

CCNA2018 WORK ORDER 5

20 " Forcemain Relocation

This Work Order Number 5 is entered into as of this ___ day of _____, 2021, pursuant to that certain Continuing Consulting Engineering Services Agreement for Professional Services entered into as of this 17th day of April, 2018 (collectively referred to as the "Agreement"), by and between INDIAN RIVER COUNTY, a political subdivision of the State of Florida ("COUNTY") and Bowman Consulting Group, Ltd. ("Consultant").

The COUNTY has selected the Consultant to perform the professional services set forth on Exhibit A (Scope of Work), attached to this Work Order and made part hereof by this reference. The professional services will be performed by the Consultant for the fee schedule set forth in Exhibit B (Fee Schedule), attached to this Work Order and made a part hereof by this reference. The Consultant will perform the professional services within the timeframe more particularly set forth in Exhibit C (Time Schedule), attached to this Work Order and made a part hereof by this reference all in accordance with the terms and provisions set forth in the Agreement. Pursuant to paragraph 1.4 of the Agreement, nothing contained in any Work Order shall conflict with the terms of the Agreement and the terms of the Agreement shall be deemed to be incorporated in each individual Work Order as if fully set forth herein.

IN WITNESS WHEREOF, the parties hereto have executed this Work Order as of the date first written above.

CONSULTANT:

Bowman Consulting Group, Ltd.

**BOARD OF COUNTY COMMISSIONERS
OF INDIAN RIVER COUNTY**

By:



By:

, Chairman

Print Name:

Erik Juliano, P.E.

Title:

Branch Manager

BCC Approved Date:

Attest: Jeffrey R. Smith, Clerk of Court and Comptroller

By:

Deputy Clerk

Approved:

Jason E. Brown, County Administrator

Approved as to form and legal sufficiency:

Dylan T. Reingold, County Attorney

EXHIBIT A -SCOPE OF WORK

Bowman Consulting Group Ltd. is pleased to submit this proposal for professional engineering services to Indian River County Utility Department for engineering services to provide for the relocation of 20' forcemain located near Main Street and the Railroad tracks in Sebastian, FL. The relocation is required due to the pipeline being constructed outside its easement and within Railroad R/W.

PROJECT BACKGROUND & UNDERSTANDING

On February 1, 2021, Eric Flavell and Bill Archebelle met with John Boyer with IRCDUS Engineering and Duke Hawkins with Operations to review the scope of the problem. The pipeline was constructed in 1989. The record drawings show a 22.50-degree bend and all pipe within the easement. The pipeline has been located and apparently the fitting was eliminated, and the pipeline was "roped" (joints pulled to effect the change in direction) which required about 300' to accomplish. This resulted in the pipeline meandering about 13' inside the Railroad R/W.

The County is interested in evaluating the situation to evaluate the alternatives. The alternatives are 1) relocate the pipeline so it is contained within the existing easement and 2) leave the pipeline where it is an obtain right of encroachment into the Railroad R/W where it is currently constructed.

We reviewed the proposed relocation in the field during our meeting and have collected thoughts and concerns of Mr. Boyer and Mr. Hawkins and will develop a concept level sketch for the proposed relocation based on that information and further engineering analysis.

We understand the County would like the following work included. Review options to determine issues and costs associated with each. Locates and potholes for connections and clearance. Topographic mapping of the site for design purposes, we will work with the County on utility locates so they can be included in the topographic mapping. We propose the consultant team of Bowman with ISS Survey and Blood Hound for locates.

SCOPE OF SERVICES

We propose to provide the following services:

Task 1 – Alternatives Evaluation (Bowman Consulting)

1. Kick-off Meeting with summary meeting notes.
2. Contact Railroad to determine permitting requirements and cost of improvements located within their right of way.
3. Contact City of Sebastian to determine permitting requirements for Main Street and restrictions for the work.
4. Develop concept level drawing of proposed improvements and utilities as located visually (not surveyed) from field marks and from information obtained from the utilities contacted observed in the field
5. Prepare a conceptual level opinion of cost for leaving the 20" Forcemain as presently located within the Railroad R/W and for constructing the proposed relocation as shown in the concept level sketch.

6. Obtain utility information from non-municipal utilities including gas, telephone, power, cable tv, and any other infrastructure found by consultant to be with in the work area.
7. Prepare summary letter of findings.
8. Meet with County and present findings and letter.

Task 2 – Civil Engineering Design Services (Bowman Consulting)

9. Attend and prepare summary meeting notes for up to two (2) meetings, anticipated to be at beginning, and 60% complete milestones of the project.
10. Prepare 24" x 36" drawings anticipated to be:

Sheet	Description
G-1 thru 2	Cover Sheet, Construction Notes Sheet (phasing)
D-1 thru 2	Details
SP-1 thru 2	SWPPP Sheets, Plan and Details
U-1 thru 2	Utility relocation drawings including approximately 300' of relocated pipe

11. Utilize IRCDUS Utility Construction Standards and supplement with specifications as necessary for the design.
12. Provide one (1) engineer's opinion of estimated construction cost with 90% design milestone. Final estimate will match bid schedule.
13. Field review design/plans at 90% complete milestone to compare with site conditions. In-house plan checking and respond to Utility's comments and prepare final drawings and specifications.

Task 3 – Permitting and Bidding Services (Bowman Consulting)

14. Prepare and submit FDEP water and wastewater permits for the project, including requisite application fees. Respond to comments and follow through to final clearance.
15. Prepare and submit City of Sebastian right of way permit for utility relocation work withing the Main Street, Including requisite application fees.
16. Prepare and submit Railroad right of way permits for utility relocation work withing the Railroad right of way Including requisite application fees. We anticipate the existing pipeline will need to be removed, flagman required during the work.
17. Bidding Services are comprised of attending a pre-bid conference, respond to contractor's bid questions and assist with preparation of addenda.

Task 4 - Survey Services (ISS Survey)

16. Provide topographic mapping and ortho photos of the project limits suitable for 1" = 20' drawings including route survey, rights of way and easements

Task 5 – Utility Locates (Blood Hound)

17. Utility soft digs to locate pipe depths within the work area at the connection points and identified crossings.

SERVICES AND/OR INFORMATION TO BE PROVIDED BY OTHERS

Client or others will provide the following services and/or information:

- A. County to provide utility easement sketch and legal within work area.
- B. County to provide utility locates for their facilities
- C. County will provide the specification front end documents and general provisions.
- D. County will authorize CEI and Certification under an addendum. Only design, permitting and assisting with bidding will be provided by Consultants with this Work Order.
- E. County will handle all aspects of public meetings, if any.
- F. County will mark water and forcemain pipelines so they can be surveyed and potholed by our team.
- G. Provide record-drawings and information of existing improvements and utility-owned facilities and other substructures.

SPECIFIC EXCLUSIONS

Specifically not included in the above Scope of Services/Compensation are the following:

- A. Any geotechnical services.
- B. Any Environmental services

EXHIBIT B – FEE SCHEDULE

COMPENSATION

We will provide the requested services on a Lump Sum Cost, with estimated task breakdown below:

Design Services:

Task	Design Services	Fee
1.	Alternatives Evaluation	\$9,205
2.	Project Design	\$29,480
3.	Permitting & Bidding Services	\$4160
	Sub Total (Bowman)	\$42,845
4.	Survey Services (ISS Survey)	*\$4,208
5.	Utility Locates (Blood Hound)	*\$5,770
	Grand Total	\$52,823

* Subconsultant fee includes 10% markup, see subconsultant proposal attached.

EXHIBIT C – TIME SCHEDULE

This Task Order shall commence upon Notice to Proceed with the work to be completed as follows:

Kick off meeting	(NTP)
Alternatives Evaluation	3 weeks
County Determination of Option	3 Weeks
Relocation Project	
Topographic Mapping	4 weeks
Utility Locates and potholing	(Concurrent with survey)
Design to 60% & Meeting	3 weeks
Permitting, Design to 90% & Submit	3 weeks
County Review	3 weeks
Respond to Comments	1 weeks
<u>Final Bid Docs and Deliver</u>	<u>1 weeks</u>
Total	21 Weeks

147 Calendar Days

The above schedule assumes reasonable response times from the permitting agencies.



February, 5 2021

Mr. Eric Flavell, PE, F-ASCE
Bowman Consulting Group
4450 W. Eau Gallie Blvd., Suite 232
Melbourne, FL 32934

**Subject: Proposal to Provide Surveying Services
Project No. BWM004 – Sebastian 20” Forcemain Relocation**

Dear Mr. Flavell:

Infrastructure Solution Services (ISS) is pleased to provide this proposal for surveying services for the Sebastian 20” Forcemain Relocation Route Survey (the “Project”) in Sebastian, Florida, for Bowman Consulting Group (BCG).

SECTION I. BACKGROUND

After speaking with Mr. Flavell (BCG and reviewing the provided scope and limits, it is ISS’s understanding that the Project consists of a topographic route survey of approximately 500’ of FEC (Florida East Coast) railroad Right Of Way (ROW) in Sebastian Florida. The Project includes the east half of the ROW from the center of the tracks to 15’ past the ROW line. The Project will start at 15’ north of the north ROW of Main Street and run south for 500’. The area to be surveyed will also include a section of Main Street starting at the center of the train tracks and running east 150’ from ROW to ROW. It is our understanding that the Project will include establishing all ROW lines and approximate lot lines per plat and property appraiser information to be utilized for the purpose of designing the relocations. All existing utility easements that are identified in the property appraisers research and or provided by the client will also be established.

ISS will establish a minimum of three (3) site benchmarks within the project area. The ISS project team will locate all visible aboveground improvements, locate limits of dense vegetation, perform cross sections at intervals no greater than 50’ to establish the project topography. Cross sections of lesser intervals will be performed if the terrain dictates and all grade breaks will be collected. ISS will locate all traffic pavement markings within the Project area. The location of any underground utilities that will be marked by others will be located when all markings are complete. ISS will contact the FEC prior to commencement of work to coordinate access to their property. Mr. Flavell (BCG) has requested a high-resolution georeferenced drone image to be used as a background in the survey.

SECTION II. SCOPE OF SERVICES

TASK 1 – Topographic Survey (As defined in Chapter 5J-17 Administrative Code)

- A. Using the nearest published horizontal and vertical control, ISS will establish a minimum of three (3) site control points with NAD 1983 State Plane coordinate values and NAVD 88 vertical values for the collection of data and to be used as site benchmarks.
- B. Establish all of the of the ROW lines, easement lines and approximate lot lines within the project area.
- C. Map all above ground existing conditions utilizing conventional survey and GPS real-time kinematic (RTK) methods along the route. Collect any marked underground utilities marked by others.
- D. Fly a predefined route in accordance with all FAA part 107 regulations with a DJI Phantom 4 Pro drone to obtain aerial images. Aerial images will be processed via Pix4D photogrammetry software for image only.

SECTION III. SUBCONSULTANTS

N/A

SECTION IV. CLIENT'S RESPONSIBILITY

BCG will be responsible for providing the ISS project team the following items:

- A. Any available easement information available.
- B. Identification and marking of underground utilities.

SECTION V. DELIVERABLES

ISS will provide the following deliverables:

Task 1 - Existing Conditions Map

Three (3) copies of signed and sealed survey maps and one (1) digital copy delivered on CD or USB drive.

SECTION VI. SCHEDULE

ISS will begin survey field work within two (2) weeks of receiving the signed proposal from BCG. Field work and drafting will be complete within two (2) weeks of Project commencement. Survey map deliverables will be provided to BCG within five (5) days thereafter.



SECTION VII. COMPENSATION

BCG shall compensate ISS a lump sum fee of Three Thousand Eight Hundred Twenty Five dollars (\$3,825) for the scope of services specified in this task order.

Any additional unforeseen expenses will be identified for approval from BCG before incurring and billed with the final invoice.

Exhibit 1: Fee Schedule by Task

TASK #	TASK DESCRIPTION	FEE
1	Establish survey control = 4hrs @ 2-man crew rate of \$150	\$600
2	Perform cross sections and locate improvements = 4hrs @ 2-man crew rate of \$150	\$600
3	Locate property control = 3hrs @ 2-man crew rate of \$150	\$450
5	Survey drafting = 8hrs @ Draftsmen Tech II rate of \$95	\$760
6	Drone flight field operations and supplemental utility locates = 3hrs @ 2-man crew rate of \$150	\$450
7	Drone data processing = 2hrs @ Draftsmen Tech II rate of \$95	\$190
8	Sr. Professional Surveyor & Manager = 5hrs @ rate of \$155	\$775
TOTAL FEE		\$3,825

SECTION VIII. ACCEPTANCE

If the above scope and fees meet your approval, please indicate by returning one signed copy to ISS which will constitute an "Agreement and Notice to Proceed" for the accomplishment of this work.

Infrastructure Solution Services

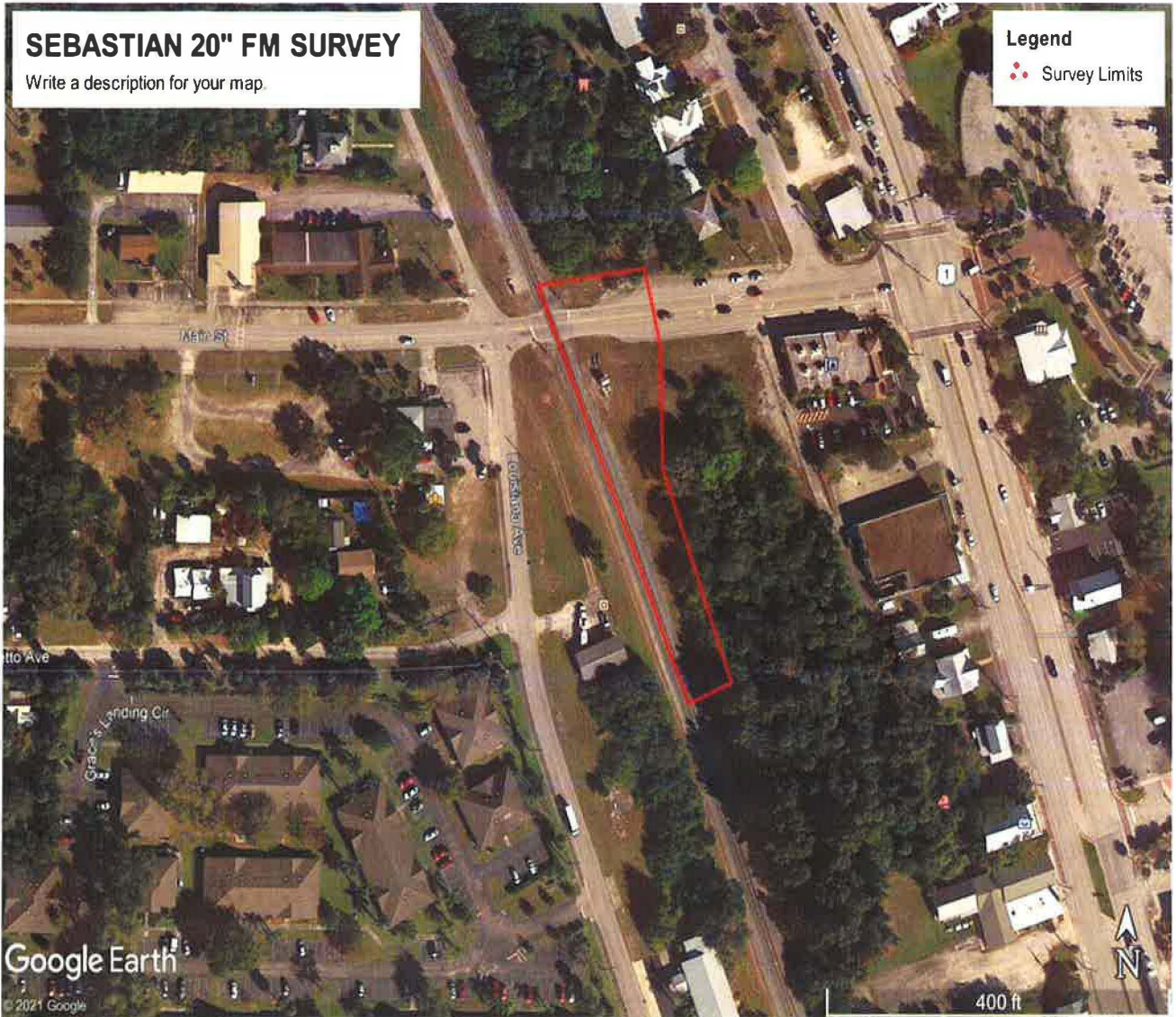
Brian Stahl
 Brian Stahl

02/08/21
 Date

Bowman Consulting Group

Date







ESTIMATE

Created Date 2/8/2021
Estimate Number 58950

Customer	Bowman Consulting Group	Name	Zachary Komninos
Billing Phone	(321) 255-5434	Phone	(321) 270-8982
Billing Address	12355 Sunvalley Drive Suite 520 Reston, VA 20191 US	Email	zkomninos@bowmanconsulting.com
Job Site Location	City of Sebastian, 919 Main St., Sebastian, Florida, 32958		

Product	Quantity	Sales Price	Total Price
Advantage Locate (hourly)	8.00	\$200.00	\$1,600.00
Mob - Single Tech (Hrly)	3.00	\$115.00	\$345.00
Mob - Vac Ex (Hrly)	3.00	\$200.00	\$600.00
Vacuum Excavation (Hourly)	12.00	\$225.00	\$2,700.00
Grand Total			\$5,245.00

Scope of Work

Customer SOW design engineering
BHUG SOW

Client has requested an estimate for the following Scope of Work:

- **The following work is being performed to Quality Level B standards in accordance with CI/ASCE 38-02.**
- **Client has requested an estimate to horizontally locate detectable underground utilities within the Red outlined areas as shown on the provided image, prior to excavation. No utilities will be located within the RR ROW.**
- **EM and Real-Time GPR Locating equipment will both be utilized to locate and mark the utility lines. A not to scale digital field sketch will be provided of our discoveries for surveying purposes. We will also provide pictures and the raw GPR data for review.**
- **Customer is advised the horizontal portion of this estimate is based on a 2-hour minimum, with a not to exceed limit. Any additional time required on site to complete the task beyond the 2-hour minimum will be invoiced in 15-minute increments @ \$50 per increment, not to exceed 8 hours. A mobilization fee is required.**
- Customer is advised that Blood Hound utilizes water-based paint and flags to identify any discoveries onsite. If this is an issue, Blood Hound must be made aware of this when scheduling. All discoveries will be painted and flagged for surveying purposes.
- All findings will be marked according to APWA standard.
- Any available as-builts, engineered or other record drawings, if available, should be supplied to BHUG prior to commencement of field work.
- Estimate does not include any camera or surveying services.



ESTIMATE

Created Date 2/8/2021

Estimate Number 58950

- BHUG is not responsible for, moved, altered, obliterated or maintaining marks. BHUG will impose an additional fee to relocate/remark facilities.
- The performance of BHUG's services is limited to full and unobstructed access to include but not limited to: mechanical rooms, manholes, hand holes, vaults, meter rooms, telecom rooms, fixtures (plumbing, electrical, communication), dispensers, fenced compounds, tanks and structures. Full cooperation from the on site personnel is necessary to perform a complete survey.
- Results are dependent upon field conditions at the time of locating services. It may be necessary to have parked vehicles or machinery moved to allow for a full scan and to access structures.
- Estimate DOES NOT include the use of Robotic or Push/Pull Cameras for assistance in locating Sewer Lines or Laterals. These lines would attempt to be marked by EM / Rodder if possible or GPR. If lines are not able to be completely located, Blood Hound will arrow the direction of each line leaving a manhole.
- CUSTOMER IS ADVISED THAT LIMITATIONS EXIST IN LOCATING PLASTIC MATERIALS WITHOUT TRACEABLE WIRES ATTACHED.
-
- **The following work is being performed to Quality Level A standards in accordance with CI/ASCE 38-02.**
- **Vacuum Excavation will be utilized to provide the precise vertical position of the conflict or connection point utilities within the specific areas as shown on the provided image and to be determined by the EOR once the horizontal locates have been completed. Based on this exhibit and for budgetary purposes it is assumed that up to five (5) excavations of varying surfaces will be required.**
- **Customer is advised the vertical portion of this estimate is based on a 4-hour minimum, with a not to exceed limit. Any additional time required on site to complete the task beyond the 4-hour minimum will be invoiced in 15-minute increments @ \$56.25 per increment, not to exceed 12 hours. A mobilization fee is required.**
- Test hole data forms will be provided with pertinent information to include size, function, depth, material (of pipes if known) and provide the precise horizontal and vertical position of any discoveries. Offsets will be provided to existing above ground features as well and all discoveries will be painted and flagged with all verification's staked with a semi-permanent marker for surveying purposes. A digital field sketch will be provided along with pictures of the areas in question.
- Cavities will be refilled with dry, native spoils (compacted in 6" lifts).
- Estimate does not include any final restoration such as hot mix asphalt, milling / resurfacing or special back fill requirements (flowable fill.) If final restoration is required by end client, city, state, or any other entity, that restoration will be the responsibility of the client. Blood Hound does not perform final concrete or asphalt surfacing. BHUG will not perform any excavations thru sidewalk without prior permission. *Test holes performed under the roadway will be repaired with an asphalt cold patch and any concrete surfaces will be repaired with a Quikrete type product.*
- Customer understands any fees required for permits and MOT services are not provided and included in this estimate.



ESTIMATE

Created Date 2/8/2021
Estimate Number 58950

- All Survey work will be completed by others.

If the Scope of Work should change, or is different than listed on the estimate, please call our office for a revised estimate.

Quoted rates are exclusive to this estimate only. Rates quoted by Call Center Representatives are in effect unless otherwise stipulated within a formal estimate.

Please note estimate is valid for 90 days from the quote created date.

Blood Hound will use electromagnetic (EM) and ground-penetrating-radar (GPR) equipment to locate private underground utilities at site indicated by client. All findings will be marked according to APWA standard. Customer is responsible for calling 811 for locates of any public utilities. If the scope of work should change or is different than that listed on estimate, please call our office for a revised estimate. Unless expressly noted, Vacuum Excavation estimates do not include any of the following services: Permitting, Traffic Control, Restoration, Special Restoration, Special Backfill or Waste Disposal. If you need any of those services please call our office for a revised estimate. Blood Hound is not responsible for the condition of the pipes or structures before or after jetting/clearing service is performed. Unsatisfactory conditions could be present within the structure and any services may bring those deficiencies to light. In the event of inclement weather, if the client still requests for crew to arrive on site, then the client will be responsible for minimum charges even if no work is performed.

Payment is due at the time of service, unless you already have an account with us. If you do have an account with us, payment terms are Net 30 days, unless otherwise stated in a pre-approved contract. To learn more, please call the office at 888-858-9830.

PRICE MAY VARY BASED ON ACTUAL TIME ON SITE. The above pricing is based only on the information supplied by the customer. If a site walk through has not been conducted, this may affect the price.

If this is a prevailing wage job, please contact our office for a revised quote as this pricing does not reflect prevailing wage rates. If at some later date a project is determined to be a prevailing wage job, then any extra expense incurred by Blood Hound will be billed to the client.

The project estimate outlined in this specific proposal is valid for 90 days from the date of the proposal. Blood Hound reserves the right to review and adjust this estimate if client does not approve of the proposal within 90 days.

We look forward to working with you.

By signing this Estimate the client acknowledges that they accept the scope of work listed on the estimate, as well as the service rates provided and are providing Blood Hound with a Notice To Proceed (NTP) for the listed Project. If the scope of work should change while the work is in progress, any changes will be documented on the technician's field notes and signed off on by the client. Signing this estimate also acknowledges that the client agrees to the terms and conditions as they relate to payment for services rendered.

Signature: _____

Printed Name: _____

Date Signed: _____



Equipment Report

Equipment Operations and Limitations

Corporate Location:
750 Patrick's Place
Brownsburg, IN 46112

Office # 888-858-9830
Fax # 888-858-9829

<http://www.BHUG.com>

Equipment Description –

Blood Hound uses a variety of equipment to identify and locate subsurface structures, such as direct connect and inductive utility location transmitters and receivers with multi-frequency broadcasts and reception capabilities, ground penetrating radar, sewer cameras (both robotic and fiber optic push/pull), and other equipment, to locate the lateral position of buried structures, as well as to provide estimates on the depths of subsurface structures.

Traditional EM equipment is used as the primary tool to determine the location of all conductive subsurface structures, as well as any utilities that have locating wires (i.e. gas lines) buried with the non-conductive utility to facilitate location. This equipment operates using frequencies ranging from 512 Hz up to and including 480 kHz. The frequency that is selected is dependent on the type of utility to be located, operator preference, estimated depth of the target utility, and distance for which the target utility must be marked. Frequencies are often changed during operations to improve the quality of the signal, decrease interference, and/or increase the range for the transmitted signal.

EM locating operates by conducting an AC electric current through the target utility at a specific frequency. This causes the target utility to radiate a radio signal at the desired frequency. This radiated radio signal is then detected using the receiver, which is tuned to detect radio fields at the desired frequency. By measuring peak or null signal measurements, the lateral line location can be determined.

Blood Hound uses a variety of Ground Penetrating Radar (GPR) units from multiple manufacturers. Blood Hound employs antenna frequencies ranging from 250 MHz up to 1.6 GHz, depending on the specific needs of the survey. Data can be analyzed in real-time, or collected for post-processing analysis, including the development of subsurface response maps.

The most commonly used antennae operate in a frequency range of 250 to 350 MHz., which provides the greatest balance of resolution and effective depth penetration. Frequency ranges higher than this provide greater resolution and better penetration through more conductive or signal absorbing materials (i.e. clay soils, concrete, etc). However, this increased resolution comes at the cost of significantly reduced depth penetration.

GPR operates by radiating a radio band frequency into the soil from the transmitter contained within the antenna assembly. This signal is reflected to the receiver contained in the antenna unit, and this received signal is then converted into visual patterns based on the intensity of the reflected signal. The depth of the target reflection pattern is determined based on the time elapsed from the transmission until the reception of the reflected signal, and is then projected by making assumptions regarding the transmission rate of the signal through the medium. If the signal velocity assumptions are not accurate, then the depth estimates will not be accurate.

Blood Hound also performs Electromagnetic soil conductivity analysis (EM Induction Survey). This method uses a Fisher TW-6 "Split Box" locator mounted on an inductive sweep bar. The bar places the transmitter and receiver four feet apart, with the inductive transmitted field oriented in an opposing orientation from the receiving antenna. This opposing orientation allows for the receiver to not register the presence of the transmitting field. When the transmitting field encounters a conductive object (metal), the field is bent, which results in the detection of the field by the receiving antenna. This equipment allows for the detection of conductive objects, and is not limited to the detection of ferrous metals as is the case with many magnetometers.

Factors Effecting Performance of Equipment –

There are several factors that can impact the effectiveness of the EM Locating equipment:

- **Target Utility Composition** – EM locating is only effective if the target utility is composed of continuous conductive material. Plastic, concrete, clay, or other non-conductive materials cannot be located using EM locating techniques. In addition, some metals are not highly conductive, which makes locating using EM techniques difficult. For example, cast iron is a poor conductor and cast iron lines can often be difficult to locate using standard EM techniques. Additionally, many pipes are composed of individual sections which may be gasketed. This can impede the current at each pipe joint.
- **Shielding of Target Utility**– Since EM locating uses an electronic signal, unshielded lines that are directly buried in the soil (i.e. water lines) can be difficult to locate for significant distances. This is due to the continuous loss of transmitted signal directly to the ground. As the signal travels along the utility, a significant portion of the signal is lost to ground, resulting in decreased signal quality. The greater the distance between the transmitter and the location point on an unshielded line, the more degraded the signal will be.
- **Conductive Pathway to Ground** – Locating is accomplished by creating a complete circuit, and the transmitted signal must be able to return to the ground in some form. An open circuit is generally much more difficult to locate since the circuit is not complete, and the emitted signal cannot return to ground. Thus, the signal may not travel along the desired pathway. Additionally, soil conditions can affect the pathway to ground. For example, in highly conductive soils, a signal can inductively find a pathway to ground even in an open circuit.
- **Depth** – The signal induced onto the target path must have sufficient strength to be detectable at the surface. Utility lines deeper than 15 feet are often difficult to locate due to the inability of the radio frequency being radiated from the target line to effectively radiate through the soil to the receiver at the surface. Similarly, shielding between the target utility and the receiver can affect the signal reception and create a loss of signal.



Equipment Report Equipment Operations and Limitations

Corporate Location:

750 Patrick's Place
Brownsburg, IN 46112

Office # 888-858-9830

Fax # 888-858-9829

<http://www.BHUG.com>

Similarly there are several factors that can impact the effectiveness of GPR surveys:

- **Subsurface Material / Soil Composition** – Soil composition and subsurface material is the most important factor impacting the effectiveness of GPR. The more conductive the subsurface material, the less effective the GPR survey will be. GPR works best in sandy soils, and is least effective in heavy clay soils or where the subsurface material contains a large volume of highly conductive backfilled debris or material (i.e. metal scraps or slag sand). Midwestern soils generally have a high clay content and create significant challenges to completing an effective GPR survey. As a general rule, the smaller the particulate matter that the subsurface material is composed of, the greater the inhibiting effect on the GPR signal.
- **Composition of the Subsurface Target** – The inherent electrostatic reflectivity of a target will impact the effective identification of the target. Lightweight subsurface material, such as PVC, are generally more transparent to radio waves and will reflect a substantially smaller percentage of the radiated signal. This will result in a smaller and more minor reflection signature, making effective interpretation more difficult. Some materials are completely transparent to radio waves and can only be identified if a reflective material (i.e. water) is contained within the target pipe.
- **Moisture Content of the Subsurface Material** – Water, when combined with dissolved ions (salt) has an inhibiting effect on GPR signals, and signals can often not effectively penetrate saturated soil material, when the soil is slightly conductive. The addition of more water increases the conductivity of the soil and more significantly inhibits the effective signal penetration.
- **Depth** – The GPR signals have a finite effective penetration depth. The deeper the target, the less likely it will be effectively identified. As the signal penetrates the subsurface material it loses strength as the depth increases. Effective signal penetration can be defined as the depth at which the reflected signal no longer has sufficient power to reach the receiver antenna of the GPR. In other words, the effective survey depth is the depth at which the penetrating signal reaches a maximum of 50% of its emitted strength, although it should be noted that at this range only a 100% reflective target (i.e. metal) would have the potential to be detectable.
- **Target Size** – The smaller the diameter of the target structure, the lower the probability of successful identification of the target during a GPR survey. The smaller the target, the less of a signal that will be reflected, decreasing the probability of a positive identification of the subsurface target. As a general (but not absolute) rule of thumb, for every 1 foot of depth you must have 1 inch in diameter in order to be observable. For example, a 3" diameter pipe must be less than 3 feet below grade in order to be observable during a GPR survey.

EM Inductive Surveys can also be impacted by environmental factors.

- **Surface and Subsurface Material / Soil Composition** – Highly conductive soils can prevent the identification of other conductive structures with this methodology. The presence of surface metal, including vehicles, fences, and debris, can swamp other readings and prevent the identification of subsurface targets. In addition, the presence of rebar reinforcement within concrete can have a similar effect and prevent identification of other structures.
- **Target Size** – Small metallic targets may not be detected, since the mass of the target object must be large enough to impact the shape of the transmission field. Small objects may not have sufficient mass to cause a field distortion significant enough to be detected.
- **Target Depth** – Deeper targets may not sufficiently distort the transmitted signal to allow for detection by the receiver. However, large high-mass targets are more likely to be detectable at significantly deeper depths, than lower mass targets.

Summary of Equipment and Survey Effectiveness –

EM locating is generally very effective in locating most subsurface utility lines. Electric, Telephone, and Cable TV can almost always be located using standard EM locating techniques. Also, many water lines can also be located. However, due to the continuous contact with the soil, and the common use of cast and ductile iron in water line construction, water lines can often prove difficult to locate. Additionally, water lines constructed of plastic are becoming more common and cannot be located using standard locating methodologies. Sewer lines (storm and sanitary) are very rarely locatable with standard techniques, unless a conductive tool can be introduced into the line (i.e. locating a sanitary lateral by running a rod containing metal through the line from a clean-out access point). All Blood Hound technicians carry a Jameson rodder for this specific purpose.

GPR surveys are an effective way of locating and identifying subsurface obstructions prior to drilling or excavating activity. However, these surveys cannot and will not identify all subsurface utilities or other obstructions, in all circumstances. Midwestern soils in particular, present significant challenges to an effective GPR survey, and should not be relied upon as the only means of protecting underground utilities. EM Induction surveys provide another level of investigation, which when combined with traditional EM locating and GPR provide the most complete non-destructive process available for the protection of subsurface utilities and other structures. When Vacuum Excavation is employed, the possibility of a damaged utility is further minimized.

In general, private utility locating surveys conducted by Blood Hound technicians are highly accurate and effective. However, there are numerous factors that can result in a line being mis-marked or left unmarked by our technicians, that are beyond the control of Blood Hound or its technicians. This includes, but is not limited to, a lack of adequate prints or available site knowledge, a lack of access to utilities (i.e. cleanouts, interior communications rooms, vaults, etc), a lack of visual indications of the utility's presence, a disruption of a conductive pathway (i.e. repair in a metal water line made with plastic), and commonly bonded lines creating undesired signal conduction pathways. While Blood Hound provides its employees with extensive training on ways to mitigate these and other issues, there are unfortunately occasions where these factors cannot be effectively eliminated.