PACIFIC GEOPHYSICS

Applied Geophysics

GEOPHYSICAL SURVEY REPORT

SURVEY TO DETECT UNDERGROUND POSSIBLE DRYWELLS

FORMER JIFFY LUBE
6317 EAST FOURTH PLAIN BOULEVARD
VANCOUVER, WASHINGTON

Project number: 090105
Survey Date: February 3, 2009

Prepared for:
PBS Environmental

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Introduction

Pacific Geophysics conducted a geophysical survey across portions of the former Jiffy Lube lot located at 6317 East Fourth Plain Boulevard in Vancouver, Washington, for PBS Environmental.

The objective of the survey was to detect possible drywells connected to two catch basins seen on the property. Ground-penetrating radar (GPR) and several hand-held instruments were used to investigate the catch basins.

This report includes descriptions of the site and scope of work, methodology and results of the geophysical survey.

It appears that both catch basins are connected to one drywell; however, a short length of the pipe exiting the north catch basin could not be detected with certainty due to the reinforced floor under a metal shed. The configuration of the detected pipes suggests they are connected.

Site Description

The site is located at 6317 East Fourth Plain Boulevard (Figure 1). The survey covered the area south of the building and the area around the catch basin to the north of the building.

The survey area was asphalt-covered except the westernmost portion just beyond the parking lot. A storage shed with metal walls covered a reinforced concrete pad southeast of the main building.

No surface patches indicated the locations of drywells. A site diagram from an old investigation provided by the client, suggested there was no drywell adjacent to the north catch basin.

Scope of Work

The scope of this project included detecting drywells connected to two catch basins.

Jeff Mann and Nikos Tzetos of Pacific Geophysics conducted the survey for PBS Environmental, on February 3. Ms. Marsha Walker of PBS Environmental was on site during the survey. This report was written by Nikos Tzetos, reviewed by Jeff Mann and sent to Ms. Walker on February 4, 2009.

Geophysical Equipment and Survey Procedures

Hand-held instruments:

An Aquatronics A6 Tracer and a Schonstedt GA92XTd magnetic gradiometer were used to locate outflow pipes and possible metallic fittings on the drywells themselves. A Radio Detection RD8000 PDL was used to trace an electrician's "fish" tape inserted in the outflow pipes of each catch basin.

GPR survey:

A GSSI SIR-2000 GPR system with a 270-MHz antenna was used for this survey.

GPR traverses were used to follow outflow pipes and were taken over the areas suspected to be the drywell locations.

Additional information describing these instruments, methods and surveys with references, can be found in the Appendix.

Results

Figure 2 is a site diagram of the survey results.

The southern catch basin's outflow pipe was traced to the west for 9 feet with the fish tape and the RD8000. Subsequent radar profiles indicated a disturbed soil zone and void, interpreted to be a possible drywell. Later excavation confirmed the interpretation. Two inflow pipes were seen inside the east wall of the drywell.

The outflow pipe from the north catch basin was traced with the fish tape and the RD8000 toward the south and the shed. Interference from buried electrical service lines caused the signal from the fish tape to be lost several feet north of the shed. The signal could not be detected under the shed floor because of interference from the reinforcement. Radar profiles made inside the shed showed a possible pipe but the data were of low quality.

Radar profiles east of the south catch basin showed a pipe extending from the vicinity of the drywell, toward the northeast. It could not be detected adjacent to the shed. It is inferred that this pipe connects to the pipe from the north catch basin suggesting both catch basins share the same drywell. Radar profiles were taken in the grassy strip north of the drywell. A second drywell was not detected there.

Profiles in the driveway east of the shed showed a pipe similar to the one seen east of the south catch basin. This pipe extended toward the restaurant to the east and lined up with the previous pipe. It is not certain the pipes are connected. It is possible that the restaurant's storm system drains to the same drywell.

Conclusion

It was determined that one drywell is connected to both catch basins. The neighboring business' storm system may be draining into the same drywell.

Limitations

The conclusions presented in this report were based upon widely accepted geophysical principles, methods and equipment. This survey was conducted with limited knowledge of the site, the site history and the subsurface conditions.

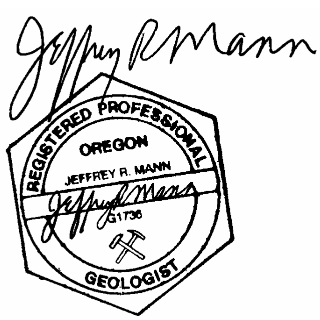
The goal of near-surface geophysics is to provide a rapid means of characterizing the subsurface using non-intrusive methods. Conclusions based upon these methods are generally reliable; however, due to the inherent ambiguity of the methods, no single interpretation of the data can be made. As an example, rocks and roots produce radar reflections that may appear the same as pipes and tanks.

Under reasonable site conditions, geophysical surveys are good at detecting changes in the subsurface caused by manmade objects or changes in subsurface conditions, but are poor at identifying those objects or subsurface conditions.

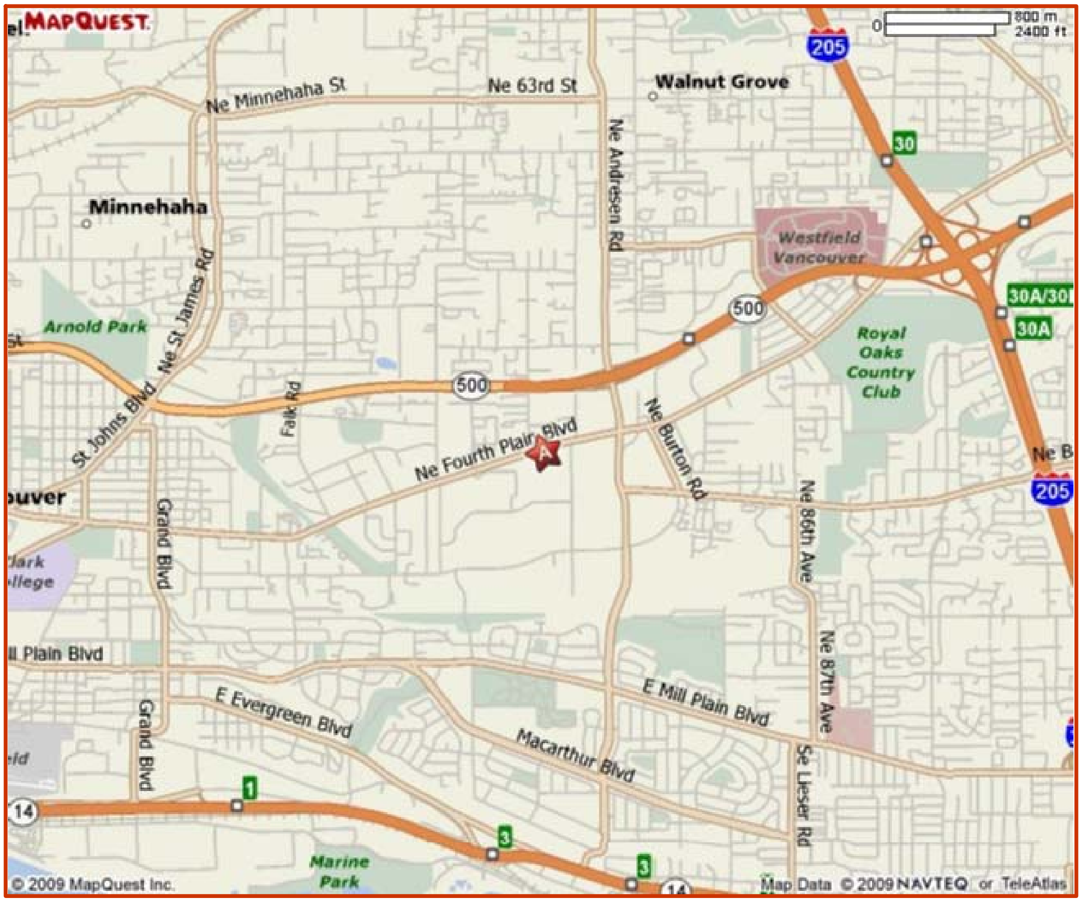
Objects of interest are not always detectable due to surface and subsurface conditions. The deeper an object is buried, the more difficult it is to detect, and the less accurately it can be located.

The only way to see an object is to physically expose it.

Nikos Tzetos — February 4, 2009
Pacific Geophysics



Jeff Mann — February 4, 2009
Pacific Geophysics



PACIFIC GEOPHYSICS Applied Geophysics	FIGURE	Site Location	
	1	Project: 090105	Former Jiffy Lube 6317 East Fourth Plain Boulevard Vancouver, Washington
		Drawn by : NT	Prepared for: PBS Environmental

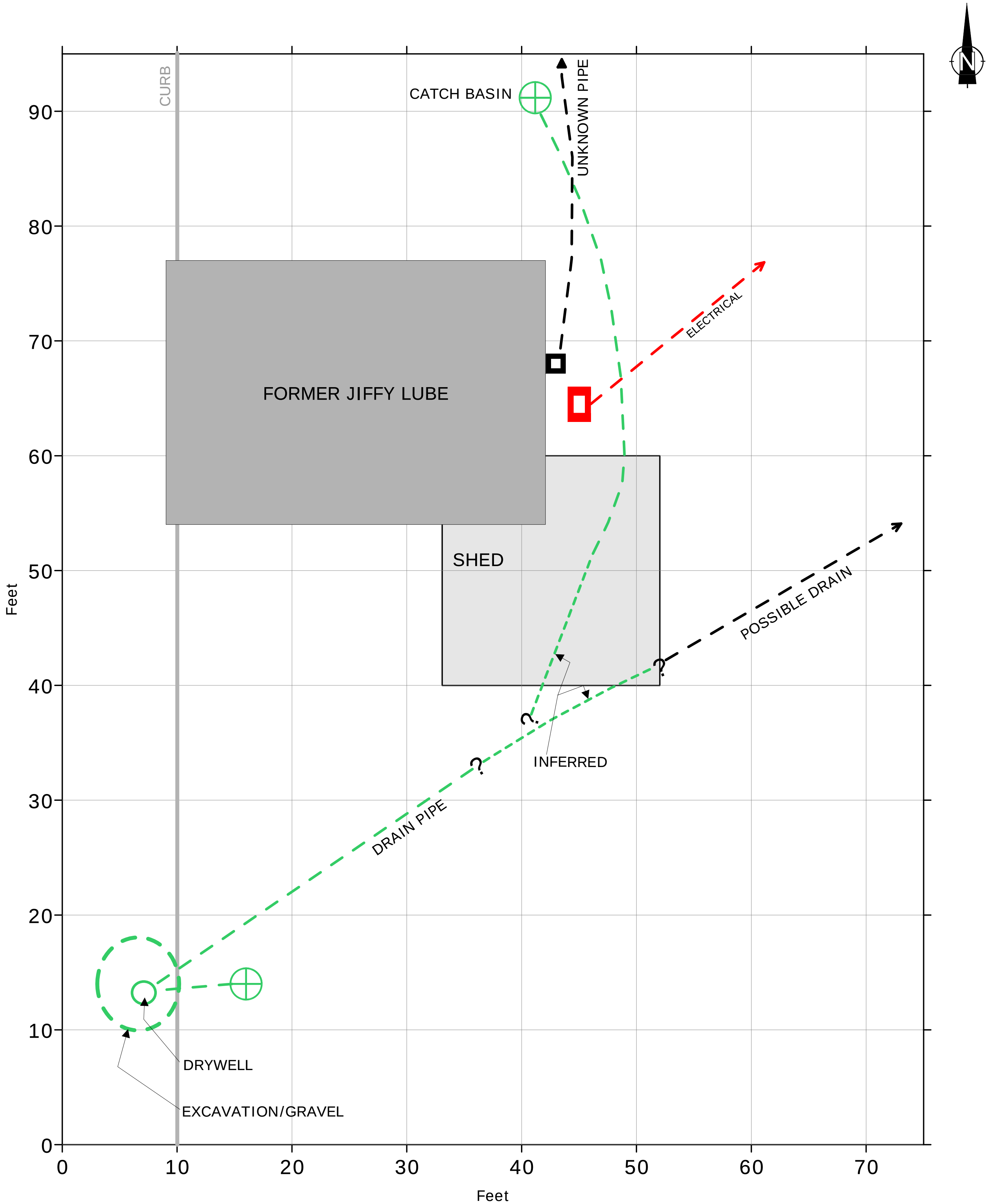


FIGURE	Site Diagram	
2	Project: 090105	Former Jiffy Lube 6317 East Fourth Plain Boulevard Vancouver, Washington
	Drawn by : NT	Prepared for: PBS Environmental

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Appendix A. Geophysical Survey Methods

Magnetometer Surveys

Small disturbances in the Earth's local magnetic field are called "magnetic anomalies". These may be caused by naturally occurring features such as metallic mineral ore bodies, or from manmade features such as metal buildings, vehicles, fences, and underground storage tanks. The magnetometer only detects changes produced by ***ferrous*** objects. Aluminum and brass are non-ferrous metals and cannot be detected using a magnetometer.

A magnetometer is an electronic instrument designed to detect small changes in the Earth's local magnetic field. Over the years different technologies have been used in magnetometers. The Geometrics G-858 Portable Cesium Magnetometer used to collect magnetic data for Pacific Geophysics uses one of the most recent methods to detect magnetic anomalies. A detailed discussion describing the method this unit uses is available at Geometrics.com.

This magnetometer enables the operator to collect data rapidly and continuously rather than the older instruments that collected data at discreet points only. The G-858 is carried by hand across the site. The sensor is carried at waist level. Typically individual data points collected at normal walking speed are about 6" apart along survey lines usually 5 feet apart, depending on the dimensions of the target objects.

It is critical to know the exact location of each data point so that if an anomaly is detected it can be accurately plotted on a magnetic contour map. At most small sites, data are collected along straight, parallel survey lines set up on the site before the data collection stage begins. For very large, complex sites, the G-858 can be connected to a Global Positioning System (GPS) antenna which allows the operator to collect accurately-located data without establishing a survey grid. With GPS, data are collected and positioned wherever the operator walks. A limitation using GPS is that the GPS antenna must have line of sight with the GPS satellites. Data can be mislocated if the GPS antenna is under trees or near tall buildings.

Data are stored in the unit's memory for later downloading and processing. A magnetic contour map of the data is plotted in the field. Geographical features are plotted on the map. Magnetic anomalies appearing to be caused by objects of interest are then investigated on the site using several small handheld metal detectors. If an object appears to be a possible object of interest, it may be investigated with GPR.

Magnetic contour maps may be printed in color in order to highlight anomalies caused by ferrous objects located under the magnetic sensor. Usually, ferrous objects situated below the sensor produce magnetic "highs" and anomalies located above the sensor produce magnetic "lows". Magnetic highs are of interest to the operator since most objects of interest are located underground.

Magnetometer surveys have limitations. Magnetometers only detect objects made of ferrous (iron-containing) metal. Large ferrous objects (buildings, cars, fences, etc.) within several feet of the magnetometer create interference that may hide the anomaly produced by an object of interest.

Ground Penetrating Radar

A Geophysical Survey Systems, Inc (GSSI) SIR-2000 GPR system coupled to a 270-MHz GSSI antenna was used to obtain the radar data for this project.

The 270-MHz radar antenna used for this survey is designed to transmit and receive electromagnetic energy. EM energy is transmitted into the material the antenna passes over. A portion of that energy is reflected back to the antenna and amplified. Reflections are displayed in real-time in a continuous cross section. Reflections are produced where there is a sufficient electrical contrast between two materials. Changes in the electrical properties (namely the dielectric constant) that produce radar reflections include the moisture content, porosity, mineralogy, and texture of the material. Metallic objects of interest exhibit a strong electrical contrast with the surrounding material and thus produce relatively strong reflections. Non-metallic objects of interest (septic tanks, cesspools, dry wells, PVC and clay tile pipes) are not always good reflectors.

Radar data are ambiguous. It can be difficult to distinguish the reflection produced by an object of interest from the reflection caused by some natural feature. Rocks or tree roots have reflections that appear similar to reflections from pipes. In concrete investigations reflections produced by metal rebar look exactly like those from electrical conduit or post-tension cables. Objects with too small an electrical contrast may produce no reflections at all and may be missed.

In addition to interpreting ambiguous data, radar has several limitations that cannot be controlled by the operator. The radar signal is severely attenuated by electrically conductive material, including wet, clay-rich soil and reinforced concrete. The quality of the data is affected by the surface conditions over which the antenna is pulled. Ideally the antenna should rest firmly on a smooth surface. Rough terrain and tall grass reduce the quality of radar data.

It is the job of an experienced interpreter to examine the GPR profiles and deduce if reflections are from objects of interest. A GPR interpreter cannot see underground, but can only interpret reflections based on experience.

The only way to truly identify an object is to excavate.

Handheld Metal detectors

Two small, non recording metal detectors are used to locate suspect magnetic anomalies detected using the G-858 Magnetometer in order to determine the likely cause of the anomaly. First, the magnetic contour map and a Schonstedt Magnetic Gradiometer are used to locate the center of the magnetic anomalies.

Once the anomaly is located an Aqua-Tronics Tracer is used to determine if the object producing the anomaly is a possible object of interest. Most anomalies are at least in part produced by features observed on the ground surface.

Schonstedt Magnetic Gradiometer: This magnetometer has two magnetic sensors separated vertically by 10”. The magnetic field surrounding a ferrous object is strongest near the object and decreases rapidly as the distance increases. If the magnitude measured by the sensor located in the tip of the Schonstedt is very high, and the magnetic field measured by the sensor located farther up the shaft of the

Schonstedt is low, there is a large vertical magnetic gradient and the instrument responds with a loud whistle indicating the object is near the surface. If there is a small difference in the magnitudes measured by the two sensors, the object is deeper. The instrument responds with a softer tone. A discussion of this instrument is available at Schonstedt.com.

Aqua-Tronics A-6 Tracer: The Aqua-Tronics A-6 Tracer uses a different method of detecting metallic objects. This instrument measures the electrical conductivity of a metal object. It is capable of detecting any electrically conductive metal, including non-ferrous aluminum and brass. The Tracer is capable of detecting three-dimensional objects as well as pipes.

The Tracer consists of a transmitter coil and a receiver coil. In the absence of any electrically conductive material in the vicinity of the Tracer, the electromagnetic field around each coil is balanced.

Basically the electromagnetic field produced by the transmitter induces an electric current into the area surrounding the instrument. Nearby conductive objects distort the EM field. The balance between the two coils is disturbed and the instrument produces an audible tone and meter indication.