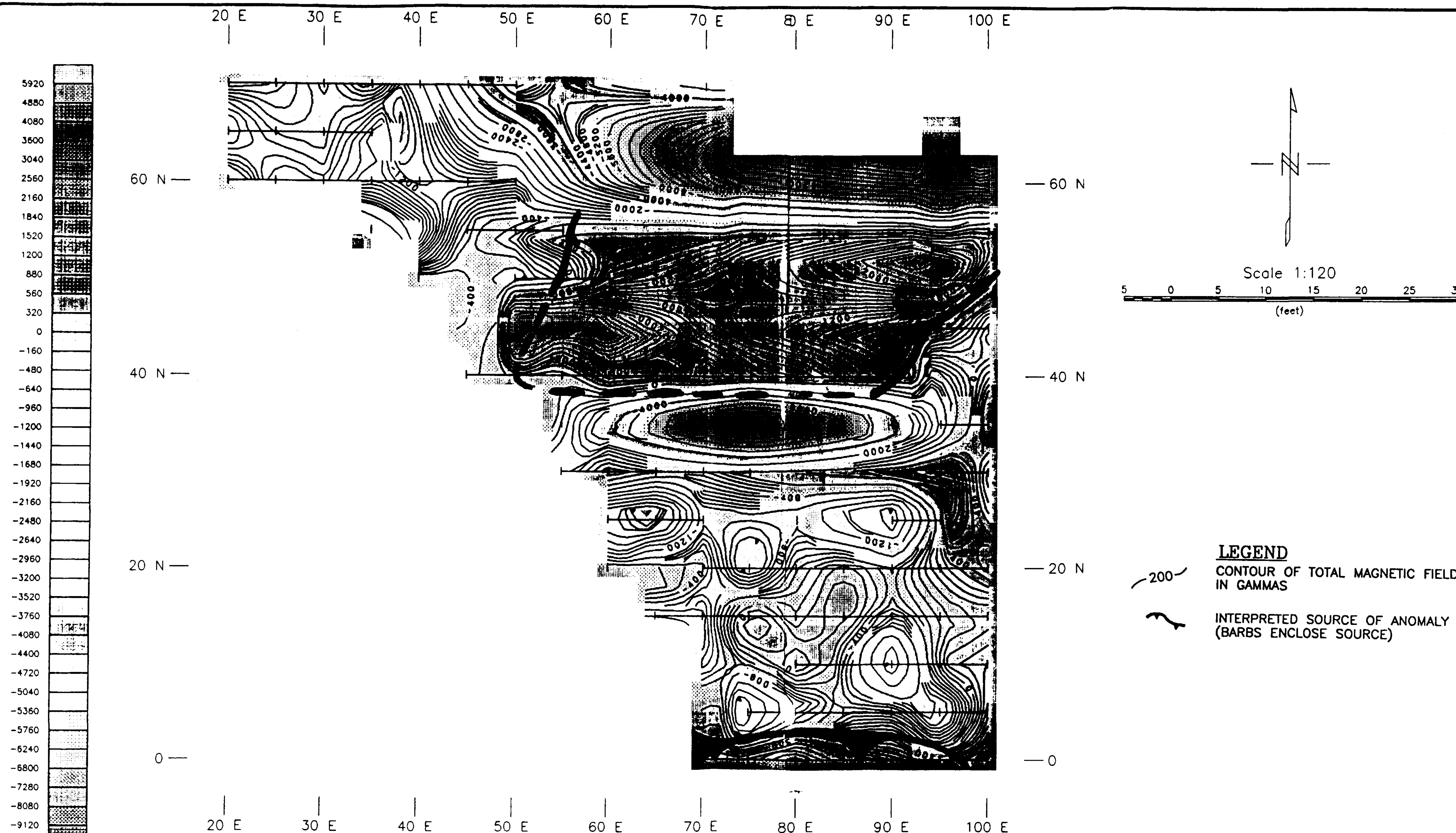
MAGNETOMETER SURVEY GRID
TEXACO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE
13

TUT 002 1134



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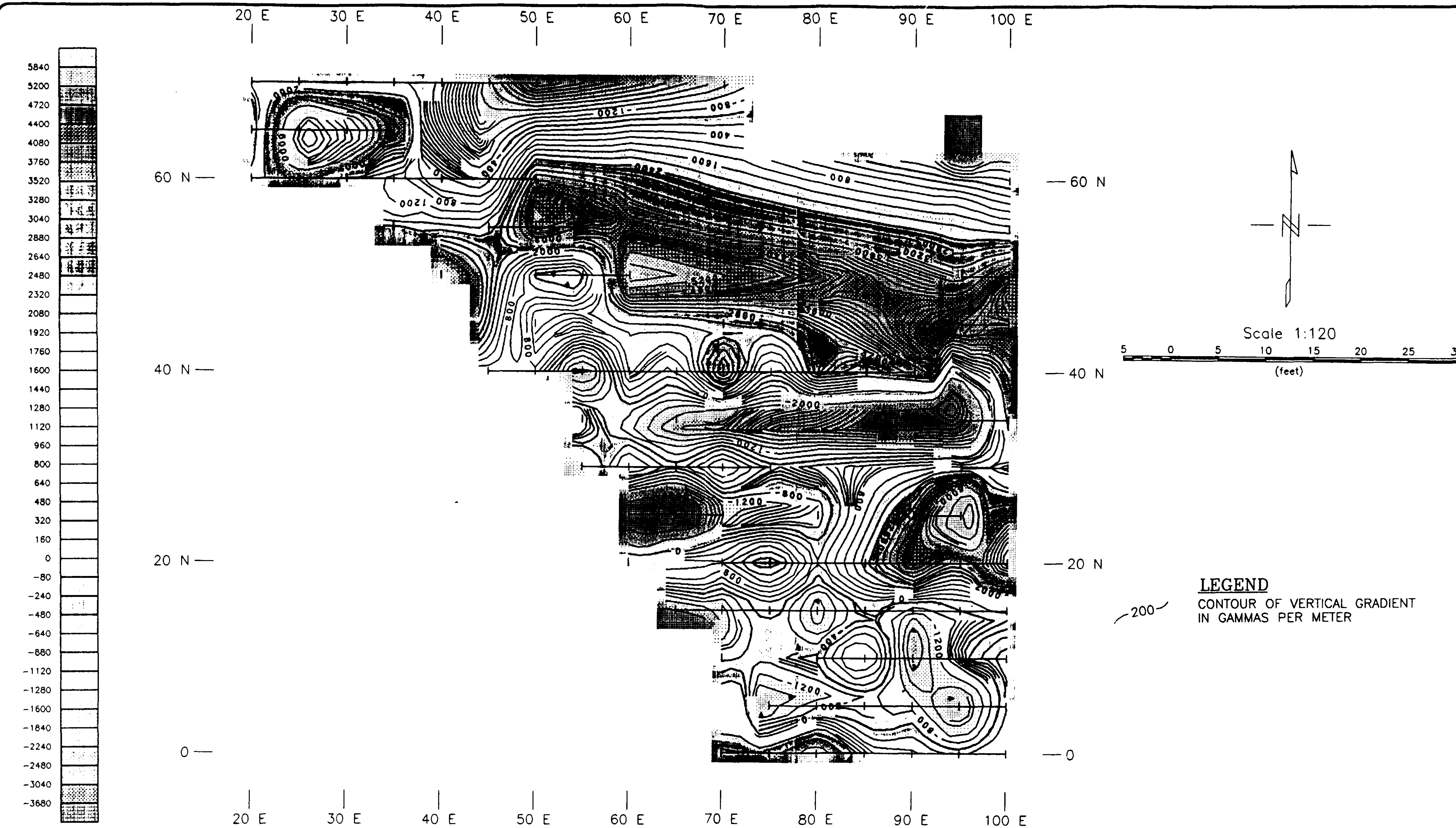
TOTAL MAGNETIC FIELD INTENSITY TEXACO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 14

TUT 002 1135



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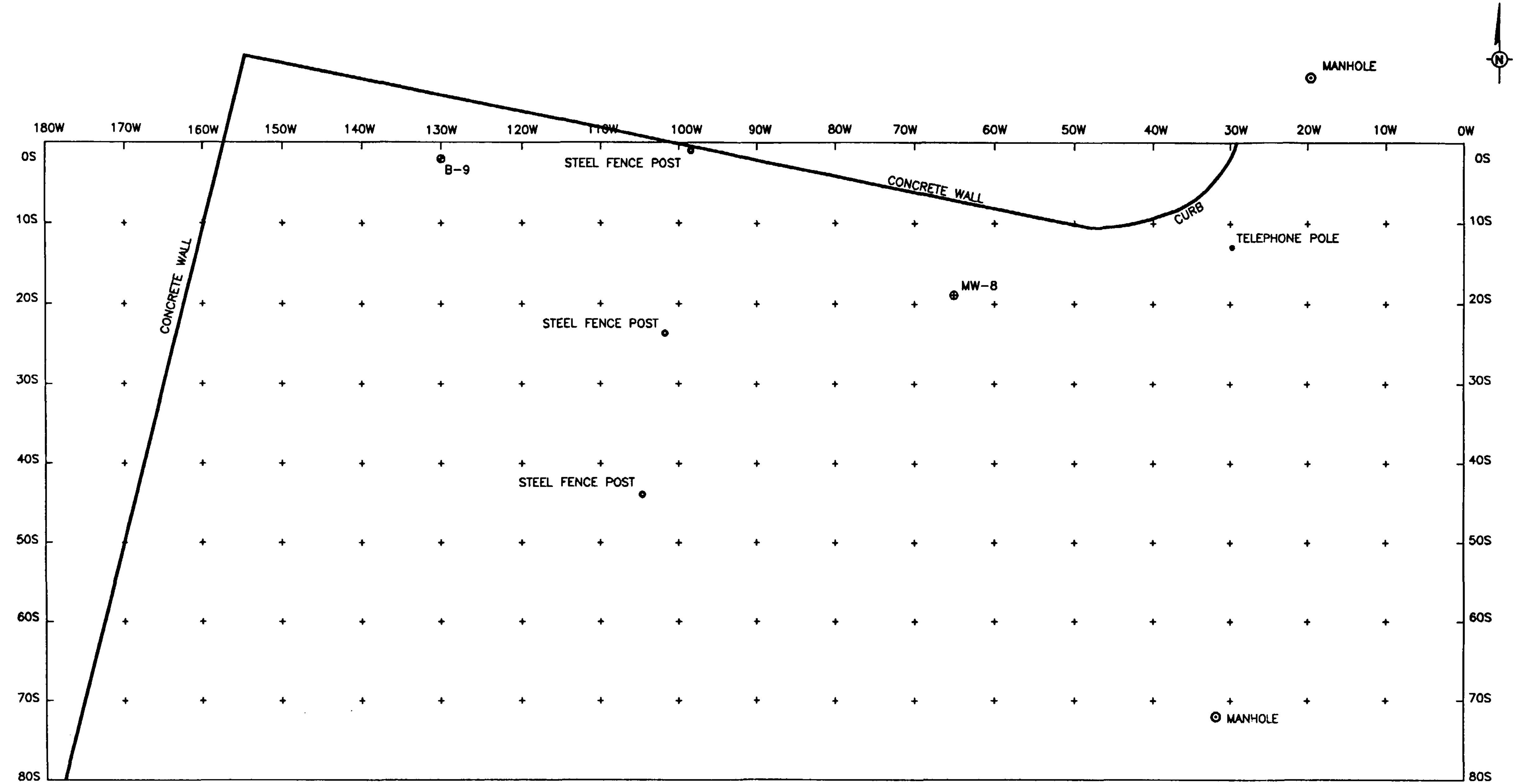
Environmental Services

VERTICAL MAGNETIC GRADIENT TEXACO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE

15



SCALE
0 10 FT

LEGEND

⊕ PROPOSED SHALLOW MONITORING WELL
⊘ PROPOSED SOIL BORING

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Environmental Services

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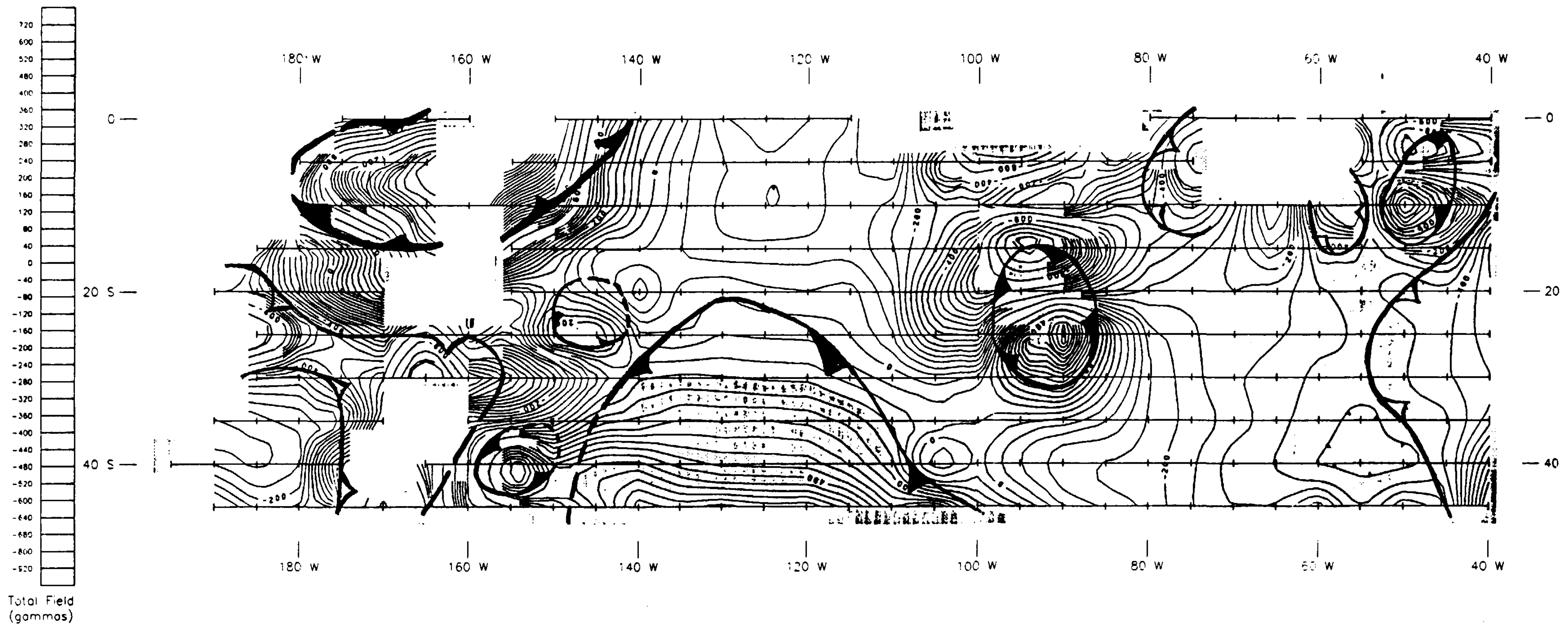
APPROVED BY: T.DANAHY	DATE:

MAGNETOMETER SURVEY GRID
ESSO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE
16



LEGEND

200 CONTOUR OF TOTAL MAGNETIC FIELD IN GAMMAS

INTERPRETED SOURCE OF ANOMALY (BARBS ENCLOSE SOURCE)

SECONDARY NEGATIVE ANOMALLY SOURCE
FREQUENTLY CAUSED BY BUILDINGS WHERE METAL IS ABOVE SENSOR

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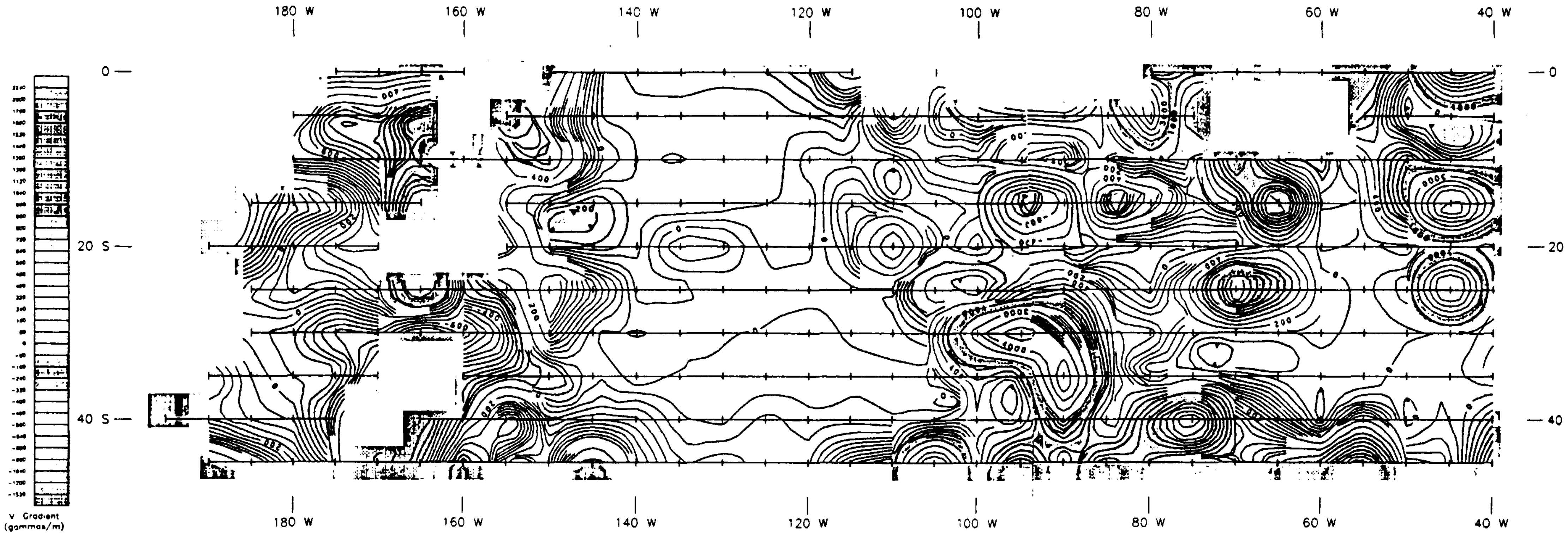
Environmental Services

TOTAL MAGNETIC FIELD INTENSITY
ESSO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 17

TUT 002 1138



LEGEND

200 — CONTOUR OF VERTICAL GRADIENT IN GAMMAS PER METER

GERAGHTY & MILLER, INC.
Environmental Services

VERTICAL MAGNETIC GRADIENT
ESSO STATION

TUTU SERVICE STATION INVESTIGATION
ST. THOMAS, U.S. VIRGIN ISLANDS

FIGURE 18

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TUT 002 1139