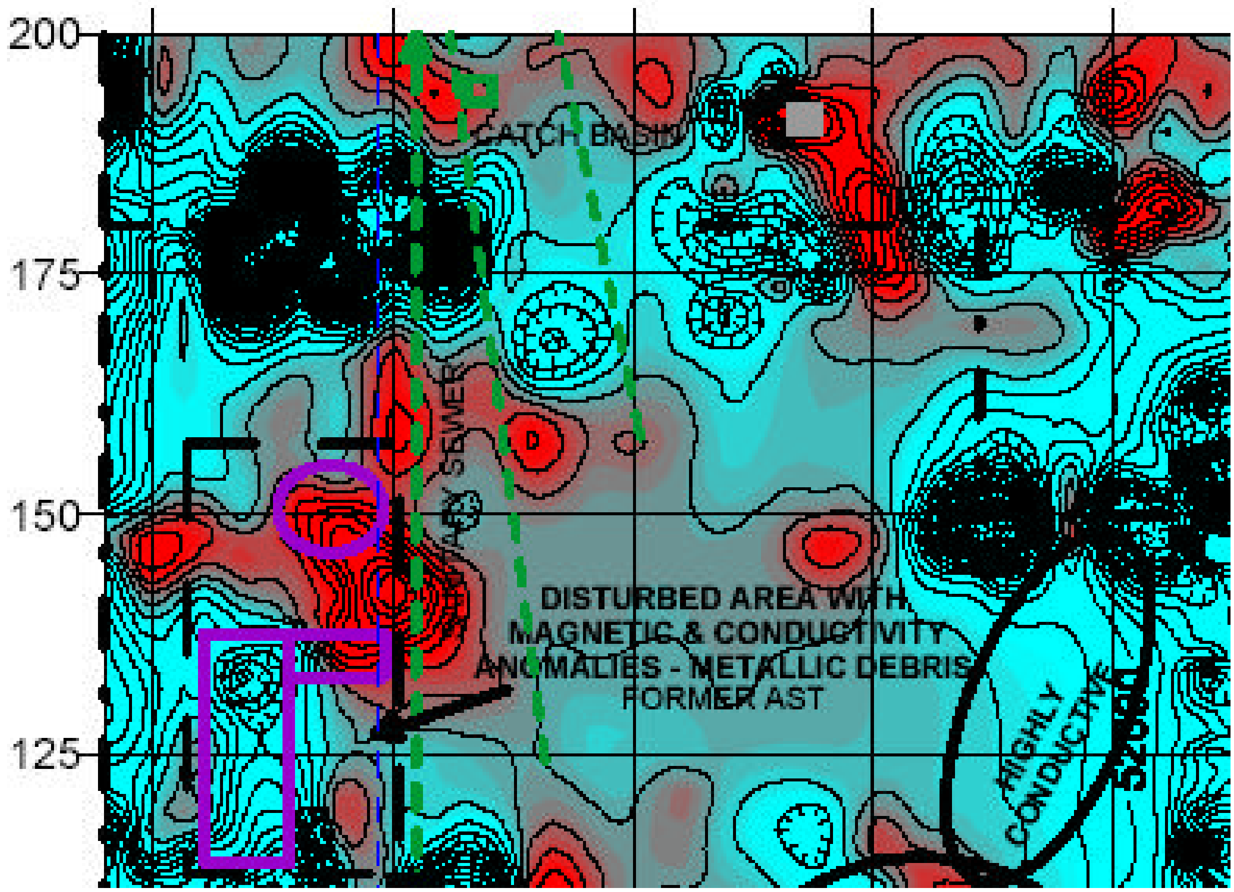
TECHNICAL MEMORANDUM
Geophysical Investigation

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

November 25, 2003



Prepared by:

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November 25, 2003
10077.003

Oregon Department of Environmental Quality
Northwest Region
2020 SW Fourth Avenue
Suite 400
Portland, Oregon 97201-4987

VIA Email/Hand Delivery

Attention: Anna Coates

**Subject: Technical Memorandum
Geophysical Survey
Astoria Area-Wide Petroleum Site
Astoria, Oregon
DEQ ECSI File #2277**

Dear Ms. Coates:

Enclosed are three bound and one unbound copies of the above-referenced document. This technical memorandum is being submitted to you on behalf of the Astoria Area-Wide PRP group as described in "RI/FS and IRAM Development Work Plan, Phase 1," dated July 15, 2002. These investigations have been conducted under DEQ Order No. ECSR-NWR-01-11.

Please call me at (503)768-5121 if you have any questions or comments.

Sincerely,
EnviroLogic Resources, Inc.

<<ORIGINAL SIGNED>>

Thomas J. Calabrese, R.G.
Principal/Hydrogeologist

cc: Distribution list attached

clients/port of astoria/003 Source-Soil Characterization/geophysicaltmdeq112503.doc

ASTORIA AREA-WIDE PETROLEUM SITE
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TECHNICAL MEMORANDUM
GEOPHYSICAL INVESTIGATION

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

October 20, 2003

Prepared for:

Astoria Area-Wide PRP Group

Prepared by:

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TECHNICAL MEMORANDUM
GEOPHYSICAL

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

November 25, 2003

EnviroLogic Resources, Inc., of Portland, Oregon, prepared this technical memorandum.

EnviroLogic Resources, Inc. Project No. 10077.003

By

____
Melanie N. Hance
Associate Project Geologist

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Thomas J. Calabrese, RG
Principal/Hydrogeologist
Project Manager

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TECHNICAL MEMORANDUM
GEOPHYSICAL INVESTIGATION

Remedial Investigation/Feasibility Study (RI/FS)
Astoria Area-Wide Petroleum Site
Astoria, Oregon

1.0 INTRODUCTION

Remedial investigation activities at the Astoria Area-Wide Site in Astoria, Oregon, are being conducted under Oregon Department of Environmental Quality (DEQ) Unilateral Order No. ECSR-NWR- 01-11. The order identifies several potentially responsible parties (PRPs) that have agreed to comply with the order. These PRPs include ChevronTexaco Products Company (ChevronTexaco), Delphia Oil Company (Delphia), McCall Oil and Chemical Company (McCall), Ed Niemi Oil Company (Niemi Oil), Flying Dutchman and Harris Enterprises (Harris/VanWest), Port of Astoria (Port), Qwest Communications International (Qwest), and Shell Oil Company (Shell). A geophysical survey was conducted on portions of the site between August 18 and 30, 2002, as part of the work being performed during the Phase 1 Remedial Investigation.

GeoPotential of Gresham, Oregon, conducted the geophysical survey. The objective of the geophysical survey was to map the location of underground utilities and subsurface anomalies. This included confirm and/or identify locations of underground petroleum pipelines, underground storage tanks (USTs) or other features of interest associated with past activities conducted at the site. In addition, as on-site drilling activities were being conducted concurrently, borehole locations were evaluated to identify locations of subsurface utilities (both abandoned and in-use) that may obstruct or endanger subsurface investigations.
The Astoria Area-Wide Study Area and the individual PRP site boundaries are shown in Figure 1. Specific boundaries are not identified for the Port in Figure 2 because the Port owns all the properties located north of Industry Street; this includes the following facilities;

former Shell Oil bulk plant, former Mobil/Niemi Oil bulk plant, and the former McCall Oil bulk plant.

The interpretations of the geophysical data presented in this memorandum summarize findings as presented in the GeoPotential report dated September 19, 2002, included in Appendix A. Field methods, procedures, and equipment used are also described in Appendix A. GeoPotential's report does not include a specific discussion on the screening of borehole locations.

2.0 GEOPHYSICAL SURVEY

The former Mobil/Niemi Oil bulk plant, Port of Astoria-leased property between the former Mobil/Niemi Oil bulk plant and the former Shell Oil bulk plant, the former Shell Oil bulk plant, and the former McCall bulk plant sites were the main focus of the geophysical survey along with petroleum product line locations. The limits of the geophysical survey on these properties are shown on Figure 2. Detailed interpretation maps are included on Figures 4 through 12 of the GeoPotential report (Appendix A). Figure 2 also summarizes the anomalies GeoPotential identfied relative to the location of present and former facilities. Each PRP site evaluated is discussed in detail below.

2.1 FORMER MOBIL/NIEMI OIL BULK PLANT

Six magnetic anomalies (MA1 through MA6) and 5 conductivity anomalies (EMA1 through EMA5) were identified on the former Mobil/Niemi Oil Bulk Plant property. These subsurface anomalies are discussed below and presented on Figure 2.

MA1, located near the southeast corner of the storage building was identified to be a small 5-foot by 6-foot UST. This UST appears to be a heating oil tank associated with the office/warehouse building. A second underground metal tank was identified near the central portion of the storage building. This underground tank was reportedly used for temporary containment of product spills from beneath the former fuel loading rack. An access port and vent pipe was observed to be associated with this secondary containment tank. Drainage lines were found to run from this tank to a catch basin located within the concrete drive slab and containment curbing. A valve inside the catch basin was used to direct flow toward the containment tank if necessary.

The GeoPotential report indicates that this catch basin is connected to an "apparent" drywell located immediately east of the fuel loading rack. However, historical site plans provided by the City of Astoria dating back to the 1920s and 1940s indicate that the concrete cylinder found just beneath the ground surface at the "apparent" drywell location was likely related to a product line manifold or valve box. Old product lines from this manifold/valve box appear to extend to the loading rack near, yet not connected to the catch basin. According to available plans of the former bulk plant site, at no time was site surface runoff routed to a drywell.

Magnetic anomaly MA2 was identified as a possible water line, but may represent the terminus of a subsurface product line. Magnetic anomalies MA3 and MA4 were identified as possible remnants of the former subsurface product distribution lines. Magnetic anomalies MA5 and MA6 were tentatively identified as buried debris.

Conductivity anomaly EMA1 is located in the same area as a former aboveground bulk storage tank and GeoPotential interpreted it to represent fill/disturbed material resulting from the removal of this storage tank. EMA2 was tentatively identified as a circular feature encompassing EMA1, possibly a remnant of a former containment barrier. EMA3 is located in the same area as a former (smaller) aboveground bulk storage tank and is interpreted to represent a possible foundation remnant resulting from the removal of this storage tank. EMA4 was interpreted to represent subsurface utilities and electromagnetic anomaly EMA5 was interpreted as a relatively low conductivity zone.

2.2 FORMER SHELL OIL BULK PLANT

Three magnetic anomalies (MA1 through MA3) and four conductivity anomalies (EMA1 through EMA4) were identified on the former Shell Oil bulk plant property (Figure 2). Magnetic anomalies MA1 and MA3 are interpreted as debris and possible piping remnants related to the former bulk plant. Additionally, a concrete slab identified near MA1 was interpreted as a remnant foundation possibly related piping formerly located in this area.

Anomalies MA2 and EMA1 along the northern property boundary are interpreted to be related to buried subsurface sewer, water, power and communication utilities as well as buried electrical wiring related to the gated entrance. Anomaly EMA2 was located just west of the Oregon State Police offices and was interpreted to represent a possible reinforced-concrete remnant.

Anomalies EMA3 and EMA4 were located in the southeast portion of the property and are believed to be related to former above-ground bulk storage tanks. Additionally, a subsurface power cable is interpreted to be located near EMA3, traversing from the Oregon State Police garage to the southwest corner of the Oregon State Police office building.

2.3 PORT OF ASTORIA PROPERTY

Several anomalies were identified on Port of Astoria property. Many of the anomalies discerned appeared to be remnants of former foundations or related to buried debris (Figure 2). Several of the anomalies (EMA1 through EMA3 and MA1 through MA3) appear to be related to subsurface utilities. Results from ground-penetrating radar surveys indicated a possible dry-well located in the approximated center of this area, based on a change in density in the material in this area and the dimension of the area of interest.

2.4 FORMER McCALL BULK PLANT

At the time of the geophysical survey substantial demolition of the former McCall Bulk Plant had taken place. Eight significant magnetic anomalies were identified during the geophyscial survey (Figure 2) and all of these anomalies were further investigated with the use of a tracked excavator.

Magnetic anomaly MA1 was determined to be the terminus of subsurface product lines leading away from the property. These lines were further investigated during gephysical product line mapping. Magnetic anomaly MA2 was found to be an abandoned pipeline, possibly a water line as it was determined to lead towards a water valve present near Hamburg Avenue. Magnetic anomaly MA3 was a known UST. Magnetic anomaly MA4 was located west of Magnetic anomaly MA3 and was determined to be buried piping.

Magnetic anomaly MA5 was located along the northern property boundary and was excavated and initially found to be a short section of small-diameter piping. Further excavation (during soil remedial activities) indicated that this anomaly might have been related to a larger subsurface section of piping that led towards the property boundary but appeared to terminate at the boundary. Magnetic anomaly MA6 was located west of magnetic anomaly MA5 and found to be associated with several buried 55-gallon drums. These drums were later excavated, along with impacted soil. Magnetic anomalies MA7 and MA8 were determined to be buried metallic debris.

2.5 PRODUCT PIPELINE MAPPING

Results of the geophysical surveys indicated that some of the former product pipelines have been removed from the site. Additionally, the geophysicist had difficulties resolving data in some areas near aboveground structures and where subsurface utilities intersect. Portions of the former product pipelines that were successfully traced were painted with yellow marking paint and surveyed by a contracted surveyor. The product lines terminating in Slip 2 were further investigated with ground-penetrating radar and found to extend only a short way (a few feet) into the bank. Results of the product pipeline mapping are presented on Figure 3.

3.0 DISCUSSION

The geophysical survey identified several previously unknown features of interest including, drums, USTs, and drywells. Anomalies at the former McCall bulk plant were investigated and resolved immediately. Two underground tanks identified at the former Mobil/Neimi Oil bulk plant site and a possible dry well located on Port of Astoria property will be evaluated during future investigations.

FIGURES

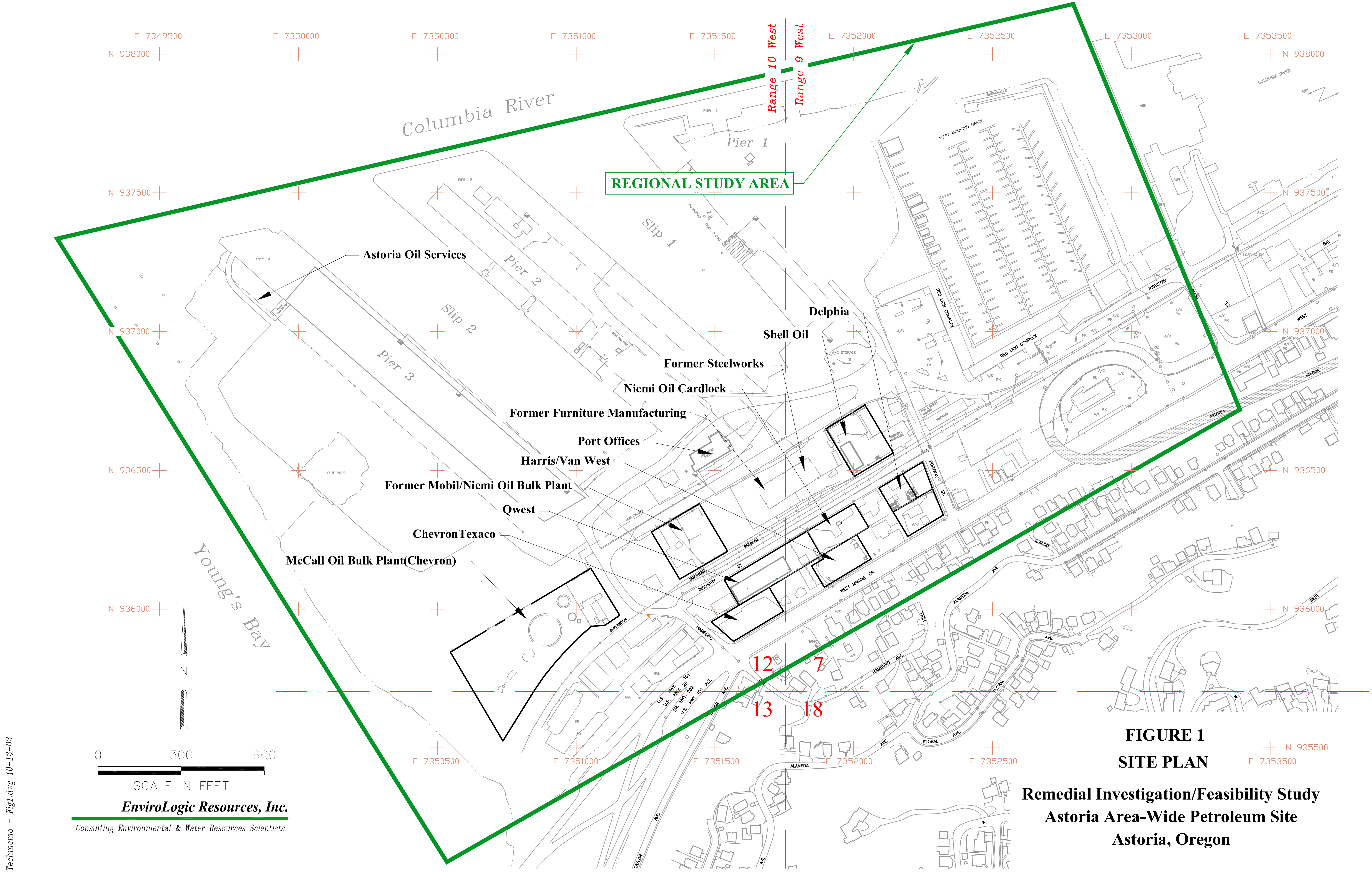


FIGURE 1

SITE PLAN

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

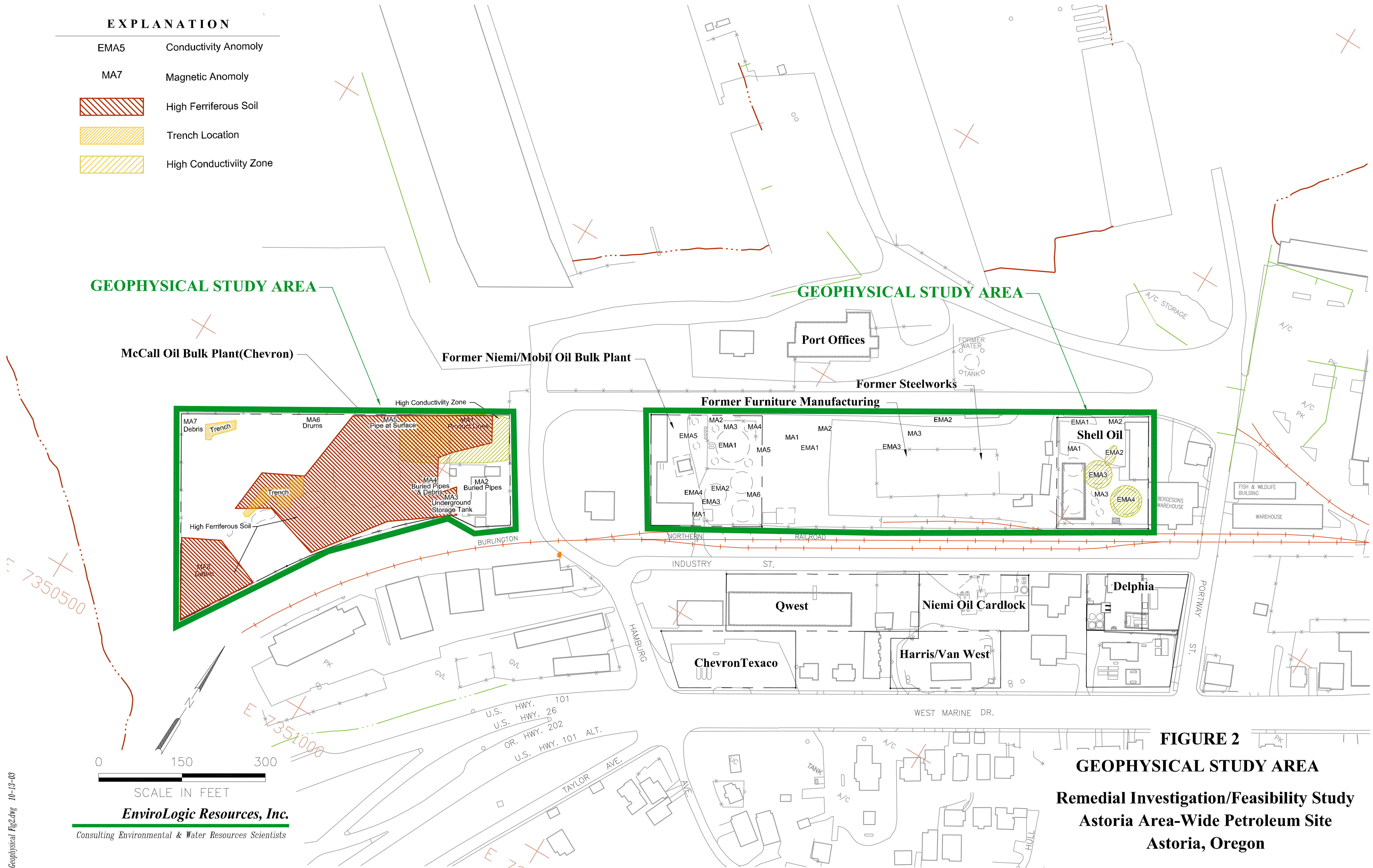


FIGURE 2
GEOPHYSICAL STUDY AREA
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

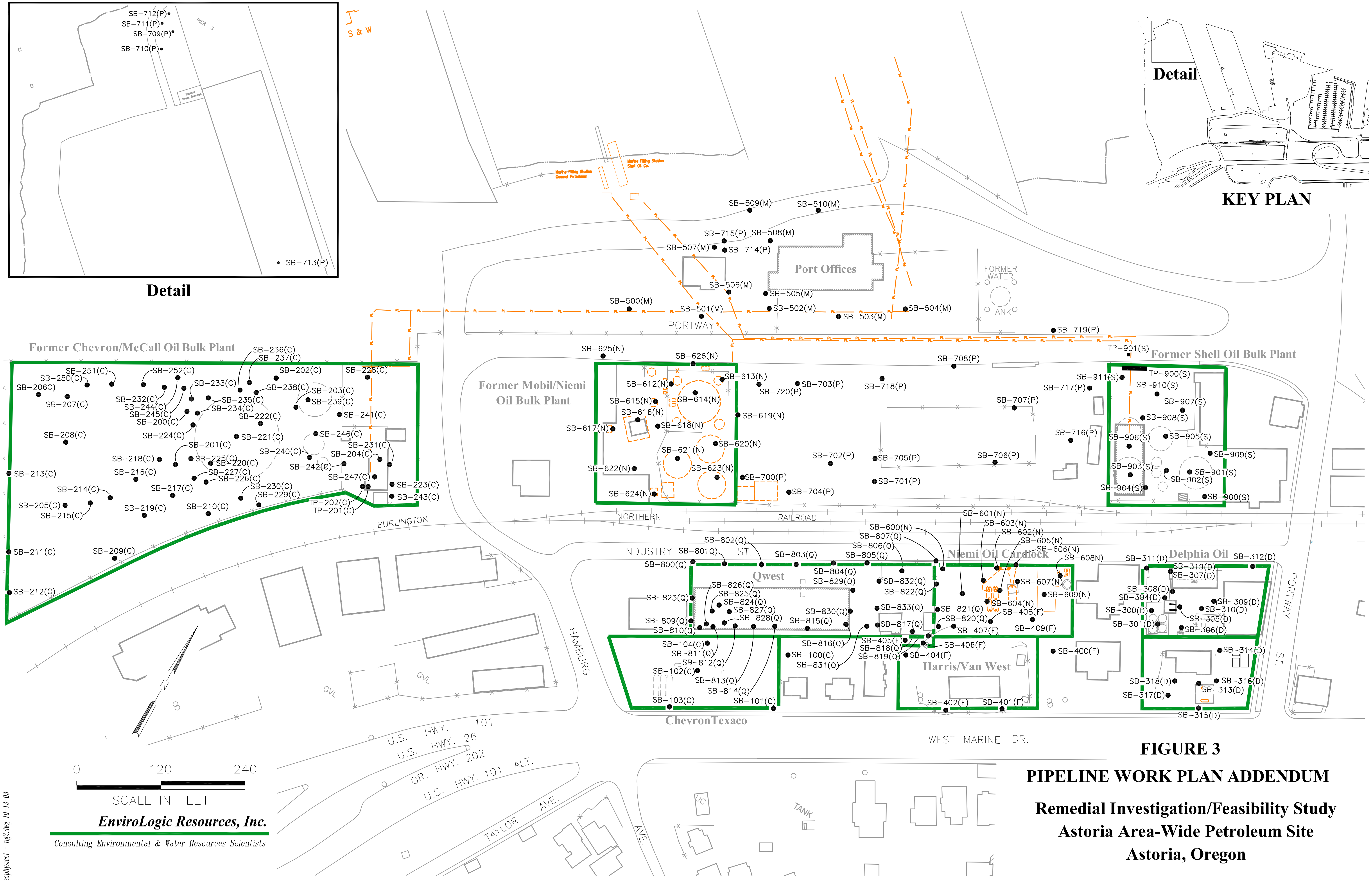


FIGURE 3

PIPELINE WORK PLAN ADDENDUM

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

APPENDIX A

REPORT FROM GEOPOTENTIAL

SUMMARY REPORT

SUBSURFACE MAPPING SURVEY

ASTORIA AREA-WIDE PETROLEUM SITE
ASTORIA, OREGON

CLIENT:

EnviroLogic Resources, Inc.
8948 SW Barbur Boulevard
Portland, Oregon 97219-4047

September 19, 2002

GeoPotential Project Number 4154

CONTENTS

FIGURES
(UNDER SEPARATE COVER)

APPENDICES

SUMMARY

A geophysical survey was conducted over portions of the Astoria Area Wide Petroleum Site in Astoria, Oregon (FIGURE 1.) to accomplish the following four tasks:

1. Map the location of Underground Storage Tanks, utilities, and distribution of fill materials.
2. Map the location of the sanitary & storm sewer systems.
3. Map the location of approximately 1.5 miles of petroleum product lines.
4. Perform a Bore Hole Clearance Survey (BHCS) over proposed borehole locations.

This report covers Tasks 1, 3 and 4. Task 2 was completed at a later date.

Magnetometer Surveys were used to identify subsurface ferriferous objects. Follow-up Ground Penetrating Radar (GPR) Surveys were then conducted in an attempt to identify the ferriferous objects. Terrain Conductivity Surveys were conducted to study contrasts in fill materials and to search for subsurface contaminants. Bore Hole Clearance Surveys were conducted to clear proposed bore hole locations for drilling. Pipe and Cable Surveys in conjunction with GPR surveys and Electromagnetic Scans were used to map utilities and petroleum product lines.

INTRODUCTION

Subsurface mapping surveys are geophysical surveys utilizing geophysical data and methods to detect and locate natural and manmade subsurface features. The Geometrics G-858 Cesium magnetometer used to obtain the magnetic data is a geophysical tool specifically designed to detect buried ferriferous (iron bearing) objects, including utilities, drums and underground storage tanks (USTs). Follow-up surveys using Ground Penetrating Radar (GPR) are often used to help determine the source of the disturbance and the depth of burial of the object. Terrain Conductivity Surveys are used to study variations in subsurface conductivity that may be related to distributions of contaminants and fill material.

TIMING

Ralph Soule, Nikos Tzetos, Jeff Mann of GeoPotential conducted fieldwork between August 18 & 30, 2002. Tom Calabrese and Lynn Green representing EnviroLogic Resources coordinated the fieldwork. The report was written by Ralph Soule, and then mailed to EnviroLogic Resources on September 19, 2002.

SURVEY OBJECTIVES

The survey objectives at this Site are specified by Tasks 1, 3 and 4 above. Task 2 was completed at a later date. Various Tasks were assigned to various parcels as shown in FIGURE 1.

Task 1 – AREAS 1 and 2.
Task 3 – Conducted over the entire Site as shown in FIGURE 2.
Task 4 – AREA 1, Qwest parcel, Niemi Oil Card lock parcel and several boreholes near the Port office building.

In addition other subsurface features of environmental interest that may be detected by the SUBSURFACE MAPPING SURVEY were to be identified and mapped.

SURVEY SITE

FIGURE 1. – INDEX MAP shows the various parcels of the Astoria Area-Wide Petroleum Site that were included in the SUBSURFACE MAPPING SURVEY. In addition FIGURE 2 shows the petroleum product lines that were mapped over the entire SITE.

Various Environmental Companies conducted environmental investigations of the various parcels:

McCall Oil Bulk Plant (Chevron) –PNG Environmental.

Niemi Oil Bulk Plant and Card lock Parcels – GeoEngineers.

Former Furniture Manufacturing and Steelworks Parcel and the Port Parcel – EnviroLogic Resources, Inc.

Shell Oil – HartCrowser, Inc.

Qwest – Tetra Tech.

Site conditions varied for the various Parcels.

AREA 1

The central portion of the parcel (dark blue color) was cleared of buildings except for a landscape supply company located at the northeast corner of this parcel. The Southeast side of the Site was occupied by commercial fishing equipment as shown on FIGURES 4 & 5. These areas could not be included in the current Survey and are to be completed later. The remainder of the Site is asphalt and gravel covered.

The NIEMI OIL BULK PLANT (red color) is occupied by a street cleaning company and stored Port of Astoria boats. FIGURES 6,7 and 8 show the surface features. The Site is covered by asphalt, sand and a concrete pad. A UST vent and two UST fill pipes are located as shown on FIGURES 6, 7 & 8. An apparent dry well was exposed on the Parcel. A concrete pad with catch basin is located adjacent to the larger UST.

The east end of AREA 1, the former SHELL OIL Parcel (FIGURES 9, 10, 11), is currently occupied by the Oregon State Police offices. The Parcel is asphalt covered. There are no surface indications of USTs.

AREA 2

FIGURES 12 & 13 show the former MCCALL OIL BULK PLANT Parcel. All structures had been removed from the Parcel and recently exposed sand covered the entire Parcel. A UST fill port was exposed as shown on FIGURE 13. Some scattered metallic debris consisting of pipes and other minor debris covered portions of the Site.

No detailed maps were constructed for the parcels that had Bore Hole Clearance Surveys with no Magnetic or Conductivity Surveys. These included the NIEMI CARD-LOCK parcel, the QWEST parce and the area around the PORT of ASTORIA offices. These areas were mainly asphalt covered with some grass and gravel covered areas.

SURVEY EQUIPMENT

The following geophysical instruments were used to conduct the survey:

- GEOMETRICS G-858 CESIUM MAGNETOMETER (Magnetic Survey)
- MALA RAMAC GROUND PENETRATING RADAR SYSTEM with a 500 MHZ ANTENNA (GPR Survey)
- GEONICS EM-31 CONDUCTIVITY METER (Conductivity Survey)
- AQUA -TRONICS A6 ELECTROMAGNETIC TRACER (EMA6 Survey)
- SCHONSTEDT GA52 MAGNETIC GRADIOMETER (GA52 Survey)
- HEATH SURE LOCK PIPE & CABLE LOCATOR (P&C Survey)

This equipment and the procedures used to meet the survey objectives of this project have been proven effective in detecting buried metallic objects such as utilities, USTs and buried waste drums (BWDs) and in measuring terrain conductivity. The Appendixes describe Magnetic, GPR and Conductivity Surveys.

PROCEDURES

PRODUCT PIPELINE MAPPING (Task 3)

A P&C Survey (FIGURE 2) was conducted to map the location of the former product pipelines. A tracing current was transmitted down the pipes from two locations where the pipelines were exposed: along the North side of AREA 2 and along the Southwest side of Pier 2 (just to the South of the existing plant on the Pier). P&C Surveys were also conducted to locate the subsurface extent of four pipes protruding from the shoreline between Piers 2 and 3 (FIGURE 3). GPR Surveys were conducted over the pipelines to help map their locations.

MAGNETIC SURVEY (Task 1)

An orthogonal survey grid was established at AREAS 1 & 2 using a surveyors level and measuring wheels. The southwest corner of the each AREA was used as the origins (0, 0) for survey grids.

Magnetic data were collected automatically at approximately 6-inch intervals along traverses orthogonal to the baselines. Traverses were five feet apart.

Data were downloaded to a laptop computer and processed in the field. Magnetic Contour maps were printed and were used to locate suspect anomalies for further investigation with the EMA6, GA52 and GPR SURVEYS. These anomalies are labeled on the MAPS as MA1 (Magnetic Anomaly 1), etc. Magnetic Maps were produced for AREA 1 (FIGURE 4), AREA 2 (FIGURE 12) and detail Magnetic Maps for the NIEMI Parcel (FIGURE 6) and the SHELL OIL Parcel (FIGURE 9).

The Magnetic Maps were contoured at an interval of 500 nT, an interval sufficient to detect underground utilities, underground storage tanks and buried waste drum piles.

The Magnetic Maps are colored to visually enhance the anomalies in the magnetic field. Magnetic highs caused by buried ferriferous objects are shown in red. Blues indicate magnetic lows, usually caused by surficial objects located above the sensor.

Anomalies not appearing to be related to observed surface objects (catch basins, vehicles, buildings, etc) were located on the Site using a measuring wheel. Their edges were defined using the EMA6 Tracer and the Schonstedt Magnetic Gradiometer, then marked with white spray paint. Buried objects appearing to be three-dimensional (possible USTs or BWDs) were further explored using GPR.

Conductivity Survey

Conductivity Surveys were conducted along the same traverses as the Magnetic Survey over AREAS 1 and 2. In AREA 2 the 200 feet along the West side was not included in the Conductivity Survey (see FIGURE 13) as this area was a Western extension of the original Magnetic Survey with the specific purpose of locating BWDs.

Conductivity data were downloaded to computers where the raw data was edited, gridded and contoured to produce the Conductivity Maps accompanying this report (FIGURES 4, 7 & 10). The Conductivity Maps are contoured in units of millisiemens per meter (mS/M) that is related to conductivity of the subsurface. Higher values indicate more electrically conductive materials (lower resistivity).

The Conductivity Maps are colored to visually enhance the distribution of Terrain Conductivities. Lower conductivity areas are colored blue and higher conductivity areas are colored red.

UTILITY MAPPING (Task 1)

Subsurface utilities were mapped on AREAS 1 & 2 using the results from the Magnetic and Conductivity Surveys. Additional GPR, EMA6, GA52 and P&C Surveys were conducted to map utilities not apparent from the Magnetic and Conductivity Surveys.

BOREHOLE CLEARANCE SURVEYS (Task 4)

Borehole Clearance Surveys (BHCS) are conducted in the immediate vicinity (in an approximate 10-foot radius) of proposed borehole locations. The purpose of the BHCS is to avoid drilling into utilities or other unexpected subsurface features. Four Surveys are conducted over each borehole; GPR, EMA6, GA52 and a P&C Survey to detect live underground power cables. If any of these Surveys detect subsurface features that should be avoided then the borehole is relocated to the nearest “clear” area.

RESULTS

The RESULTS are shown on the INTERPRETATION MAPS (FIGURES 5, 8, 11 and 13). Results were marked on the SITE with marking paints.

PRODUCT PIPELINE MAPPING (FIGURE 2)

In general the product pipelines had been removed from AREAS 1 & 2. The remaining portions of the pipeline detected by the SUBSURFACE MAPPING SURVEY are shown on FIGURE 2 and were marked on the surface with yellow marking paint. The area to the Southeast of the PORT building was difficult to map due to the intersection of several subsurface utilities. Portions of the pipeline have apparently been removed from the piers, as the pipelines appeared to end before an outfall on the pier was reached as shown by old utility maps.

MAGNETIC ANOMALY MA1 in AREA2 (FIGURES 12 & 13) was excavated during the SUBSURFACE MAPPING SURVEY and found to be the ends of the product pipeline. This was used as one of the two transmitter locations for the P&C SURVEY.

On the NIEMI Parcel (FIGURE 8) MAGNETIC ANOMALIES MA3 & MA4 my also be termination points for the product pipeline.

The product pipeline for the SHELL Parcel appears to terminate in the middle of PORTWAY as shown on FIGURE 2. During the SUBSURFACE MAPPING SURVEY, trenching adjacent to PORTWAY along the SHELL Parcel by GeoEngineers produced no evidence for a product pipeline on the Parcel.

FIGURE 3 shows the results of the SUBSURFACE MAPPING SURVEY of four pipes protruding from the shoreline between piers 1 & 2. The results indicate the two product lines have been truncated near the shoreline. The eastern storm drain extends to a catch basin. The western storm drain was apparently truncated by the construction of the Port Garage. A south Projection of this storm drain indicates it may have been connected to a storm drain leading from a catch basin on the South side of PORTWAY.

AREA 1 (FIGURE 5)

The results of the SUBSURFACE MAPPING SURVEY between the NIEMI and SHELL Parcels are shown on FIGURE 5. The interpretation indicates that all of the Magnetic and Conductivity Anomalies are caused by a combination of subsurface utilities, old building foundations and debris. No USTs or BWDs are interpreted from the Surveys.

A possible dry well (shown as a green circle on FIGURE 5) was interpreted from the GPR Survey.

A series of linear Conductivity Anomalies along PORTWAY are interpreted to be caused by communication cables running parallel to PORTWAY just to the North of the SURVEY.

NIEMI PARCEL (FIGURE 8)

The Western half of the Parcel exhibits higher frequency Magnetic Anomalies and a higher Conductivity area. These are interpreted to be caused by reinforced concrete, utility lines and foundations remaining from the bulk tank farm.

Magnetic Anomaly MA1 is caused by the 5’X6’ UST. The anomaly is subtle because of interference by the surrounding buildings. The 6’X10’ UST produced no Magnetic Anomaly as it was covered by a vehicle at the time of the Magnetic Survey. Product lines were found to run from the UST to the valve in the slab by the catch basin.

MA2 is interpreted to be caused by a water line but may also be caused partially by the end of a product pipeline. Anomalies MA3 and MA4 are interpreted to be the ends of the product pipelines leading to the former tank farm. MA4 correlates with the end of the product lines on FIGURE 2.

MA5 and 6 are interpreted as debris.

The western area shows a conductivity circular low anomaly EMA1 (centered on the “stake”) that correlates with the former bulk tank that had previously occupied the area. The conductivity low may indicate a change in fill material or perhaps elevated hydrocarbon residuals in the soil. EMA2 is a narrow anomaly circling EMA1 on three sides and may be reflecting the former containment wall. EMA3 is a circular conductivity high anomaly interpreted to be a foundation for a smaller bulk tank that had occupied the area. EMA4 is interpreted to be caused by utilities. EMA5 is interpreted as a relative conductivity low but may also indicate a zone of increased hydrocarbon concentration.

The catch basin was found to drain to the dry well.

SHELL PARCEL (FIGURE 11)

Magnetic Anomalies MA1 and MA3 are interpreted to be caused by debris and piping foundations from the former bulk oil plant. Next to MA1, an L shaped concrete slab was identified and may be an old support structure for above ground piping.

The series of Magnetic and EM Anomalies along the North edge of the Parcel (MA2 and EMA1) are caused by an underground power/communication cable along PORTWAY, electrical control for the fence gate and sewer/water lines.

EMA2 is a high conductivity area that may be caused by mesh reinforced concrete.

EMA3 and EMA4 are higher conductivity areas that correlate with the former location of bulk storage ASTS.

An underground power cable crosses EMA3. The GPR Survey of this area showed debris and piping.

The GPR Surveys of EMA4 did not produce evidence of a former AST foundation indicating that the EM high anomaly is a soil conductivity anomaly that may indicate a different fill material under the former AST.

All other EM and MAGNETIC Anomalies are interpreted to be caused by surface features or subsurface utilities and minor debris.

AREA 2 (FIGURE 12)

The Magnetic Survey over AREA 2 produced 8 significant Magnetic Anomalies that were excavated shortly after completion of the Survey:

MA1 - truncated ends of product piping that extend to PIER 2. These were used as a transmitter location for the P&C Survey of the product pipeline.

MA2 - buried pipes.

MA3 - a known UST that had the fill exposed at the surface.

MA4 - buried pipes & debris.

MA5 – pipe at the surface.

MA6 – buried waste drums.

MA7 & 8 – buried ferriferous debris.

Two areas of generally stronger magnetic field are observed and may be caused by slightly higher iron content of the soil due to the metallic structures that had previously occupied those areas.

The Conductivity Survey of AREA 2 produced a higher conductivity zone in the northeast corner as shown on FIGURE 13. This may be caused by a variation in the type of fill material.

LIMITATIONS

Geophysical surveys consist of interpreting geophysical responses from subsurface features. Since a variety of subsurface features can produce identical geophysical responses it is necessary to confirm the geophysical interpretation with intrusive investigations such as excavating or drilling. In addition many subsurface features may produce no geophysical response. The use of this SUBSURFACE MAPPING SURVEY is the sole responsibility of the CLIENT.

Ralph Soule **September 19, 2002**
GeoPotential

APPENDIX A
MAGNETOMETER SURVEYS

The earth's magnetic field, measured in "nano Teslas" (nT), behaves like a bar magnet, with the strongest magnetic field located at the poles, and the weakest field located near the equator. In the United States, the average field intensity varies widely, however, the average value is about 50,000 NT. Also, like the magnetic field around the bar magnet, the earth's magnetic field is inclined. This inclination varies between 60 and 75 degrees, generally depending upon the latitude of the measuring location. The earth's magnetic field varies constantly and, during sunspot activity, quite dramatically. A magnetometer is an electronic device that measures the intensity of the earth's magnetic field.

Naturally occurring geologic features and buried ferrous metal objects such as underground storage tanks, drums, ordnance, pipes and debris filled trenches produce both horizontal and vertical disturbances to the earth's local magnetic field. The objects causing these "anomalies" can be detected quickly and reliably using portable magnetometers.

The intensity of an anomaly is a function of the mass, size and depth of burial of the object. As a rule of thumb, single drums buried several feet below the surface produce anomalies of about 200 nT relative to the normal undisturbed background and can be detected at a horizontal distance of about 15 feet, while large caches of drums can produce anomalies of many thousands of nT and may be detectable 50 feet away.

Magnetometers generally measure horizontal variations in the local magnetic field. A magnetic gradiometer is a variant of the magnetometer that measures both the horizontal and the vertical magnetic field at each survey point. It consists of two identical sensors located vertically on a staff and having a fixed separation. The intensity of the magnetic field caused by a buried metal object varies inversely with the distance between the object and the sensor. The relative intensities measured simultaneously at each sensor are used to determine the relative depth of burial of an object.

Relative depth estimates of buried metal objects can be made using a single sensor. In general, for a given mass object, the deeper the object is buried, the lower the amplitude and the wider the anomaly. Shallowly buried objects produce higher amplitude anomalies with closely spaced contour lines.

Magnetic surveys can only detect **ferrous metal** objects and cannot be used to identify the buried object. Estimates of the total mass of a buried object are difficult due to the physical properties of the object and other factors. Interference caused by observed surface metal objects limits the accuracy of the survey. The anomalies produced by fences, power lines, cars and buildings can easily mask the anomaly caused by an underground target.

Magnetic surveys are cost effective. Using the standard "step and wait" magnetometer, data from approximately 1000 points can be obtained in one field day corresponding to between 1 acre and about 5 acres depending on site conditions and survey goals. More modern cesium magnetometers collect up to 10 readings per second continuously, thus the operator can proceed without stopping. Many modern magnetometers use an audible signal to call attention to anomalous data as it is obtained. At some sites metallic objects can be detected and marked in the field at the time of the survey.

The use of a second, automatically recording "base station" magnetometer is highly recommended due to temporal variations in the earth's magnetic field. These changes must be removed from the field data before an accurate interpretation can be made, particularly when searching for small-buried objects.

Magnetic data are most commonly presented in two contour maps. The TOTAL MAGNETIC FIELD CONTOUR MAP shows the horizontal magnetic field and, therefore, the areal extent of anomalies. The GRADIOMETER CONTOUR MAPS show the vertical magnetic field and indicate the relative depth of burial of the objects causing those anomalies. Color versions of these maps may be produced showing only the magnetic highs and lows.

APPENDIX B
GROUND PENETRATING RADAR SURVEYS

Ground Penetrating Radar (GPR) uses high frequency radio waves directed into the ground to acquire information about the subsurface. The energy radiated into the ground is reflected back to the antenna by features having significantly different electrical properties to that of the surrounding material. The greater the contrast, the stronger the reflection. Typical reflectors include water table, bedrock, bedding, fractures, voids, contaminant plumes and man-made objects such as UST's and utilities. Data are digitally recorded or downloaded to a laptop computer for filtering and processing.

GPR can be a valuable tool to accurately locate both metallic and non-metallic UST's and utilities, buried drums and hazardous material even below reinforced concrete floors and slabs. GPR can delineate trenches and excavations and, under some conditions, it can be used to locate contaminant plumes. It has been used as an archaeological tool to look for buried artifacts. It can accurately profile fresh water lake bottoms either from a boat or from a frozen lake surface. GPR can locate voids below roads and runways. GPR has numerous engineering applications. It can be used in non-destructive testing of engineering material, for example, locating rebar in concrete structures and determining the thickness of concrete and other structural material.

GPR is often used in conjunction with magnetometer surveys. Magnetometer Surveys are very fast and large areas can be covered cost effectively. Often, magnetic anomalies can be marked in the field, then can be further investigated using ground penetrating radar.

Under some conditions, although a UST itself may not be clearly visible in a GPR record, the excavation or trench in which the UST is buried is evident. When combined with other complimentary data, such as magnetometer data, it is safe to assume that a GPR “trench” with no clear GPR UST reflection, combined with a large “tank-shaped” magnetic anomaly indicates the presence of a UST.

ADVANTAGES

GPR provides continuous records along traverses which, depending on the goal of the survey, may be interpreted in the field.

In clean, dry, sandy soil, reflections from targets as deep as 100 feet are possible.

At flat, open sites, for reconnaissance purposes, the antenna can be towed behind a vehicle at several mph.

Many GPR antennas are shielded and are unaffected by surface and overhead objects and power lines.

The resolution of data is very high particularly for high frequency antennas.

GPR can be used in conjunction with magnetic or EM surveys to accurately locate buried objects.

Even under adverse site conditions, shallow, man-made objects generally can be detected.

Fiberglass UST’s can be detected using GPR.

LIMITATIONS

Subsurface objects can be detected but, in general, they cannot be identified. USTs and utilities have a characteristic reflection, however, large rocks and boulders have a similar reflection.

The reflection visible in a GPR record is very complex and may be caused by small changes in the electrical properties of the soil. The target in mind may not produce it.

Other methods may be necessary to aid in the interpretation of the data (use a magnetometer to detect a large metallic mass, then GPR to determine if the object is tank-like, or a utility locator to determine if there are feed lines and fill pipes leading to the object).

Penetration of the GPR signal is "site specific" and its depth of penetration at a particular site cannot be predicted ahead of time. Near surface conductive material, such as salty or contaminated ground water and wet, clay-rich soil, may attenuate the radar signal, limiting the effective depth of the survey to several feet.

Adequate contrast between the ground and the target is required to obtain reflections. UST's may be missed if they are badly corroded.

To determine the depth to an object without "ground truth", assumptions must be made regarding soil properties.

GPR may not be cost-effective for some projects. For a detailed survey mapping underground storage tanks and utilities, it may be necessary to collect data in orthogonal directions at 5-foot line spacing.

To acquire the highest quality data, proper coupling between the antenna and the ground surface is necessary. Poor data may be obtained at sites covered with tall grass and brush.

APPENDIX C
TERRAIN CONDUCTIVITY SURVEYS

Electromagnetic induction surveying is a surface geophysical technique used to measure the electrical conductivity of subsurface soils, rocks, and groundwater. The basic principle of operation of the electromagnetic method is shown in the figure below. A transmitter coil radiates an electromagnetic field that induces circular electrical currents (termed eddy currents) in the earth below the coil. These eddy currents in turn generate a secondary magnetic field. Both the primary field and the secondary field are detected by a receiver coil, and the instrument converts the ratio of the two magnetic fields to a measurement of the apparent conductivity (terrain conductivity) of the subsurface. The terrain conductivity represents the cumulative subsurface conductivity from the ground surface to the effective depth of exploration of the instrument.

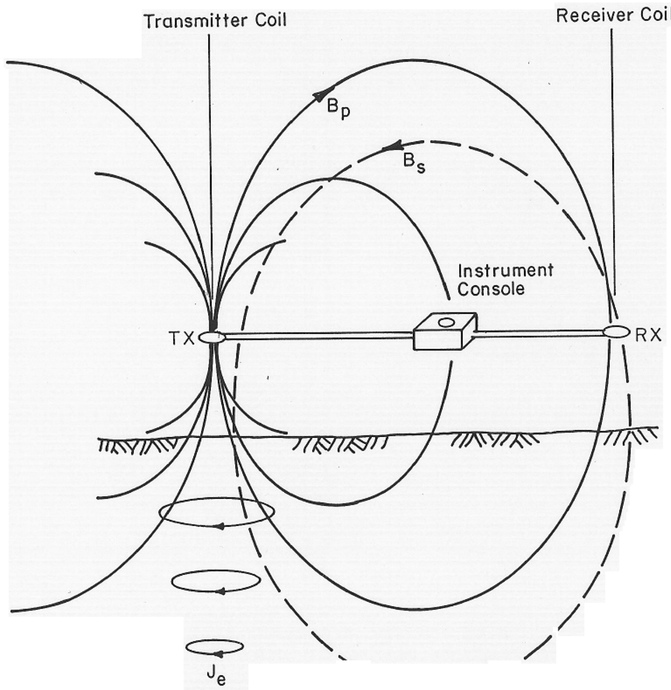
Since in most cases the soil- and rock-forming minerals are electrical insulators, subsurface conductivity arises principally from the flow of electrical currents through the moisture-filled pore spaces within the soil and rock matrix.

The three most important factors affecting terrain conductivity measurements are the following: 1 - Porosity of the subsurface material, 2 - Degree of saturation and 3-Concentration of dissolved electrolytes in the pore fluids.

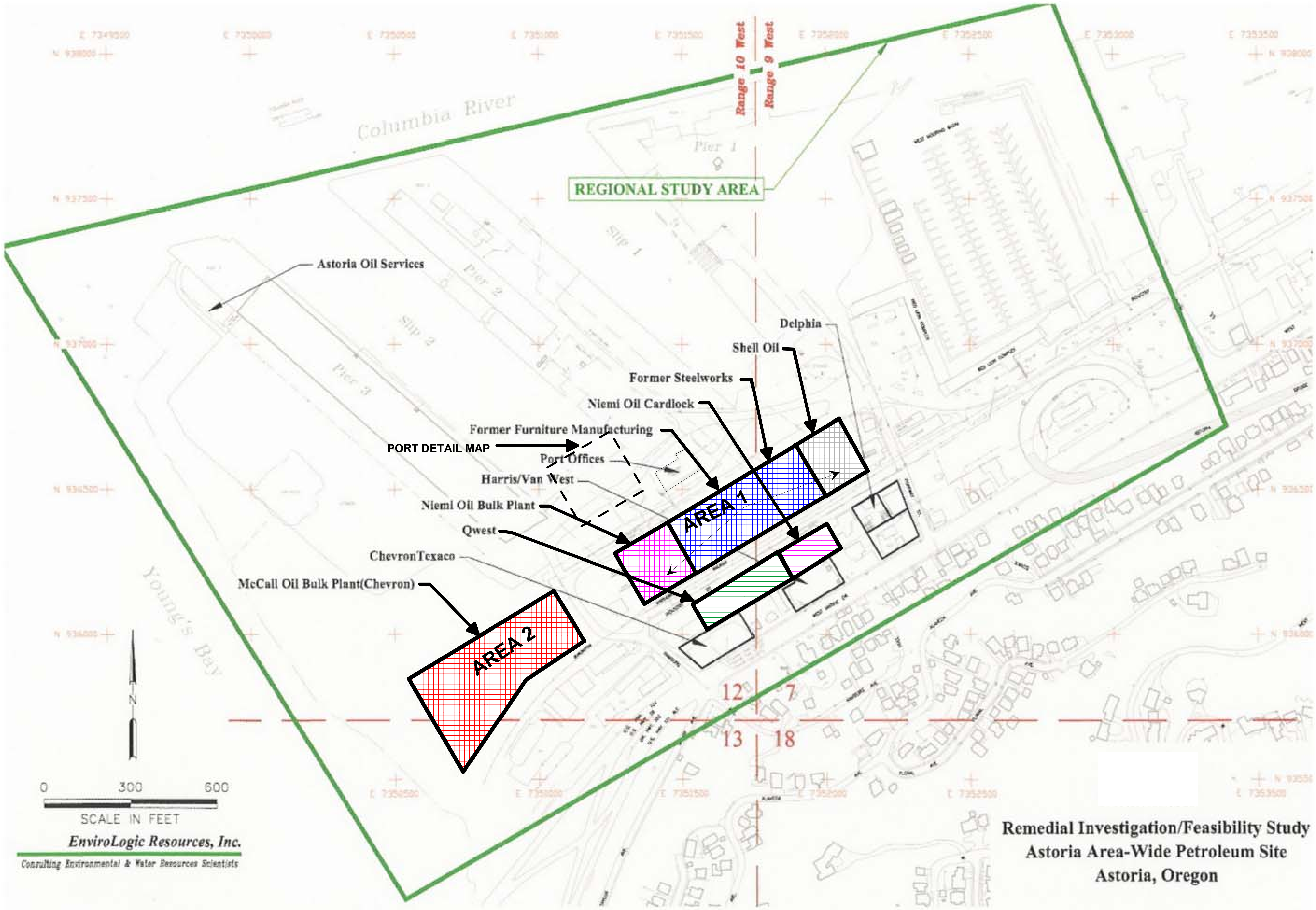
Subsurface conductivity is also influenced by soil type because of the effects of soil particle size and shape on the geometry of the flow paths that electrical currents must follow around the insulating soil particles. Conductivity generally increases with decreasing particle size due to a more direct current path in finer-grained soils. Thus, silty soils tend to be more conductive than clean sands and gravels. As soil grain size decreases even further to that of the true clays, an additional increase in conductivity (termed ionic conduction) arises due to the large numbers of exchangeable ions that are held on the surface of clay particles.

While it is apparent from the discussion above that terrain conductivity is a complex function of a number of subsurface parameters, it often turns out that the conductivity (specific conductance) of the pore fluids dominates the measurement. This has been found to be particularly true near older unlined landfills, due to large quantities of electrolytes that are added to the unsaturated and saturated zones by leachates emanating from the landfill materials. The geophysical contrast, which these inorganic salts provide has been found to be very useful at a large number of sites for mapping the shape of groundwater contamination, plumes emanating from the landfills.

The electromagnetic induction method is generally not capable of mapping contamination from organic sources, in that organic materials act electrically as insulators. It is often found, however, that the inorganic contaminant plume is an excellent guide to the configuration of the organic contamination plume due to common geologic controls. Thus, EM mapping results are not the final word in terms of definition of groundwater contamination, but they do provide a rapid and cost effective method for locating problem areas and guiding more direct sampling methods.



The portable electromagnetic induction unit creates a primary field Bp that induces eddy currents Je In the ground. These in turn produce a secondary magnetic field Bs. The ratio Bs/Bp is indirectly measured by the receiver and is related to the ground conductivity.



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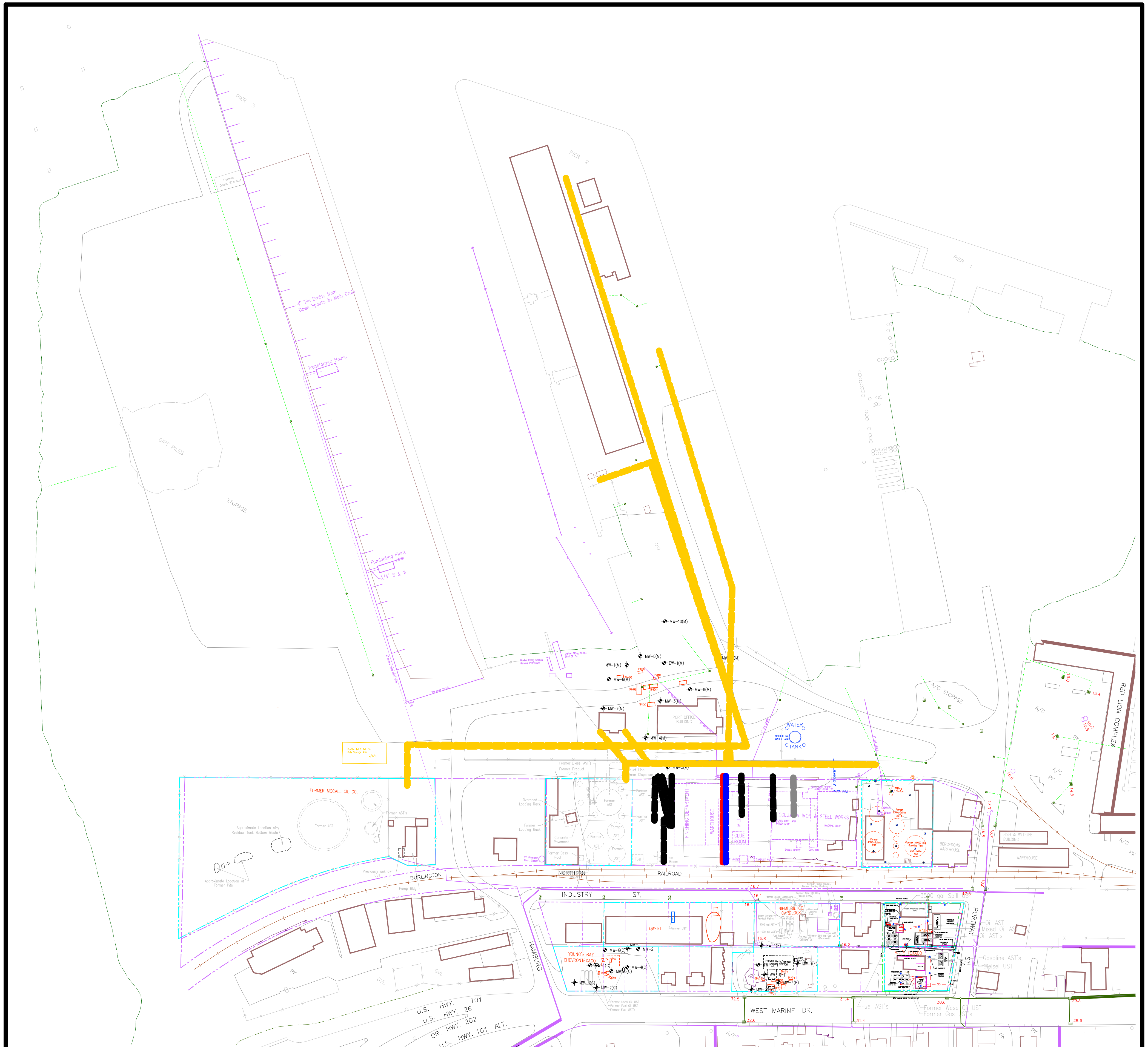
DATE: September 16, 2002 SUBSURFACE MAPPING SURVEY PROJECT No. 4154	CLIENT: EnviroLogic Resources, Inc.	



LEGEND

UNDERGROUND POWER/ELECTRICAL CABLE

PRODUCT LINE

WATER LINE

SEWER LINE

UTILITY LINE

500 FEET

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FIGURE 2.
PRODUCT LINE/UTILITY MAP

CLIENT: **EnviroLogic Resources, Inc**

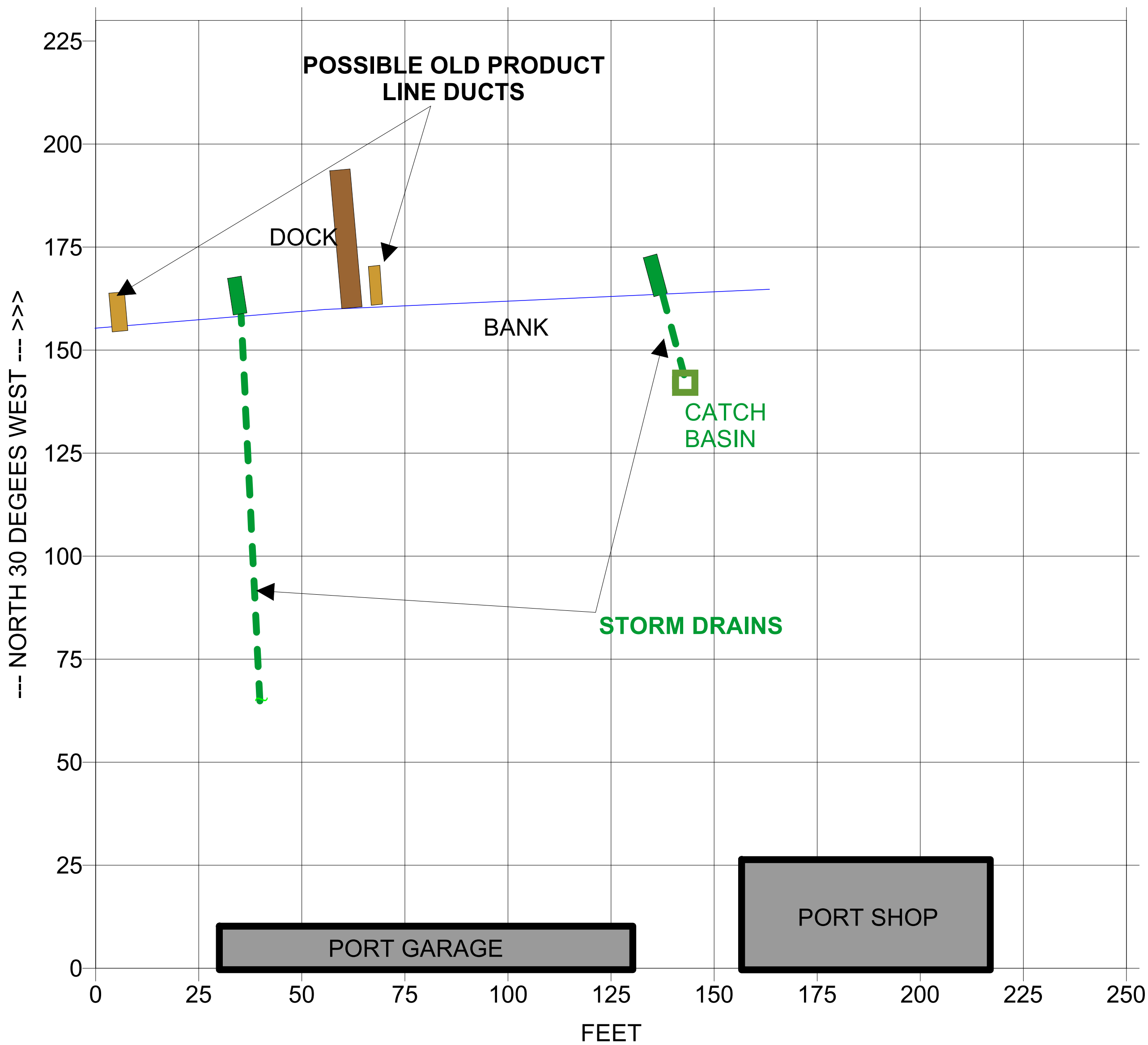

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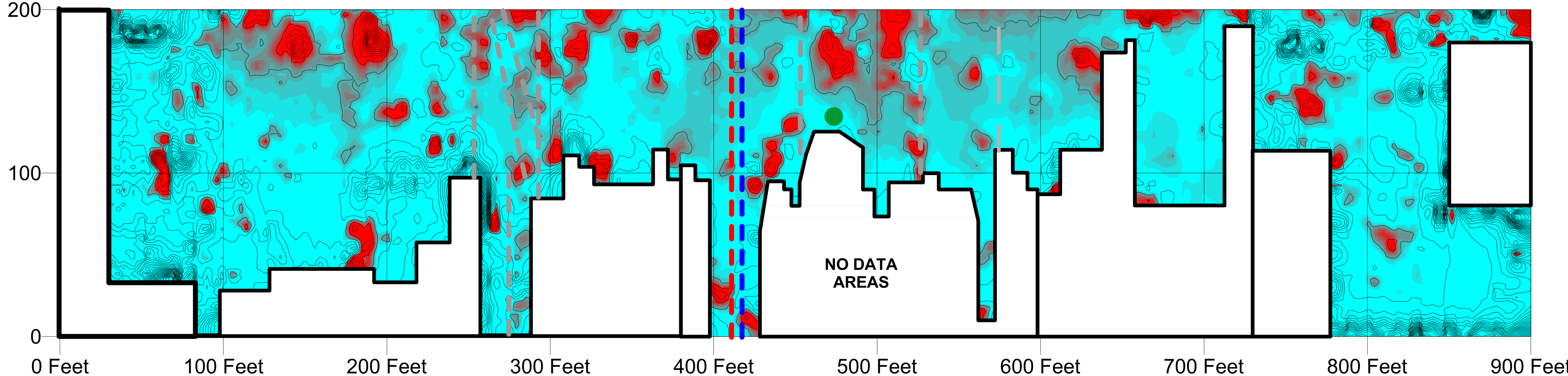
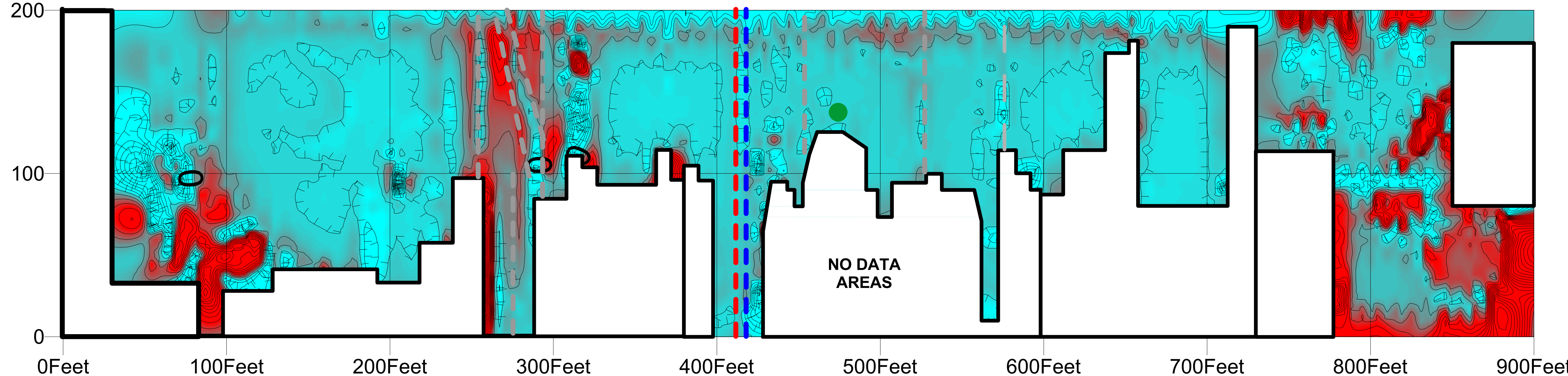
FIGURE 3.
PORT DETAIL MAP

MAGNETIC MAP (CI = 1,000 nT)



EM CONDUCTIVITYMAP (CI = 25 mS/M)



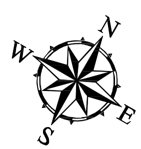


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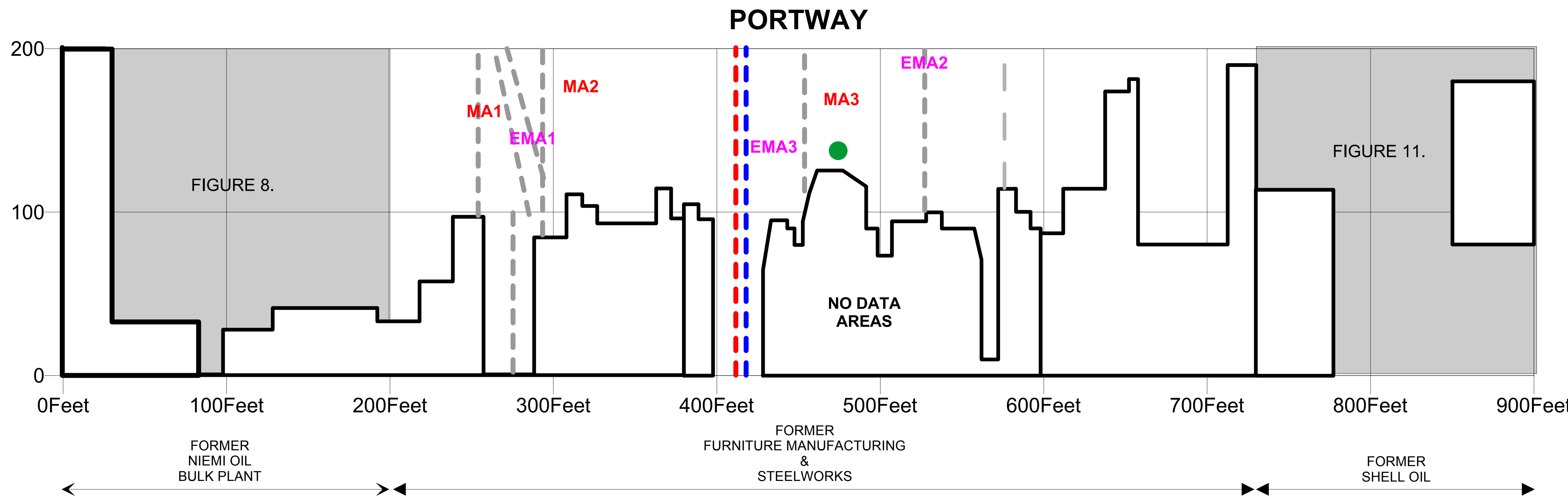
FIGURE 4.
AREA 1
TOTAL MAGNETIC INTENSITY MAP
&
EM31 CONDUCTIVITY MAP



LEGEND

- UNDERGROUND POWER/ELECTRICAL CABLE
- UNDERGROUND COMMUNICATION CABLE
- NATURAL GAS LINE
- WATER LINE
- SEWER LINE
- UTILITY LINE
- MA1 MAGNETIC ANOMALY
- EMA1 CONDUCTIVITY ANOMALY

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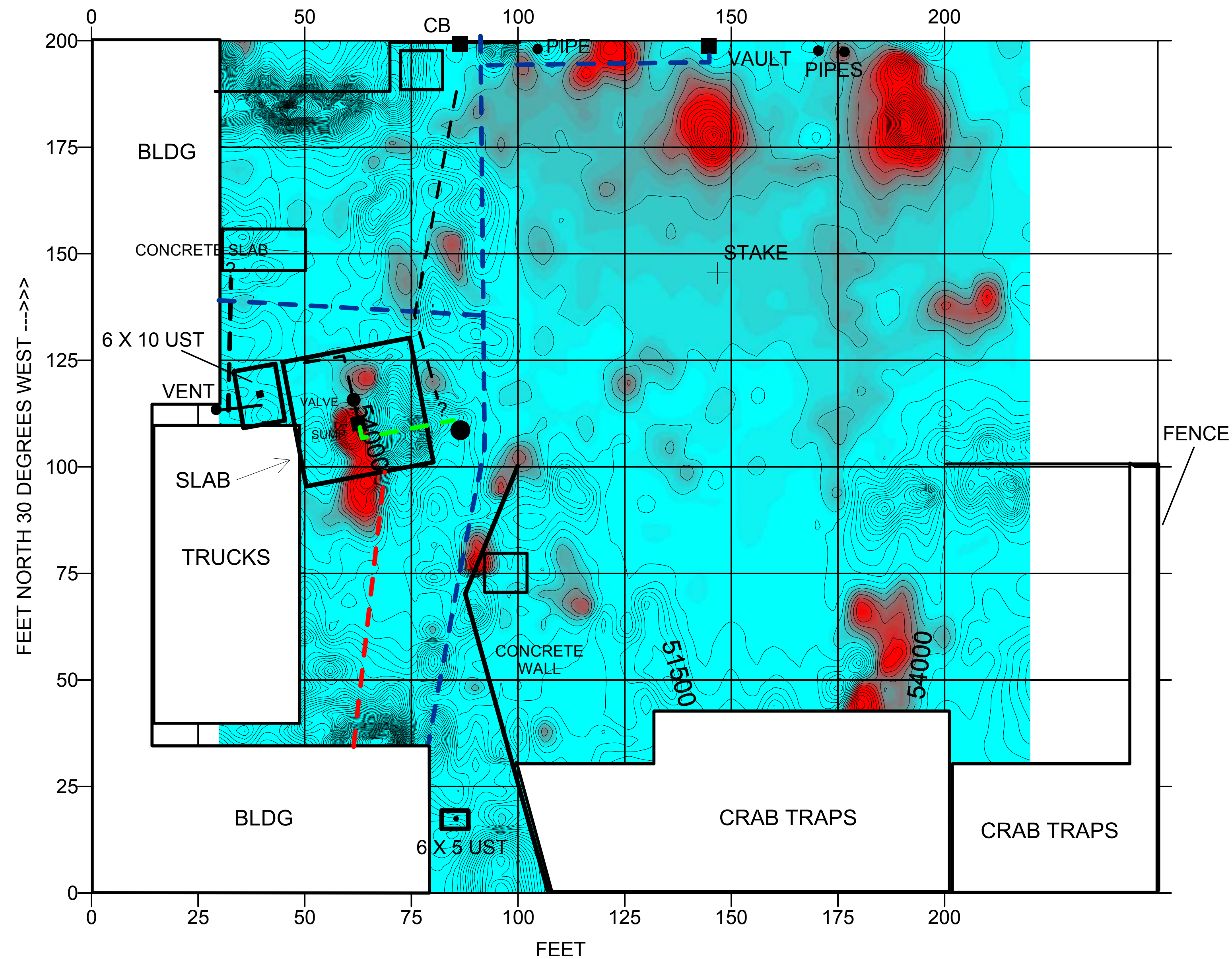
FIGURE 5.
AREA 1
INTERPRETATION MAP



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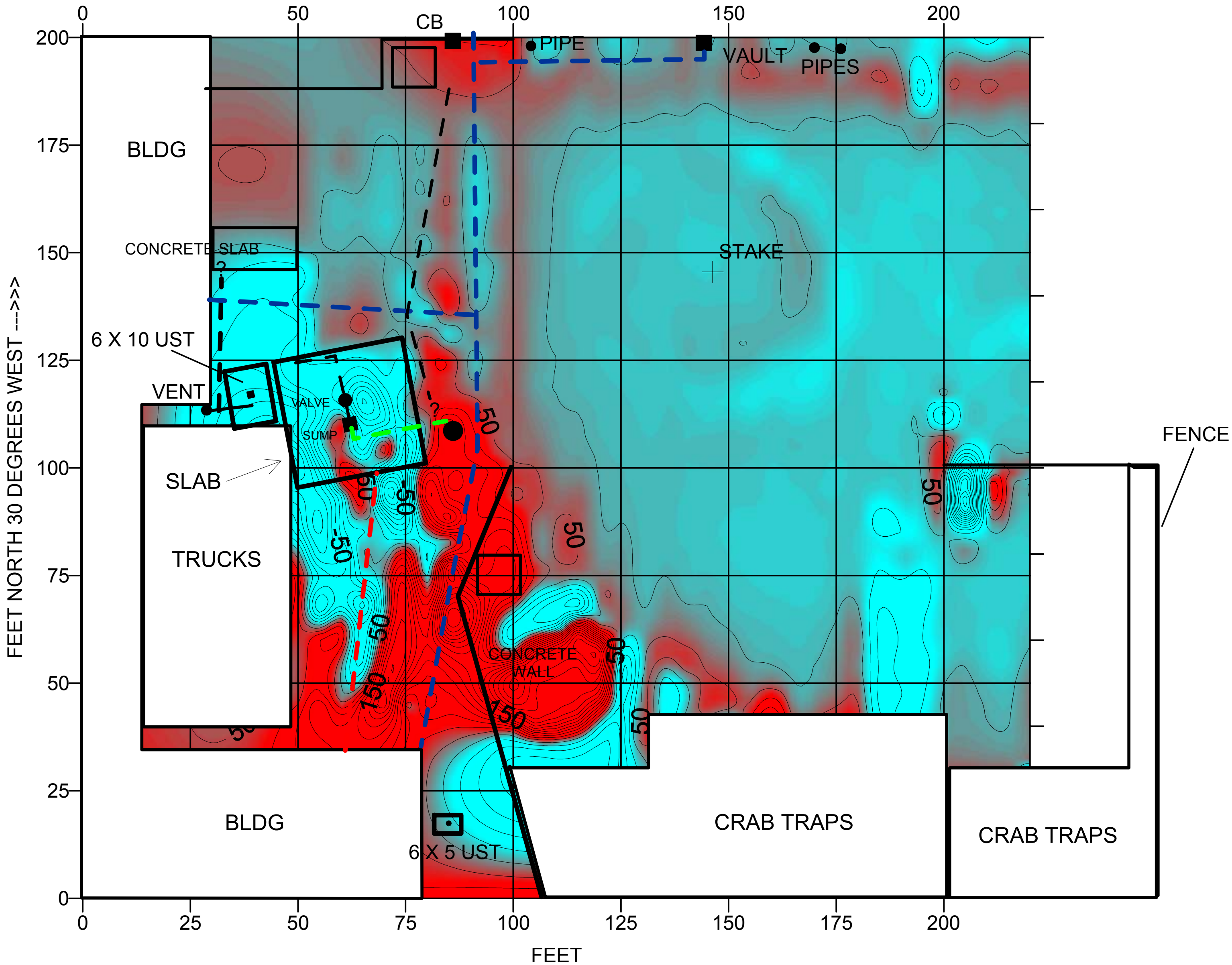

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FIGURE 7.
NIEMI OIL BULK PLANT
EM31 CONDUCTIVITY MAP
(C.I. = 20 mS/M)

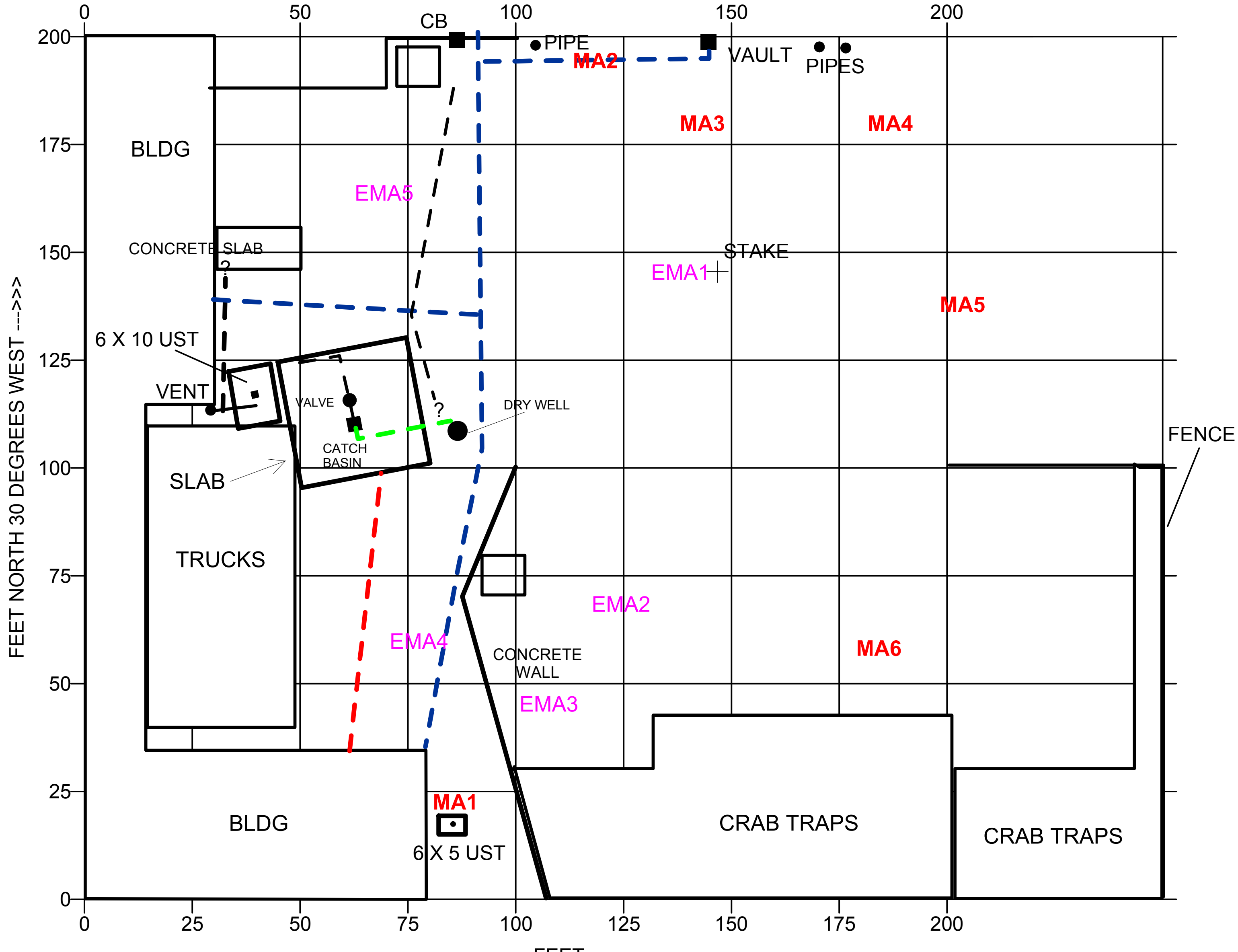

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FIGURE 8.
NIEMI OIL BULK PLANT INTERPRETATION MAP

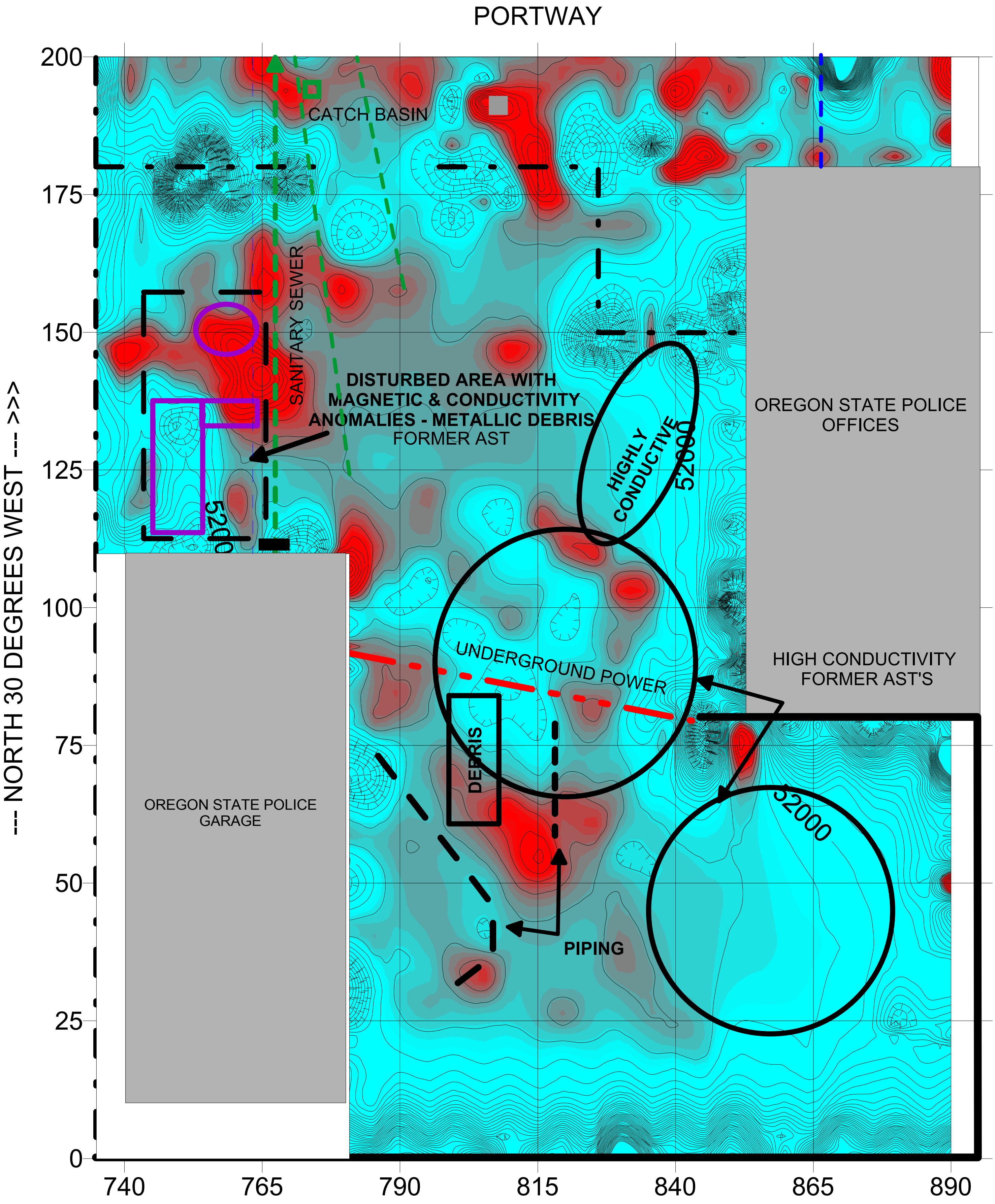

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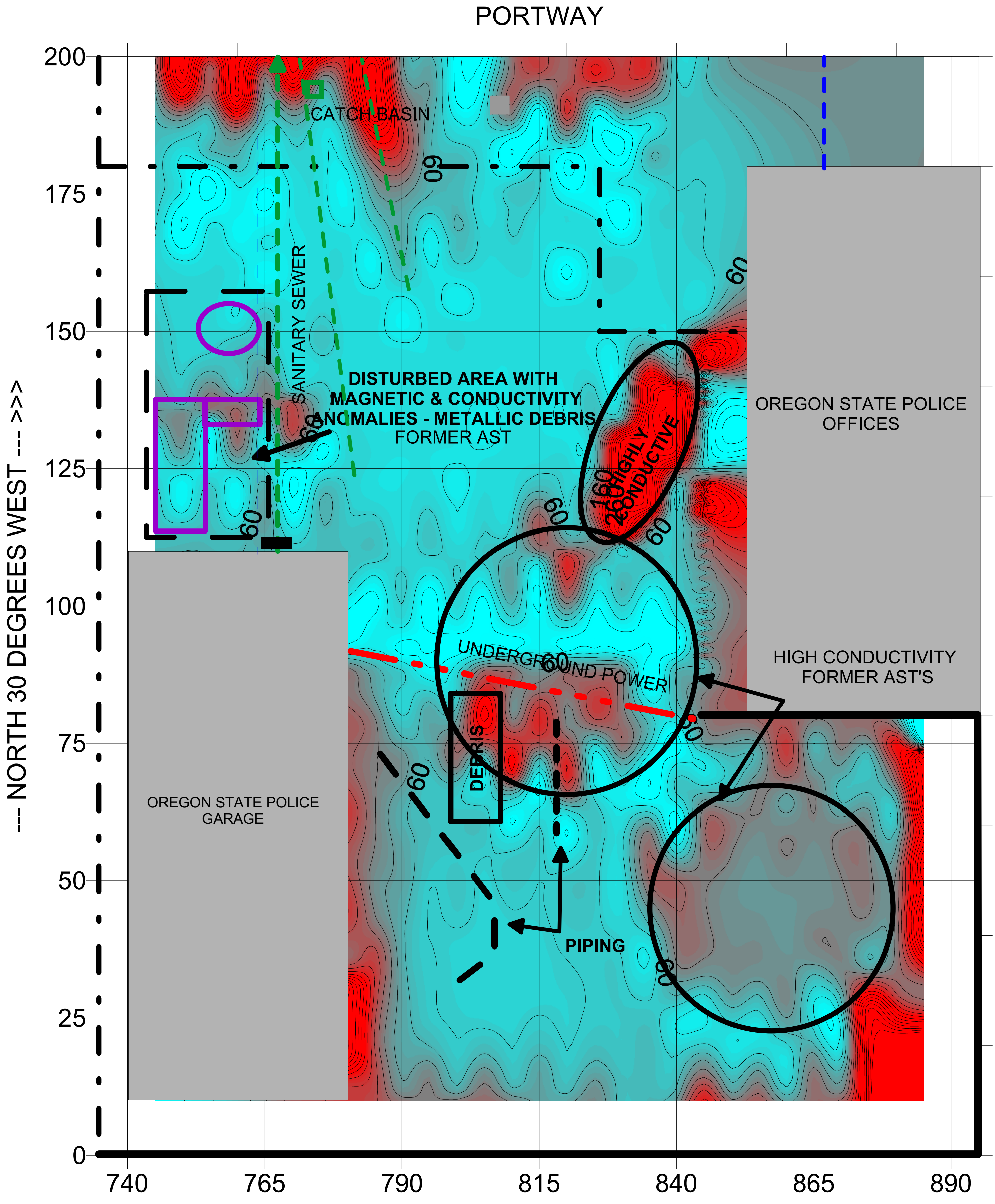
FIGURE 9.
SHELL OIL
MAGNETIC MAP
(C.I. = 500 nT)



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LOCATION: Astoria Area-Wide Petroleum Site, Astoria Oregon	CLIENT: Enviroogic Resources, Inc.		FIGURE 10. SHELL OIL EM31 CONDUCTIVITY MAP (C.I. = 20 mS/M)

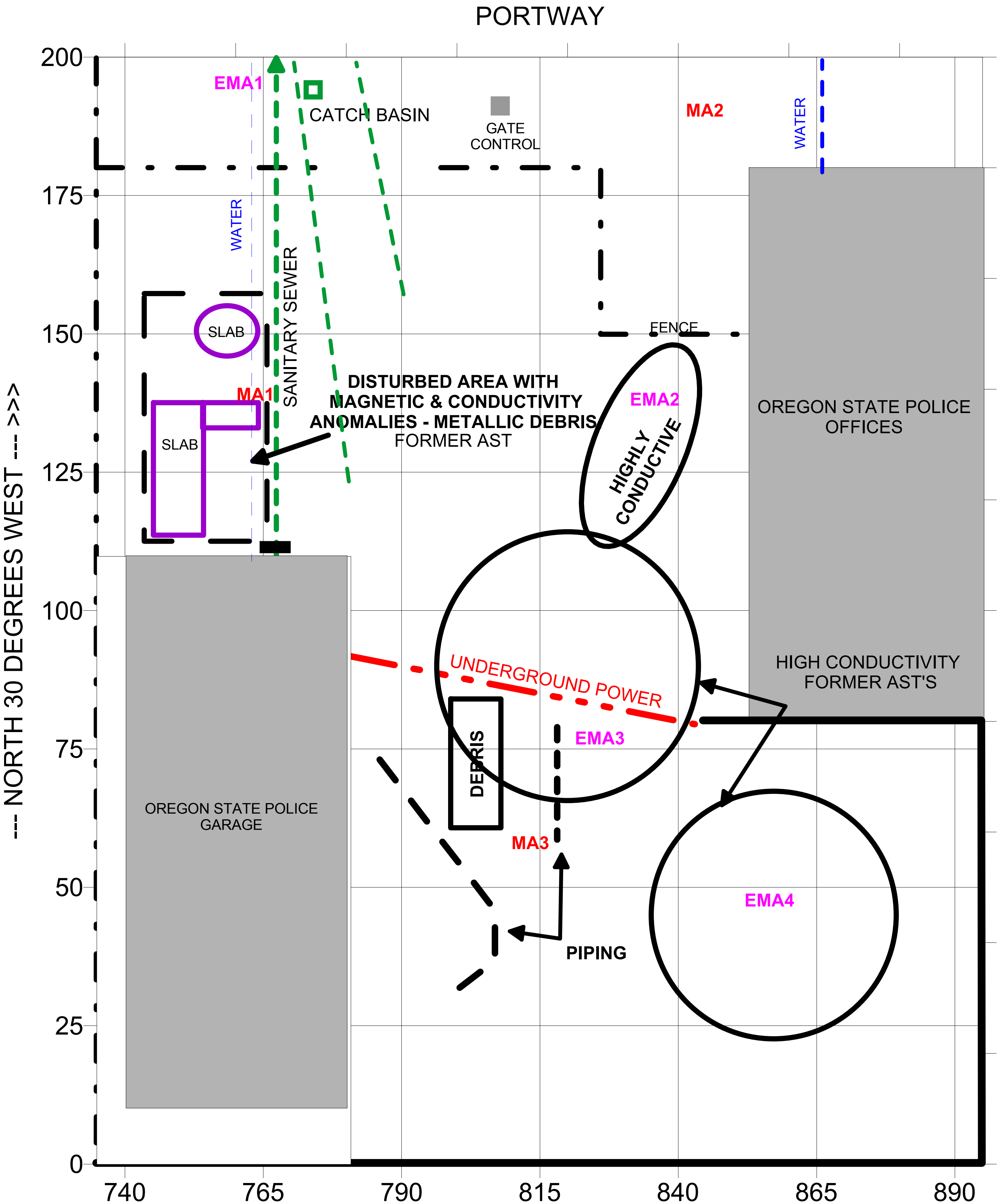

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FIGURE 11.
SHELL OIL
INTERPRETATION MAP

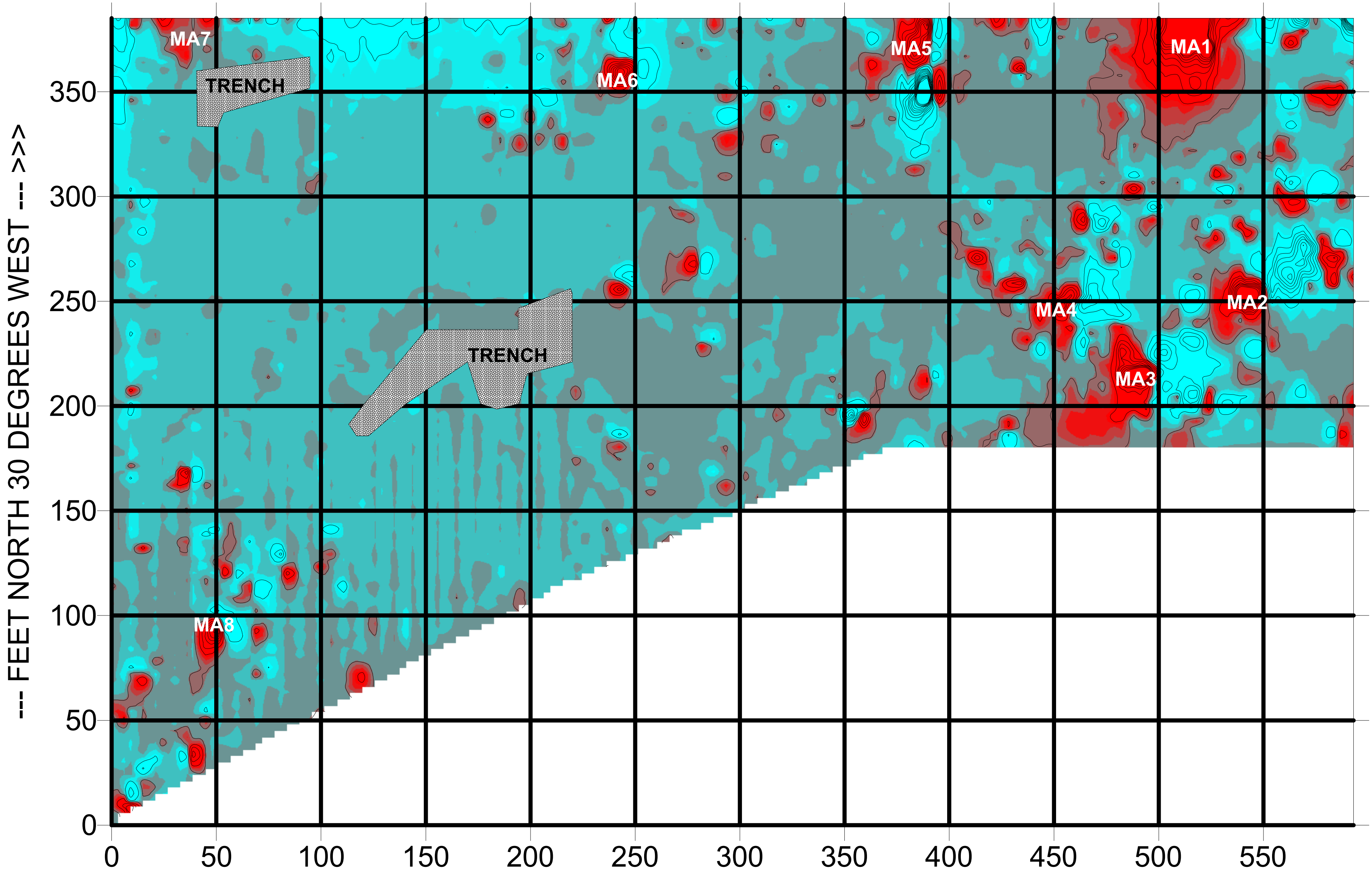

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FIGURE 12.
MCCALL OIL BULK PLANT
MAGNETIC MAP (C.I. = 500 nT)

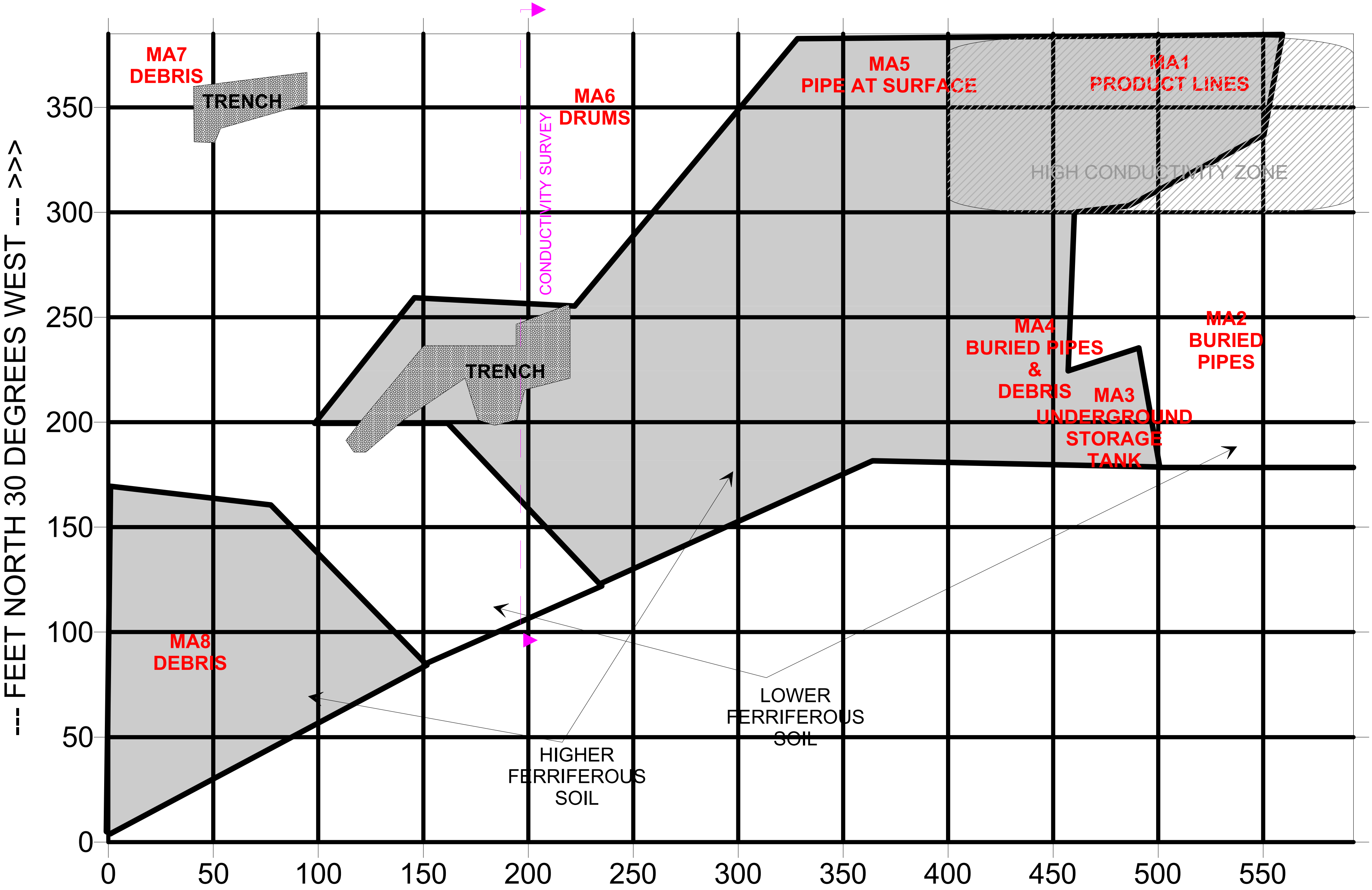

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FIGURE 13.
MCCALL OIL BULK PLANT
INTERPRETATION MAP