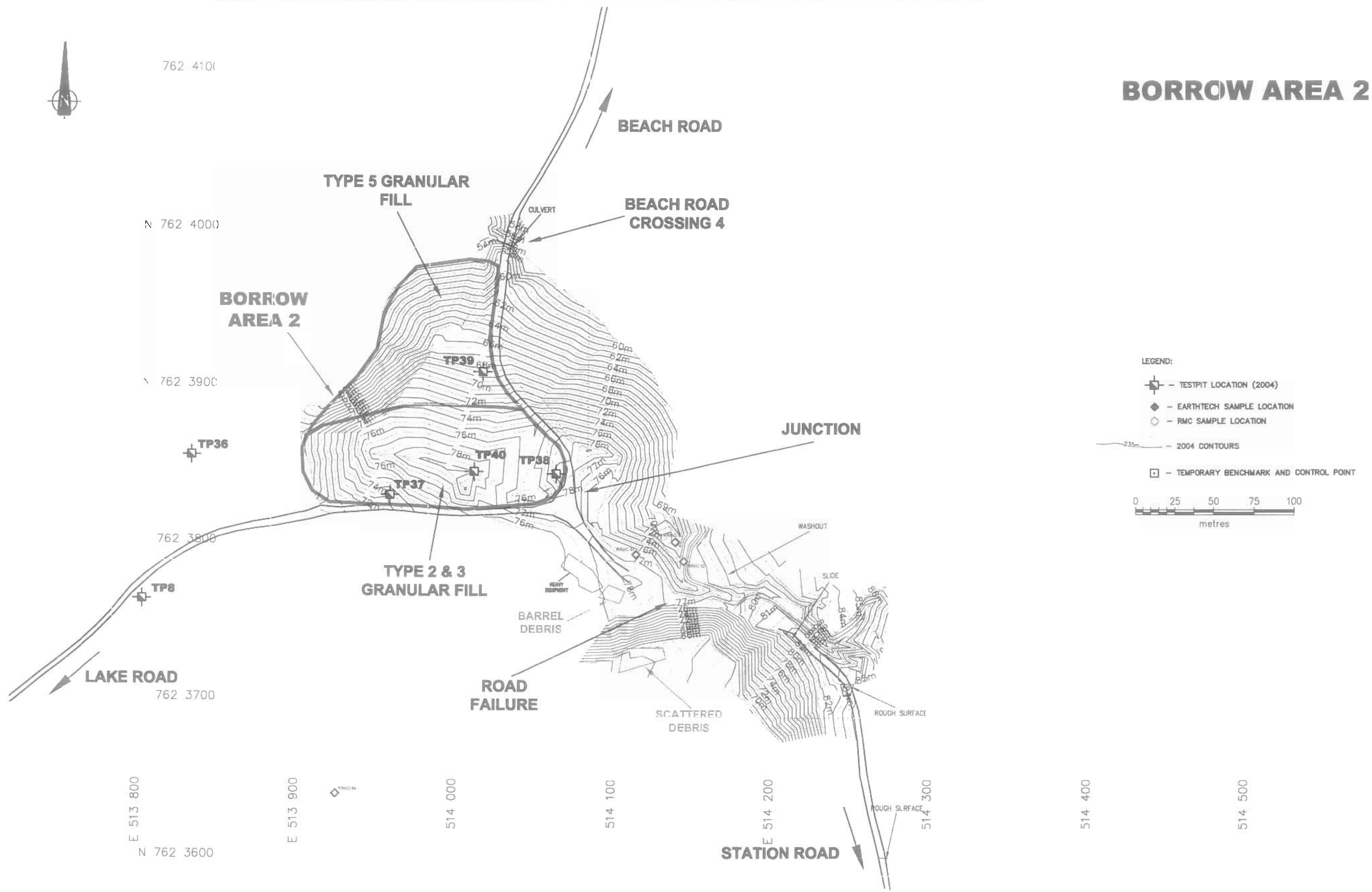
BORROW AREA 2



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BORROW AREA 2

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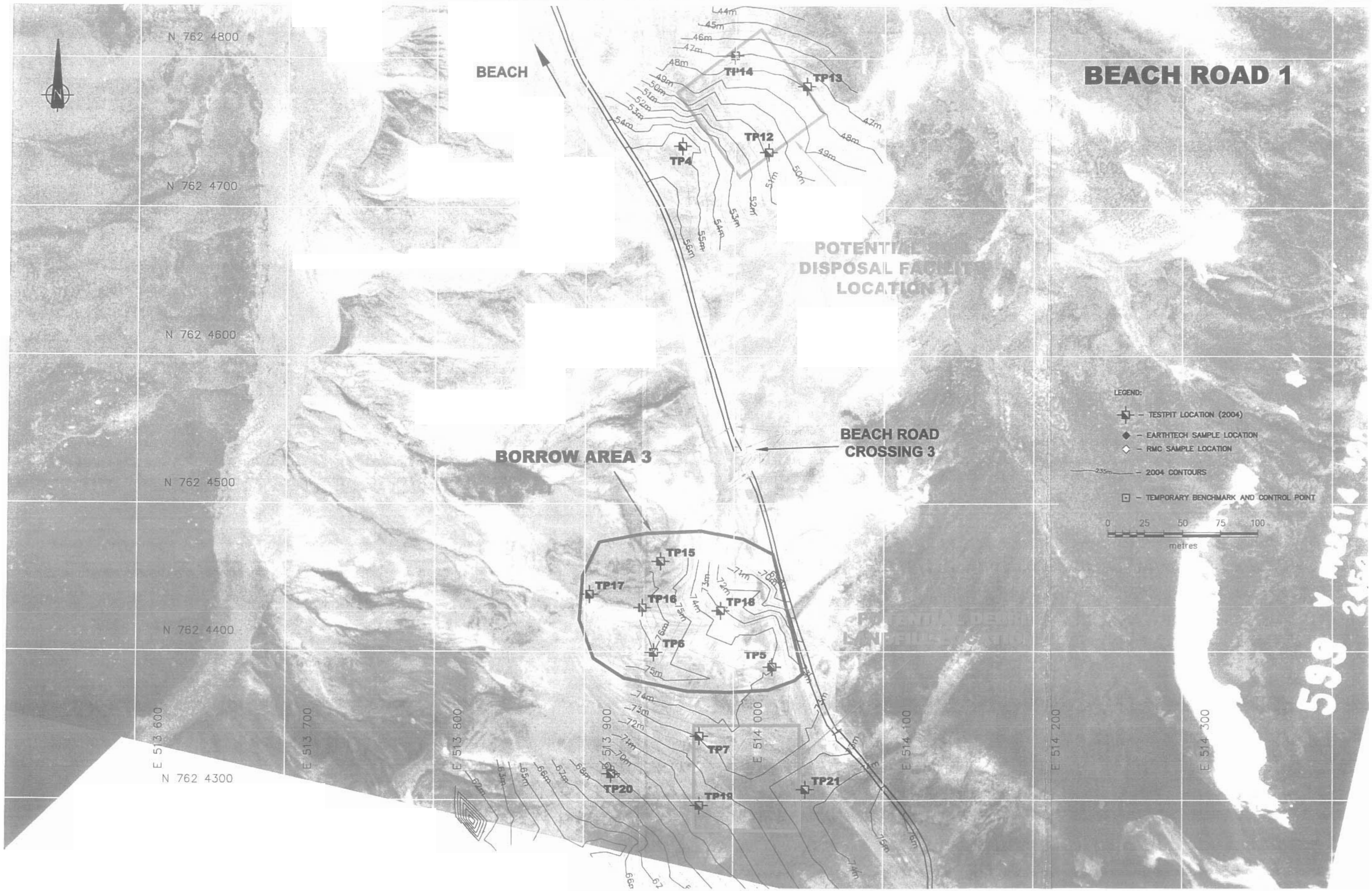
FIGURE: 10



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BEACH ROAD 1

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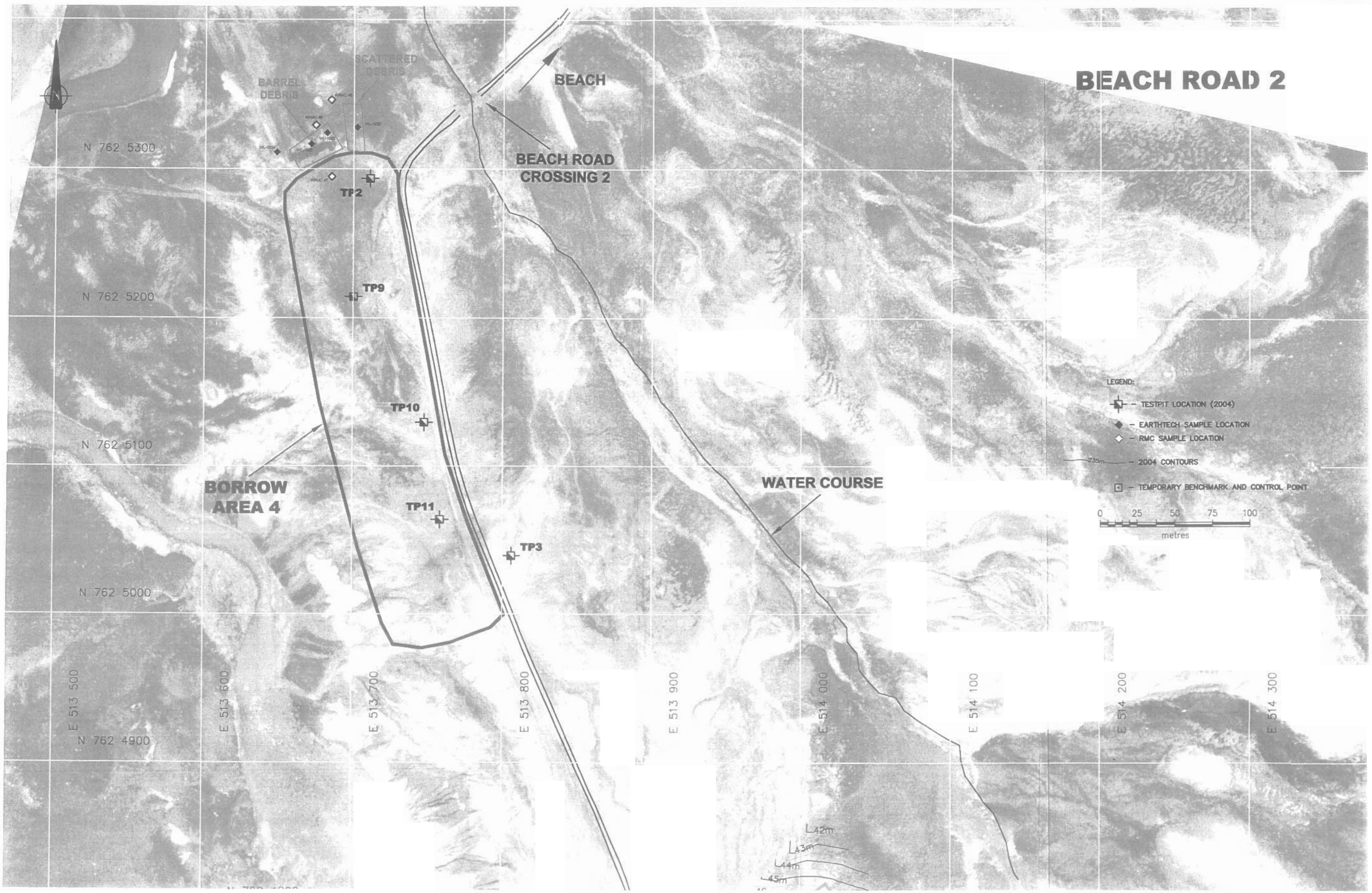
FIGURE: 11



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BEACH ROAD 2

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FIGURE: 12

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BEACH AREA

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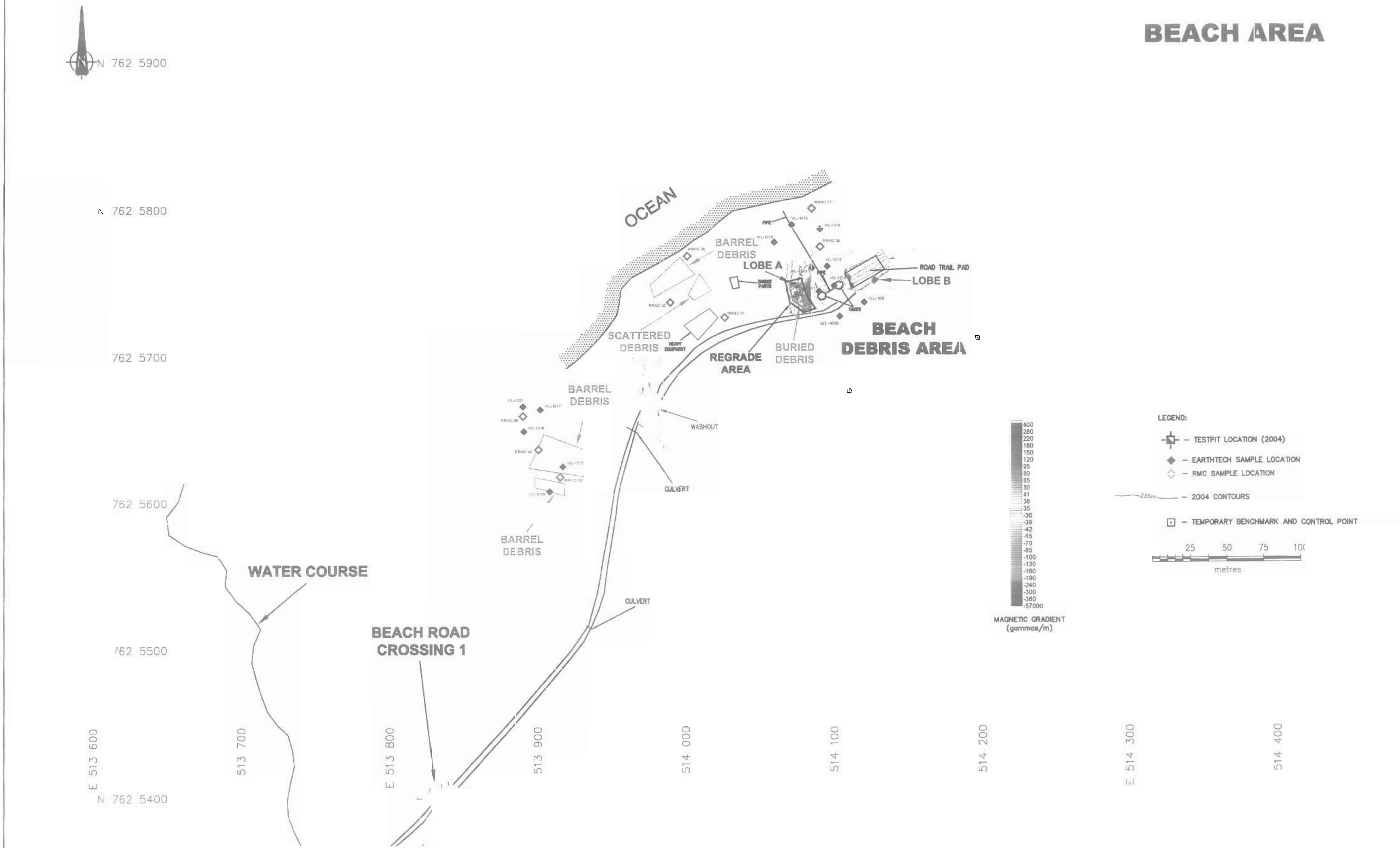
FIGURE: 13A

BEACH AREA



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BEACH AREA GRADIENT GEOPHYSICS

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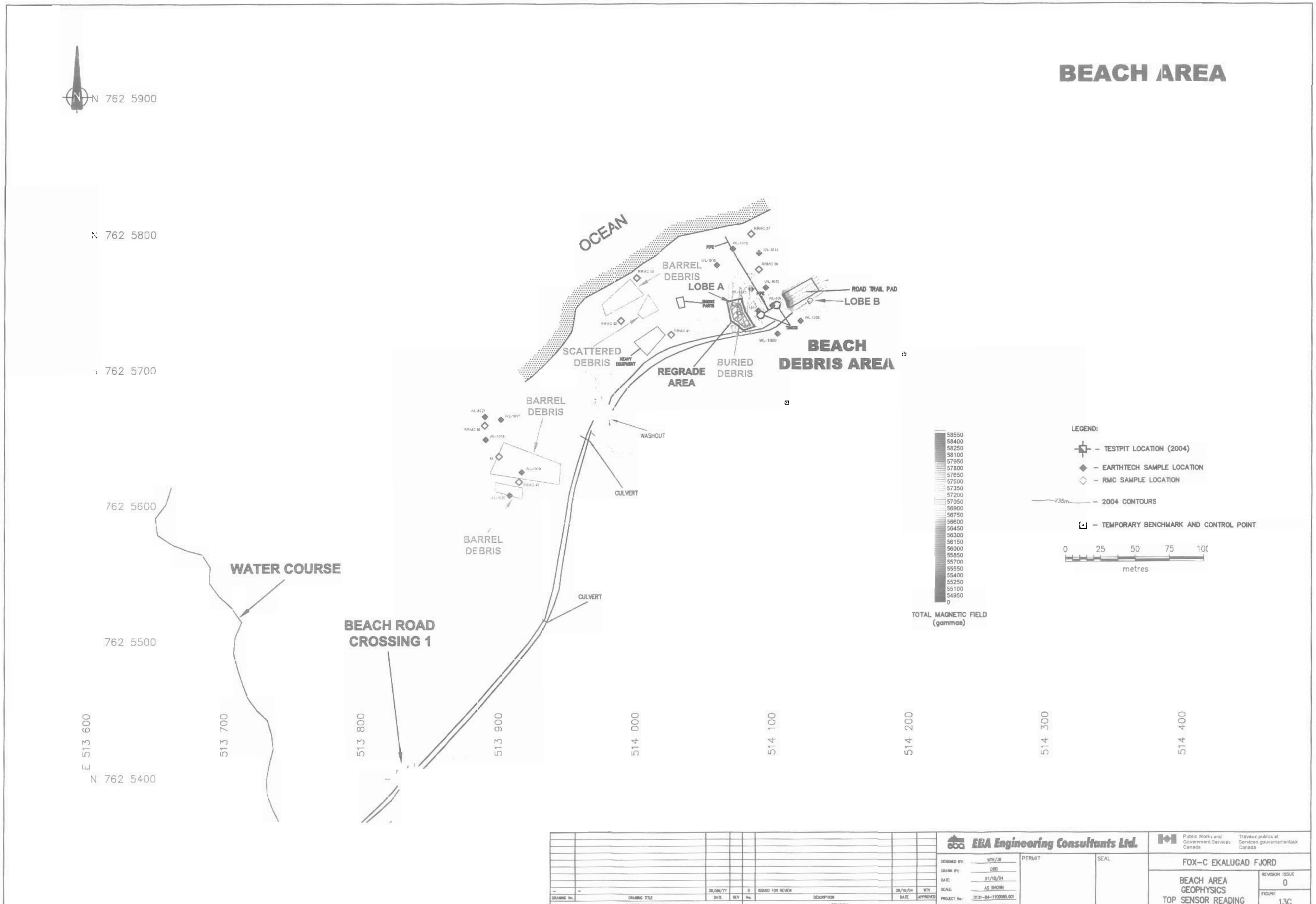
FIGURE: 13B


BEACH AREA
N 762 5900
N 762 5800
762 5700
762 5600
762 5500
N 762 5400
E 513 600
513 700
513 800
513 900
514 000
514 100
514 200
514 300
514 400
OCEAN
BARREL DEBRIS
LOBE A
ROAD TRAIL PAD
LOBE B
SCATTERED DEBRIS
REGRADE AREA
BURIED DEBRIS
BEACH DEBRIS AREA
BARREL DEBRIS
WASHOUT
CULVERT
BARREL DEBRIS
CULVERT
WATER COURSE
BEACH ROAD CROSSING 1
58550
58400
58250
58100
57950
57800
57650
57500
57350
57200
57050
56900
56750
56600
56450
56300
56150
56000
55850
55700
55550
55400
55250
55100
54950
0
TOTAL MAGNETIC FIELD (gammas)
LEGEND:
– TESTPIT LOCATION (2004)
– EARTHTECH SAMPLE LOCATION
– RMC SAMPLE LOCATION
– 2004 CONTOURS
– TEMPORARY BENCHMARK AND CONTROL POINT
0 25 50 75 100
metres
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FOX-C EKALUGAD FJORD
BEACH AREA GEOPHYSICS TOP SENSOR READING
REVISION ISSUE 0
FIGURE 13C
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DATE: 27/10/04
SCALE: AS SHOWN
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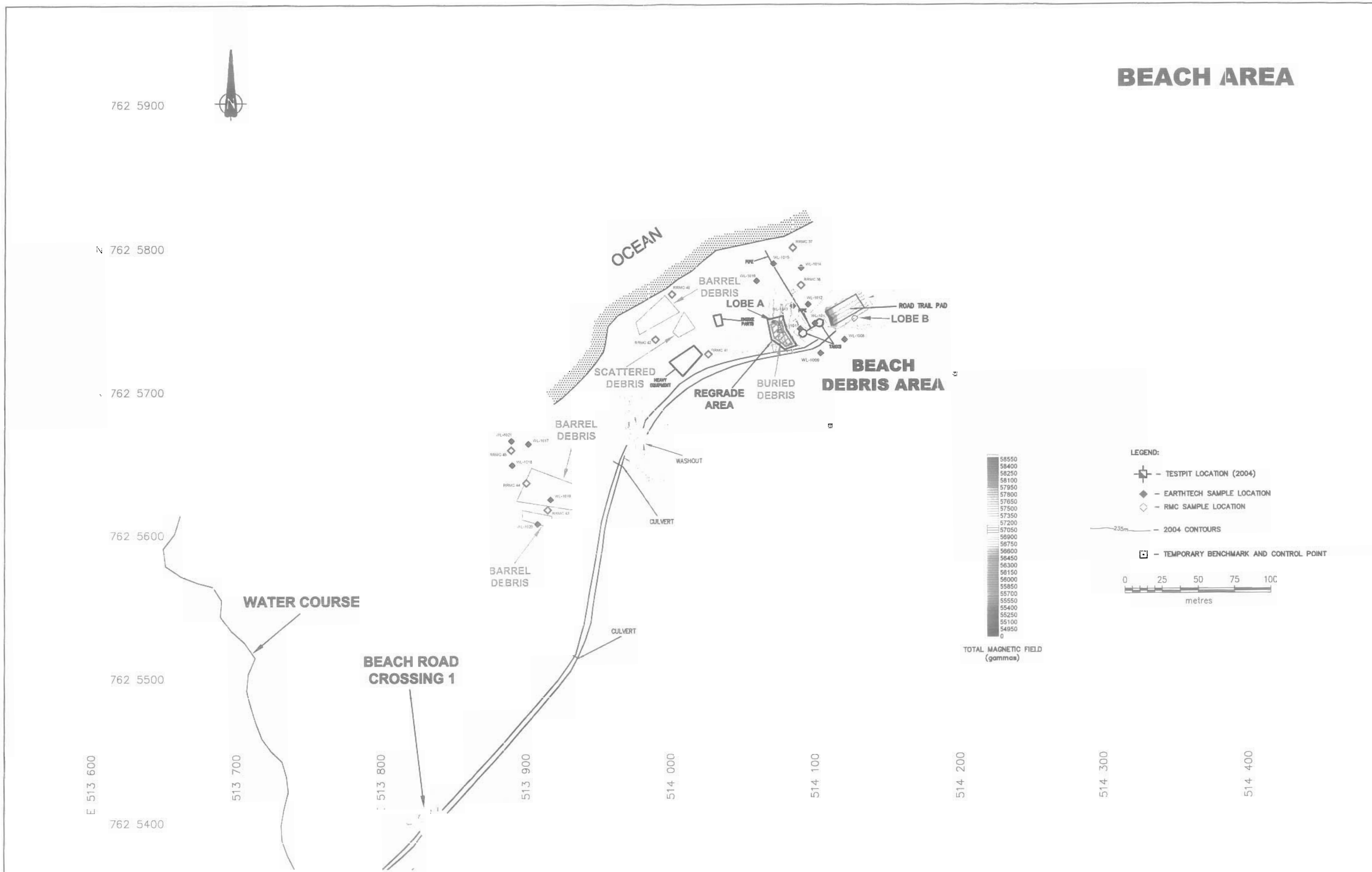

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BEACH AREA
GEOPHYSICS
BOTTOM SENSOR READINGS

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FIGURE: 13D

APPENDIX A

GEOPHYSICAL SURVEY PROCEDURES

GEOPHYSICAL SURVEY PROCEDURES

A.1 Background

The objective of the geophysical program was to define the areal limits of known landfills, and to identify and delineate other locations with partially or completely buried debris in areas where suspicious activity has taken place. The geophysical data was recorded with complete spatial positioning information to enable both the results and coverage to be accurately documented for future reference. A number of geophysical techniques can be used including Magnetometer, Electromagnetic Induction tools, (EM31), Electromagnetic Transient (EM61) and Ground Penetrating Radar (GPR). All techniques have advantages and disadvantages and all techniques will be adversely affected by significant amounts of surface debris. Based on experience at other DEW Line sites a survey procedure using magnetometer systems was used At FOX-C. This choice was driven by three considerations:

1. It provided the most cost effective solution in terms of maximising the area surveyed within the field time constraints.
2. The data collected permitted an analysis of the data in the field and easy field confirmation of the results.
3. Based on experience at many DEW Line sites, all debris areas and landfills contain a proportion of ferrous material and therefore can be mapped successfully using magnetometers. The issue of surface debris was addressed by noting the distribution and magnitude of debris and compensating for its presence when interpreting the measured results.

A.2 Magnetic Survey Procedure

A Geometrics G-858 portable cesium magnetometer/gradiometer magnetic system (G-858) was used to map the aerial extent of the landfills and partially or completely covered debris areas. A Geometrics G-856 proton precession magnetometer was used to record diurnal variations in the background magnetic field strengths for total magnetic field strength corrections.

The G-858 is a single-person portable system that was used to measure total magnetic field strengths at two sensor locations on a continuous basis as a survey area was walked. Variations in the total magnetic field (anomalies) are typically indicative of buried metallic (ferrous) debris. The two sensors are vertically separated by approximately 1 m, and magnetic readings are taken at both sensors and compared. The difference between the two readings provides the magnetic gradient, which is proportional to the quantity, distance and orientation of the neighbouring ferrous metal. All magnetic data is collected with an integrated DGPS positioning system. Data is usually collected along parallel profile lines to ensure consistent areal coverage, but in situations where access is restricted, or in a more general reconnaissance mode, a randomly oriented line approach may be appropriate. GPS positioning data is collected and logged at the same time as the geophysical data and is differentially corrected in real time using a RTCM differential correction string obtained from an MSAT based satellite link. The position of the magnetic sensor is logged to submetre accuracies (x,y) once every second during data collection. By integrating the magnetic data collected with a sub-metre real time DGPS positioning system, it is possible to cover large areas quickly and provide detailed grids over anomalies determining their shape and distribution in the field immediately after data collection. This data is then used to mark the boundaries of any buried material for consideration in the environmental sampling program.

A.3 Geophysical Survey Methodology

The survey methodology consisted of several steps.

1. All known areas of concern were surveyed using the G-858 with line spacing of approximately 5 meters.
2. Areas where there was no possibility of buried debris (outcrop rock, undisturbed soil) were generally not surveyed. There were three exception to this and they were:

   a) Areas where it was important to document a "clean" zone surrounding landfill or debris areas for planning purposes.
   b) Areas where it was important to document that there was minimal debris (potential borrow locations for example).
   c) Areas where there was enough scattered surface debris over a large enough area to make mapping the location of the surficial debris using the magnetometer useful.

3. Magnetic base station data was collected using the G-856 at a nearby 'clean' area to allow the total magnetic field strength readings to be diurnally corrected.

4. The G-858 was used to walk the disturbed areas on site in reconnaissance mode to identify if there are further buried debris piles in areas showing surface disturbance. Any such areas found were surveyed in detail to define the extent of any buried material.

5. All geophysical data collected included integrated, real-time differentially corrected GPS positions with a sub-metre accuracy (x,y) to allow the location and contouring of the data in the field for evaluation and documentation.

6. The perimeter of any buried landfills and buried debris piles were marked using pin flags to facilitate environmental sampling.

A.4 Geophysical Data Presentation

The magnetometer data was processed and plotted as a colour contour map with UTM coordinates. Site plan information is integrated as a layer on the drawing.

On the colour contour map, anomalies appear as areas of high magnetic gradients either red (positive) or blue (negative), on a yellow background of limited or no response. There is no significance to whether the anomaly is red or blue. The red/blue colours simply represent the positive/negative gradient. Locations with high magnetic gradients will correspond to locations with ferrous debris and therefore the landfill or debris pile. The extent and intensity of the total magnetic field readings usually indicates whether one is looking at a small highly magnetic surface object or conversely a more massive, deeply buried object.

Interpreting the data is done by grouping the magnetic gradient anomalies (red or blue areas) into anomaly areas. Anomaly areas are groupings of individual magnetic responses that may be related based on knowledge of site conditions (buried concrete rubble with rebar, water wellhead, barbed wire fence), similarities in total field data, or by reviewing the final colour plots. These anomaly groupings are then compared against the total magnetic field readings for those locations in order to gauge their potential significance (quantity of ferrous material).

A.5 Magnetic Theory

The theory behind magnetic or gradiometer data at its simplest level involves taking a point measurement of the earth's total magnetic field strength at a specific location at an instant in time. The earth is surrounded by a magnetic field generated by the interaction of the molten core, convection currents within the core, and the earth's rotation. The field strength varies with time (diurnal variations). These variations are primarily caused by changes in the convection currents and the influence of solar activity, which is highest during periods of intense solar flaring (sunspot activity) and conversely lowest level when the sun is quiet. Usually, these variations are less than a few hundred gammas (nanoTesla, nT) in magnitude, but they are more pronounced at more northerly and southerly latitudes. Variations due to location on the earth's surface are solely a function of relative position with respect to the earth's magnetic poles. As the magnetic poles drift, so do the location readings. The earth's magnetic field varies by approximately 35,000 gammas from the magnetic poles to the equator.

Magnetic data is useful in locating objects such as buried steel and other ferrous objects since the earth's background magnetic field is distorted by the presence of magnetized rocks, soils and ferrous (iron) objects. This is because these objects also possess an induced field in the presence of the background field and the background and induced fields will combine to produce a resultant total field strength that is a summation of the two magnetic field vectors. Objects can be detected by subtracting the earth's background magnetic field from field data and contouring the remainder. In general, the effect from natural materials such as rocks and soils is small over small areas and is usually less than 1 gamma/m. Concentrated ferrous debris; however, can cause magnetic field distortions of up to 30,000 gammas/m.

A gradiometer differs from a magnetometer only in that two readings of the total magnetic field strength are taken at a specific location and time. The two readings are taken at slightly different positions; therefore, the difference between the two readings is a reflection of the magnetic gradient at that location. This reading is sensitive to near surface ferrous objects and gradient anomalies can, therefore, be interpreted as an indicator of potential targets. This difference is plotted as contours on a grid system and provides a visual representation of the location and distribution of magnetic gradient anomalies.

The G856 proton precession magnetometer takes advantage of the fact that molecules of hydrocarbon fluids behave as small magnets (dipoles) and; therefore, will align or polarize themselves with the lines of magnetic flux when exposed to a uniform magnetic field. In the sensor head this is achieved in a controlled fashion by means of an energized electric coil. When the uniform magnetic field is removed, the molecules will rotate (precess) from their polarized orientation in a circular fashion around the direction of the ambient or local magnetic field lines (similar to the way a spinning top will wobble in a circular fashion in the presence of a gravitation field). The rate at which this precession occurs is proportional to the intensity of the ambient field. By measuring the rate (frequency) of precession and applying a well known atomic constant (the gyromagnetic ratio of the proton), one can calculate the total magnetic field strength at a specific point in time.

By using this technique to measure total magnetic field strength, measurements can be made utilizing an instrument with no moving parts to an accuracy of 0.1 nT (gammas). The disadvantage of this method is that adequate time has to be allowed for the sensor system to energize (polarize the molecules) and then relax the field and take the reading. This requires a minimum reading rate of no faster than one reading every three seconds. As the sensor has to be stationary during this period it is difficult to collect data at a high enough rate for real-time evaluation of the data. In addition, the system stability and accuracy degrades in the presence of high magnetic gradients and background noise. If correctly tuned and setup; however, proton precession magnetometers are ideal for monitoring background magnetic readings at a static location.

A G858 cesium vapour magnetometer offers several advantages over the more traditional proton precession or flux-gate magnetometers, particularly for collecting field readings over large survey areas. These advantages include more stable readings in high field gradients, increased resolution (0.01 nT), and high sampling rates. This means that it is possible to use these devices as "real-time" detectors when seeking magnetic anomalies and it also allows data to be collected rapidly with high horizontal data resolutions while walking a site without having to stop at each reading location.

The theory behind how cesium vapour magnetometers work is based on quantum physics. Briefly, the sensor head measures the total magnetic field at a point in space at a reading interval of up to 10 times a second. It does this by shining circularly polarized light through a glass chamber (called an absorption cell) containing a small amount of cesium vapour in a partial vacuum. Cesium vapour is used because it only has one electron present in the atom's outermost electron shell and this simplifies the excitation effect being measured. This electron can exist in nine different energy states in the presence of an external magnetic field. This effect is called Zeeman splitting. The energy differences from one Zeeman level to the next are approximately equal and are proportional to the strength of the ambient external magnetic field. By shining circularly polarized light generated by a cesium lamp through the absorption cell and measuring the Larmor frequency of an injected RF signal (called the H1 drive) required to reset photons within the absorption cell (so that they can absorb that light), one can measure their changes in energy and hence the ambient magnetic field strength. The constant of proportionality between the Larmor frequency and the ambient magnetic field strength is 3.498572 Hz/nT. This value is valid for the full range of typically encountered magnetic field values (20K nT to 90K nT).