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Mr. Joshua Cook
New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 625 Broadway, 11th Floor
Albany, New York 12233-7014

Subject:
Induced Polarization (IP) – Electrical Resistivity (RES) Work Plan
Port Jervis Former Manufactured Gas Plant (MGP) Site
City of Port Jervis, Orange County, New York
Site No. 3-36-049

ENVIRONMENT

Date:
January 28, 2010

Contact:
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Our ref:
B0043021

Dear Mr. Cook:

This letter presents the *Induced Polarization (IP) – Electrical Resistivity (RES) Work Plan* (IP-RES Work Plan) which will be conducted to supplement the pre-design investigation (PDI) activities at the above-referenced site. The IP-RES Work Plan will be implemented by ARCADIS on behalf of Orange and Rockland Utilities, Inc. (O&R). As previously discussed with the New York State Department of Environmental Conservation (NYSDEC) during a November 16, 2010 meeting and December 10, 2010 webinar, IP-RES are surface geoelectrical investigation methods that can provide information on subsurface lithology and the delineation of accumulations of non-aqueous phase liquids (NAPL). Surveys can be performed in two-dimensions (2-D) by single linear cables and electrodes along the surface or in three-dimensions using an orthogonal grid cable and electrode layout.

The IP-RES survey at the Port Jervis site will consist of three 2-D transects located within/along the privately-owned properties located to the south (across Pike Street) of the former manufactured gas plant (MGP) site – namely, Tax Parcels 18-14-8.2 and 18-14-9.11 (the Meder properties; Figure 1). In addition, and as described below, a calibration transect will be performed on the O&R-owned Operations Center property. Please note that the transect locations and lengths may be subject to change based on field conditions and property access.

Theoretical Basis of Technology

The RES method involves the measurement of the apparent resistivity of subsurface soils and rock as a function of depth and/or position. The resistivity of soils and rock is a complicated function of porosity, permeability, ionic content of the pore fluids, and clay mineralization.

During a resistivity survey, current is injected into the earth through a pair of current electrodes and the potential difference (voltage) is measured between one or more pairs of adjacent potential electrodes. The current and potential electrodes are generally arranged in a linear fashion with the geometry of the current and potential electrodes being referred to as an array type. Different arrays provide various resolutions and depths of penetration. Depth penetration is a function of the length of the array and is generally from 25 percent to 50 percent of the length. Using combinations of arrays provides more unique imaging of the subsurface. The measured value of a resistivity array is apparent resistivity, which is the bulk average resistivity of all soils and rock influencing the current. It is calculated by dividing the measured potential difference by the input current and multiplying by a geometric factor specific to the array being used and electrode spacing.

While electrical resistivity is calculated by measuring the injected current, the produced voltage, and the geometry of the electrodes, the derivative technique of IP is a measure of the time in which the produced voltage returns to baseline after the applied current is removed. The IP technique is performed with the same equipment as resistivity and, in addition to measuring resistivity values, measures the time the earth material takes to discharge voltage. IP has been widely used for the location of disseminated mineral deposits because these deposits are generally much more polarizable than the surrounding earth material. IP response can be affected by clay content because many clay minerals are ionic and can be charged. The higher the soil clay content, the more pronounced the IP response.

In the most basic terms, the IP effect is a measure of the earth's ability to store an electrical charge. Upon application of an electrical current, ions along the interface of clay minerals, metals, or in pore fluid align themselves on a path along the electrical current path. Upon termination of the current, the ions will redistribute or relax back to the pre-current conditions. This relaxation is the source of the IP effect. While resistivity equipment measures the magnitude of the electrical conduction, IP measures the magnitude of the ionic shift and the time for the ions to relax back to equilibrium conditions. In soils not impacted by hydrocarbons, the injected current travels through the pore fluid via interconnected pores (permeability) and has minimal interaction with the soil grains. NAPL and near NAPL concentrations of hydrocarbons displace water from soil pores and occlude the pore throat, thus restricting the ability of electrical current to travel through the pore fluid. This restriction causes the charge to spill over onto the adjacent soil grains and polarize the grain itself. When the current is turned off, the polarization of the pore fluid dissipates near instantaneously. However, when the soil grains have been polarized by the restricted pore throat, these areas will take a longer time to dissipate the charge. The IP method maps these areas with higher chargeability. These high chargeability IP anomalies can indicate areas with NAPL accumulation. Areas of

exposed metals such as uncoated piping or particularly, corroded metals, will also produce a significant IP response that can be difficult to discriminate from the response produced by NAPL. A practical way to overcome this is to measure IP in an area with piping but without known NAPL in order to qualitatively remove the contribution made by the metal piping when interpreting data in NAPL-impacted areas.

Proposed Survey Methodology

The 2-D RES and IP data will be acquired along transects across the area of interest (Figure 1). The resistivity equipment used during this investigation will consist of an Advanced Geosciences, Inc. (Austin, Texas), SuperSting™ R8/IP memory earth resistivity system with an 112-electrode switch box, electrode cables with a 3.25-meter connector spacing, and stainless steel electrodes.

While final determination of line locations/lengths will be made in the field based on access and field conditions, generally, the survey lines will be installed with up to 112 electrodes and an inter-electrode spacing of 3-meters. The depth penetration for a dipole-dipole array is approximately 25 percent of the length of the line. Therefore, the depth penetration for each line may vary. Lines lengths of approximately 200 feet will be used to achieve a target depth of 50 to 70 feet below ground surface. In general, the resolution of this technique is approximately 50% of the inter-electrode spacing, so roughly 1.5 square meters will be resolved. However, smaller lithologic features that are closely clustered often appear as a single large unit and are resolvable. The electrodes are high grade stainless steel and are approximately 12 inches long and ¼ inch in diameter. They will be hammered into the ground surface to a depth of 6 to 8 inches and sparingly wetted with a dilute salt solution to improve electrical coupling with the ground surface. The electrodes are then connected to the cables via stainless steel springs at each cable take out. The cables are connected to the SuperSting R8/IP meter via an external switch box. See photographs below.

Once the electrodes and cables are deployed, the survey will begin. The unit is powered by two deep cycle marine batteries. Two types of surveys are planned for each survey line. The first is RES and IP using a dipole-dipole array. The second is the Inverse Schlumberger array which, when combined with the dipole-dipole array, improves the resolution of laterally continuous lithologic features.

Data for each array type will be downloaded and inverted in the field as soon as the survey is complete to evaluate quality assurance before moving the line to a new location. An adaptive approach as to which array types work best will be used for subsequent lines. Once the selection of array parameters is optimized for site conditions, the survey is anticipated to be completed in three to four days by a two-person field crew depending on weather and access.

RES and IP data will be stored in the internal memory of the SuperSting R8/IP and downloaded to a laptop computer upon completion of each survey. Field data files will be assigned a name that includes the site ID and the transect name and array type. Preliminary modeling of the field data will be conducted in the field and completed in the office at a later date.

Quality Assurance/Quality Control

Prior to collecting data along each line, the electrodes and cables undergo a contact resistance test which tests the integrity of each electrode coupling and ensures that the electrical resistance between the electrode and the soil material is appropriate to produce quality RES measurements. The survey will not begin until an adequate contact resistance test is completed. In addition to the above, a “pre-investigation” survey line will installed within the O&R-owned Operations Center property within an area historically observed to contain NAPL (e.g., along the centerline of Gas Holder A). By conducting survey activities along the “pre-investigation” survey line, the equipment will be calibrated based on the IP response for the site-specific NAPL. The location of the “pre-investigation” survey line will be located both within and outside the perimeter of Gas Holder A, where recent soil borings have identified NAPL-impacted soils within the holder.

Upon collection of the data, several QA/QC filters are applied to the data. Measurement points that do not meet these criteria are removed from the dataset. Final graphical representations of the results will show area(s) in which data were removed to provide confidence that the final inverted image was produced with sufficient data coverage. Areas with inadequate data coverage will be designated as questionable for the purpose of interpretation.

Results

Results will be in the form of inverted pseudosections (graphical depictions) for both the RES and IP models. Additionally, distribution maps showing area(s) in which data were removed due to QC filtering will also be provided. O&R will summarize the results on a letter report to DEC within 30 days of completing the survey.

As discussed with NYSDEC, O&R will attempt to verify the results of the IP-RES survey by installing two soil borings within areas potentially containing NAPL (based on the survey results) and two soil borings within areas where NAPL was not shown to be present. Verification activities are anticipated to be accomplished through the installation of the soil borings proposed in the November 2, 2010 *Proposed Modifications to Scope of Remaining PDI Activities*.

Based on the results of the IP-RES survey, and associated level of confidence with the survey results, proposed soil borings on the Meder Property may be relocated or additional locations proposed. The scope of such modifications will be agreed upon with NYSDEC prior to implementation.

Please feel free to contact Maribeth McCormick of O&R at 845.783.5534 with any questions or comments regarding the enclosed documents.

Sincerely,

ARCADIS of New York, Inc.

Boyce Clark/ACE

Boyce Clark, PhD
Principal Geologist

Andrew Corbin, P.E.
Principal Engineer

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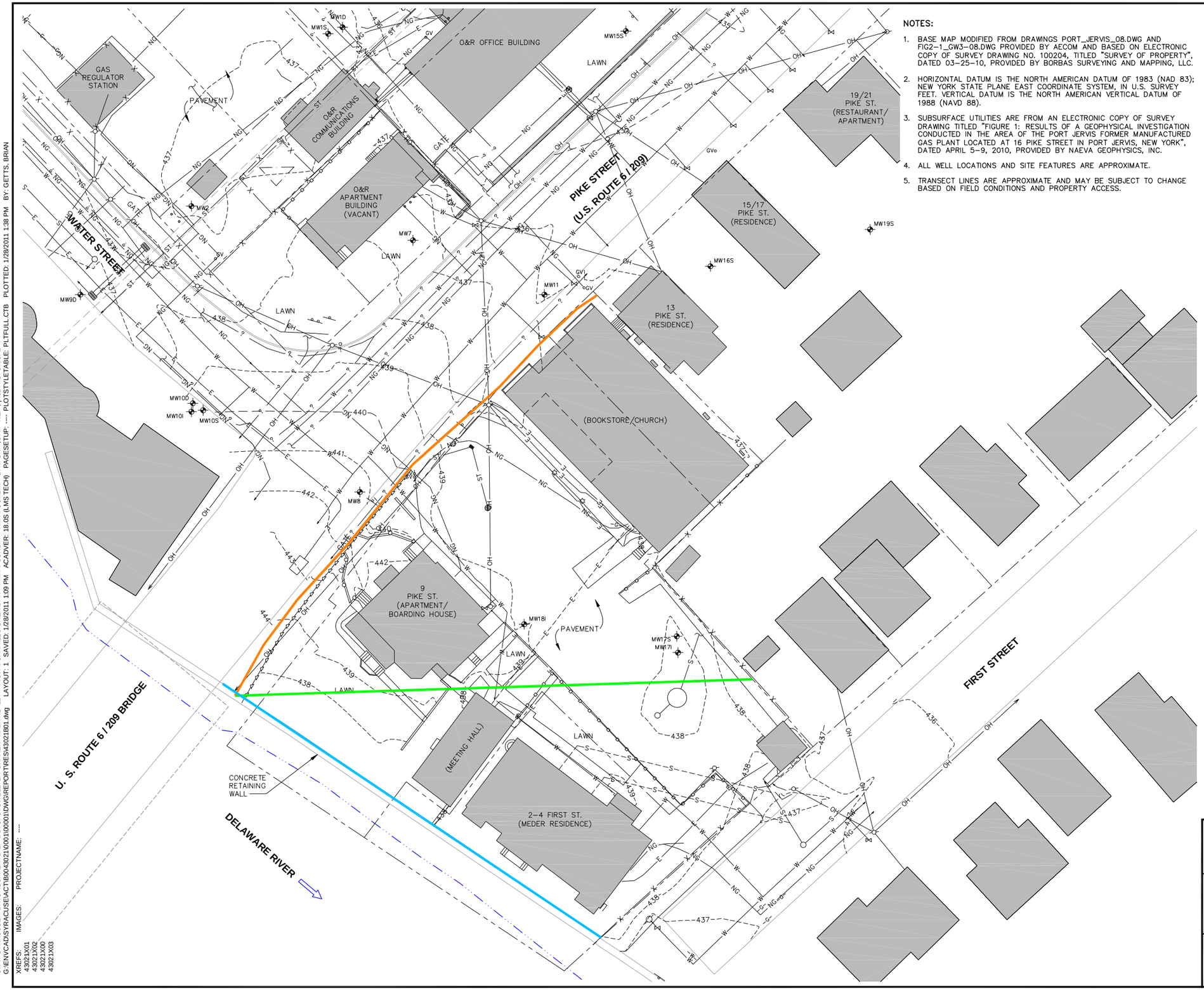

NOTES:

1. BASE MAP MODIFIED FROM DRAWINGS PORT_JERVIS_08.DWG AND FIG2-1_GW3-08.DWG PROVIDED BY AECOM AND BASED ON ELECTRONIC COPY OF SURVEY DRAWING NO. 100204, TITLED "SURVEY OF PROPERTY", DATED 03-25-10, PROVIDED BY BORBAS SURVEYING AND MAPPING, LLC.
2. HORIZONTAL DATUM IS THE NORTH AMERICAN DATUM OF 1983 (NAD 83); NEW YORK STATE PLANE EAST COORDINATE SYSTEM, IN U.S. SURVEY FEET. VERTICAL DATUM IS THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD 88).
3. SUBSURFACE UTILITIES ARE FROM AN ELECTRONIC COPY OF SURVEY DRAWING TITLED "FIGURE 1: RESULTS OF A GEOPHYSICAL INVESTIGATION CONDUCTED IN THE AREA OF THE PORT JERVIS FORMER MANUFACTURED GAS PLANT LOCATED AT 16 PIKE STREET IN PORT JERVIS, NEW YORK", DATED APRIL 5-9, 2010, PROVIDED BY NAEVA GEOPHYSICS, INC.
4. ALL WELL LOCATIONS AND SITE FEATURES ARE APPROXIMATE.
5. TRANSECT LINES ARE APPROXIMATE AND MAY BE SUBJECT TO CHANGE BASED ON FIELD CONDITIONS AND PROPERTY ACCESS.

LEGEND:

- PROPERTY LINE
- EDGE OF WATER (APPROXIMATE)
- 436 GROUND SURFACE CONTOUR (1-FOOT INTERVAL)
- EXISTING STRUCTURE/BUILDING
- X EXISTING CHAIN-LINK FENCE
- EXISTING WOOD FENCE
- EXISTING WIRE FENCE
- EXISTING GUARDRAIL
- 60-INCH-DIAMETER STORM SEWER LINE (APPROXIMATE)
- OH OVERHEAD WIRES
- ? UNKNOWN/SUSPECTED UTILITY LINE
- E ELECTRICAL UTILITY LINE
- NG NATURAL GAS UTILITY LINE
- T TELEPHONE UTILITY LINE
- W WATER UTILITY LINE
- S SANITARY SEWER UTILITY LINE
- ST STORM SEWER UTILITY LINE
- UTILITY POLE
- LIGHT POLE
- GAS MARK-OUT BY OTHERS
- GV GAS VALVE
- WATER MARK-OUT BY OTHERS
- WATER VALVE
- HYDRANT
- MANHOLE
- GRATE
- INLET
- BOLLARD
- SIGN
- MW14S MONITORING WELL LOCATION
- TRANSECT #1
- TRANSECT #2
- TRANSECT #3

0 20' 40'
GRAPHIC SCALE

PORT JERVIS FORMER MGP SITE
ORANGE AND ROCKLAND UTILITIES, INC.
PORT JERVIS, NEW YORK
IP-RES WORK PLAN

TRANSECT LOCATIONS

ARCADIS

FIGURE
1

CITY: SYRACUSE DIV/GROUP: ENV141 DB: G. STOWELL L. FORAKER K. DAVIS LD: PIC: M. CARRILLO-SHERIDAN PM: A. CORBIN TM: A. CORBIN LYR: ON=*;OFF=*REF*, [X01 HISTORICAL*
G:\ENVCAD\SYRACUSE\ACTIVE\60430210\0010\0001\DWG\REPORT\RES\43021B01.dwg LAYOUT: 1 SAVED: 1/28/2011 1:09 PM ACADVER: 18.0S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/28/2011 1:38 PM BY: GETTS, BRIAN
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