Ms. Wilhelmina Montero, PE
Project Manager, ECSD
City of Hollywood – Public Utilities
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Hollywood, FL 33022-9045

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www.arcadis.com

Subject:
Disinfection System Upgrades - Four-Log Disinfection Using Free Chlorine

WATER

Date:
August 19, 2021

Contact:
Tung Nguyen, PE, PMP

Phone:
954.246.0936

Email:
tung.nguyen@arcadis.com

Our ref:
-

Florida License Numbers

Engineering
7917

Geology
GB564

Surveying
LB7062

Dear Ms. Montero:

Arcadis U.S., Inc. (Arcadis) is pleased to submit this Work Order proposal to complete the detailed design, permitting, and bidding support services for the modifications identified in the "Chlorine and Ammonia Feed System Assessment for Implementation of Four-Log Disinfection Basis of Design Report (BODR, September 2020)" at the City of Hollywood's (City) Water Treatment Plant (WTP). These modifications are required for the City to comply with the Florida Department of Environmental Protection (FDEP) conditions outlined in the approval letter "Determination of Four-Log Virus treatment of Ground Water [Conceptual]" dated November 29, 2017.

This Work Order proposal covers services outlined in Article 2.3 (Engineering Design Phase) of the Professional Services Agreement (PSA) (Number 17-1324) executed by and between the City and Arcadis on November 11, 2017. The Terms and Conditions of the PSA shall apply to this Work Order.

BACKGROUND

The City received conceptual approval from Broward County Department of Health (BCDH) on November 29, 2017 for achieving four-log virus treatment of source water by using free chlorine for disinfection. As part of the conceptual approval, BCDH required an evaluation of the chlorine feed and storage system capacity along with the implementation of any needed improvements to satisfy four-log virus treatment and requirements of Florida Administrative Code (FAC) Chapter 62-555.320. Since the City attained the conceptual approval of implementing four-log disinfection at the WTP, the Southeast District of the FDEP has become the "Authority Having Jurisdiction" over these improvements to the

WTP. The City and Arcadis have since met with FDEP to obtain approval to continue the evaluation including soliciting guidance and permitting requirements related to WTP modifications that support the conversion to four-log inactivation using free chlorine. Subsequently, Arcadis has completed the field bench testing and basis of design report phase for the City which identified and validated the modifications required to meet four-log treatment using free chlorine at the WTP.

SCOPE OF WORK SUMMARY

Arcadis and its sub-consultants (McKim and Creed and Corrosion Probe, Inc.) shall furnish professional engineering services for the project management, detailed design, preliminary phasing of work, preliminary construction schedule, cost estimating, permitting, and bidding phase services for the implementation of four-log disinfection using free chlorine at the WTP. The specific facility evaluations and upgrades are described in the Final BODR dated September 15, 2020 and summarized below:

- Perform visual inspections of all nine (9) existing sodium hypochlorite tanks
- Demolish the on-site generation equipment and brine tank at the Chlorine Storage Building and repair structural supports for three existing horizontal tanks which will be reused
- Install five (5) new metering pumps sized for 12% sodium hypochlorite solution in the Chlorine Storage Building. These pumps will allow for continued operations of the Raw Water and LS Pre-Filter (Spiractors 7-12) injection points while the LS/HEX Chemical Storage/Area is being rehabilitated structurally and mechanically.
- Install three (3) new transfer pumps to deliver back-up bulk storage from the Chlorine Storage Building to the Membrane Building Storage and LS Cl2/Hex Storage areas.
- Demolish the existing metering pumps in the LS CL2/HEX Chemical Storage/Feed Area, rehabilitate floors and concrete elements, and replace with six (6) new metering pumps. Two (2) new transfer pumps will be provided to transfer between tanks at this location and containment walls will be added.
- Demolish the existing three (3) sodium hypochlorite metering pumps at the Membrane Building Chemical Storage Area and replace with five (5) new metering pumps for 12% solution to serve the Blend Tank and Odor Control. Two (2) new transfer pumps will be provided to transfer the solution between tanks at this location.
- Demolish the existing two (2) pumps at the Chlorine Shed and the location will be repurposed as an instrument shed.
- Modify the feed and controls systems to accommodate the increased sodium hypochlorite dose in the blend tank. This change is required to operate a free chlorine segment through the blend tank and 42-inch piping.
- Install an ammonia injection point and static wafer mixer at the 42-inch pipe upstream of the ground storage tanks.
- Install new ammonia tanks and a new feed system with a pressure feed and a mass flow meter/controller at new location between the 3.5 MG ground storage tanks. The design of this system will be coordinated with the chemical supplier who offers this system on lease to the City.

Leak and pressure alarms will be integrated to the existing SCADA system. A gas leak detector system and audible field alarm will be included.

- Demolish the existing ammonia feed system.
- Install new chemical feed and transfer piping. This piping will be tubing in carrier pipe to limit potential for leakage. Flow meters will be added for the upgraded sodium hypochlorite system. The preferred location by the City is to have flow monitoring at each injection point, if possible, in lieu of having a common meter on discharge headers. The final locations will be determined during design.
- The control system will be modified to accommodate emergency operations. Specifically, during Ground Storage Tank Bypass operations (also known as GST Mode), the reverse osmosis/membrane softening (RO/MS) trains will be offline and raw water from lime-softened water from filters 1-6 will flow directly to the high-service clearwells and to the ground storage tanks from filters 7-12. Two new hypochlorite injection points will be added to the effluent headers for filters 7-12 and the existing pre-filter injection point for filters 1-6 will be modified to accommodate emergency operations.

DESIGN PHASE SERVICES

Task 1 - Project Management and Kick-off Meeting

Project management effort includes Arcadis staffing, subconsultant coordination and oversight, QA/QC, budget control, and schedule management. The services to be provided under this task shall cover all phases of this project including design, permitting, and bidding services. Subconsultant proposals are included as Attachment B and are incorporated into this letter proposal herein.

A one-hour kick-off meeting will be scheduled with the City via Microsoft Teams within two (2) weeks from authorization to proceed (ATP) to review the project scope, schedule, budget, and other key coordination requirements with the City. A baseline schedule will be developed and presented during this meeting. Subsequently, Arcadis shall schedule and facilitate monthly progress calls with the City. Arcadis shall issue monthly invoices with schedule updates in accordance with the terms of the PSA for the duration of the project.

Deliverable(s):

1. Kick-off Meeting Agenda, Meeting Materials (as applicable), and Summary Notes
2. Baseline Schedule
3. Monthly Invoices
4. Monthly Project Schedule Updates

Task 2 - 60% Design Documents (Intermediate Design)

Arcadis shall prepare and submit to the City 60% design documents incorporating the design concepts developed in the Final BODR developed as part of a separate work authorization. Arcadis shall prepare

design drawings and specifications for incorporation into the City's standard bidding documents that shall include the following activities and components:

A. Tank Inspections – Tank inspections will be conducted by Corrosion Probe in accordance with their proposal included as part of Attachment B, and as follows:
    a. Five (5) horizontal side-entry tanks and two (2) vertical top-entry tanks will be assessed for suitability for relining and change in service from 0.8% to 12% sodium hypochlorite.
    b. Two (2) existing horizontal side-entry tanks have been previously relined by the City. These will be assessed for structural adequacy and continued storage of 12% sodium hypochlorite.
    c. It is assumed that relining of existing tanks is the preferred modification for continued service and the existing storage tanks can be reused. The design for replacement tanks, modified tankage, or layouts is not included in this project.

B. Subsurface Utility Engineering (SUE) – Underground utility location services will be provided by Bloodhound, LLC, in accordance with their proposal included as part of Attachment B, and as follows:
    a. Horizontal and vertical utility locating services will be provided for the preliminary chemical piping routing between the Chlorine Storage Building and the MS Building and LS/HEX chemical storage areas. Utility designation will adhere to Quality Level B standards in accordance with CI/ASCE 38-02.
    b. Two mobilizations are anticipated. The first will be to designate and locate sub-surface utilities based on existing as-builts and preliminary design layouts. Following the horizontal identification, a follow-up mobilization is scheduled to do exploratory boring with vacuum hose. It is estimated that up to 40 bores will be required to verify the subsurface utilities.
    c. Bores are expected to be approximately 6-12 inches in diameter and will be filled with extracted fill and grouted with a quick drying cement.

C. Drawings
    1. Drawings will be developed in 2D utilizing AutoCAD 2019 software.
    2. Drawing backgrounds will be created based on the most recently-available record drawings for each respective area. A survey will not be conducted to verify elevations since no new or existing structural elements will be designed and operating hydraulics will not be modified at the WTP.
    3. Subsurface utility engineering will be included. Arcadis will use the latest information available and coordinate with City staff on known changes prior to field locating. Data collected will be made part of construction documents but as informational only. Provisions will be included in the construction documents for the Contractor to validate exploratory utility surveys, protect the site, and repair utilities if damaged.

4. The following table provides an estimate of the number of drawings and disciplines required for the project:

Discipline	Estimated No. of Drawings
General	3
Demolition	3
Civil	5
Structural	6
Mechanical	12
Instrumentation	10
Electrical	10
Total	**49**

D. Specifications
   1. Existing guidance specifications from the Aeration Building Pump Station Rehabilitation (2021) in CSI 50 format including the City's standard bidding and front-end specifications will be used as the basis for this project.

   2. Arcadis shall provide the City with an initial list of specification sections that require input and/or final information that is to be supplied by the City relating to bidding instructions, forms, and procurement requirements.

E. Opinion of Probable Construction Cost (OPCC)
   1. A cost estimate for the project based on the 60% design at a AACE Class 3 level of accuracy (-20% to +30%) will be prepared.

F. Construction Schedule
   1. A construction schedule outlining major construction activities and identifying the critical path for the project will be prepared.
   2. Schedule shall include considerations for sequencing, outages, and by-passing activities and durations.

G. Quality Control
   1. Arcadis's Quality Control Plan developed for this project will be followed to facilitate proper reviews of deliverables prior to submittal. Reviewed documents will include design calculations, drawings, specifications, OPCC, and schedule.

H. Review Meeting

1. Arcadis shall coordinate a 60% design review meeting with the City via Microsoft Teams. Meeting agenda and meeting summary will be provided.
2. It is assumed that the City will provide review comments within fifteen (15) days from receipt of submittal. Arcadis shall respond in writing to review comments made by the City and will incorporate applicable design adjustments in the 90% submittal.

Deliverable(s):

The 60% submittal shall include the following:

1. Five (5), hardcopy sets of 60% specifications on standard 8-1/2" X 11" size paper
2. Five (5), hardcopy sets of 60% drawings shall be supplied in half-size (11" x 17")
3. Recommended equipment listing by manufacturer
4. List of information required from the City to complete the specification sections related to bidding instructions, forms, and procurement requirements.
5. 60% Opinion of Probable Construction Cost
6. 60% Construction Schedule with preliminary outage/tie-in plan considerations
7. Review agenda and meeting summary notes
8. Written responses to 60% review comments

Task 3 - 90% Design Documents (Pre-Final Design)

Arcadis shall prepare and submit to the City 90% design documents advancing the design from 60% to 90% and incorporating edits resulting from the 60% design review by the City. This design submittal will also be used for commencement of permitting activities detailed under Task 5. The 90% design will be considered pre-final; remaining changes will be related to addressing final permitting comments and preparing for bid (i.e., signing and sealing).

A. Drawings
    1. Drawings will be updated to include final design information and incorporate edits resulting from the 60% design review by the City.

B. Specifications
    1. Specifications will be updated to include final design information and incorporate edits resulting from the 60% design review by the City.
    2. An updated list of specification sections and information that remain outstanding and are required to finalize sections related to bidding instructions, forms, and procurement requirements.

C. Opinion of Probable Construction Cost (OPCC)
    1. A cost estimate for the project based on the 90% design at a AACE Class 2 level of accuracy (-15% to +20%) will be prepared.

D. Construction Schedule
   1. Construction schedule will be updated outlining major construction activities including sequencing, outages, and by-passing activities and durations.

E. Quality Control
   1. Arcadis's Quality Control Plan developed for this project will be followed to facilitate proper reviews of deliverables prior to submittal. Reviewed documents include design calculations, drawings, specifications, OPCC, and schedule.

F. Review Meetings
   1. Arcadis shall coordinate a 90% design review meeting with the City via Microsoft Teams. Meeting agenda and meeting summary will be provided.
   2. It is assumed that the City will provide review comments within 10 days from receipt of submittal. Arcadis shall respond in writing to all review comments made by the City and will incorporate appropriate design adjustments resulting from the review exchange into the project in the next scheduled submittal.

Deliverable(s):

The 90% submittal shall include the following:

1. Five (5), hardcopy sets of 90% specifications on standard 8-1/2" X 11" size paper
2. Five (5), hardcopy sets of 90% drawings shall be supplied in half-size (11" x 17")
3. Final equipment listing by manufacturer
4. List of information required from the City to complete the specification sections related to bidding instructions, forms, and procurement requirements
5. Updated Engineer's Opinion of Probable Construction Cost estimate (AACE Class 2)
6. Final Construction Schedule with milestones summary and final constraints for outage/tie-in during construction
7. Review meeting agenda and summary notes
8. Written responses to 90% review comments

Task 4 - 100% Design Documents (Final Bid Documents)

Arcadis shall prepare final bid documents that the City may utilize for the bidding process after addressing final comments from the City's review of the 90% documents and regulatory comments received during the permitting process.

Deliverable(s):

The submittal shall include the following:

1. Five (5), hardcopy sets of Final (100%) specifications on standard 8-1/2" X 11" size paper
2. Five (5), hardcopy sets of Final (100%) drawings shall be supplied in full size (22" x 34")

3. Drawings and Specifications will be signed and sealed digitally in accordance with guidance from Florida Board of Professional Engineers (FBPE) and Section 471.025, F.S (Florida Statue) regarding engineering seals
4. Updated Engineer's Opinion of Probable Construction Cost estimate (AACE Class 2, -15% to +20%)
5. Electronic specifications will be provided in a compiled PDF and Word 2019 or later.
6. Electronic copy of all drawings will be provided in PDF and AutoCAD 2019.

Task 5 – Permitting

It is anticipated that FDEP, Broward County, and City of Hollywood Building Division permits will be required for this project. Permit applications shall be prepared and submitted by Arcadis based on the 90% design documents. The design documents submitted will be noted as "Permit Set" and will be signed and sealed as required. The BODR will be updated to reflect changes as needed to meet permitting requirements.

Arcadis will communicate with FDEP, Broward County, and the City of Hollywood Building Division in response to Requests for Additional Information (RAIs). It is assumed that a maximum of one (1) RAI will be responded to by Arcadis regarding each permit submittal.

Arcadis will provide copies of correspondence and/or technical data supplied to the agencies in support of the permit applications. The City will pay fees for all permits. Arcadis will notify the City a minimum of fifteen (15) working days in advance of permit submittal to allow for the preparation of payment of the application fee(s).

Deliverable(s):

1. FDEP Application for a Specific Permit to Construct PWS Components (electronic submittal)
2. City of Hollywood Building Division Permit Submittal (electronic submittal)
3. Updated BODR to reflect final design phase changes (electronic submittal)
4. Broward County Planning and Development Management Division (electronic submittal)
5. Responses to RAIs from each permitting agency (assumed maximum of one each, for a total of three (3))

Task 6 – Bid Support

Arcadis shall provide bidding support services to the City for the project. Bidding phase services shall include the following:

1. Pre-Bid Meeting: Arcadis shall attend and participate in a Pre-Bid Meeting to provide background information on the project.
2. Respond to Bidder Requests for Information (RFI): Arcadis shall respond to written Bidder RFIs during the bid period. The City will receive the RFIs from the Contractors and send to Arcadis for

review. Arcadis shall coordinate up to two (2) RFI response packages with the City for responses to the Contractors. Responses shall be provided by way of Addenda to be published by the City. Revisions to plans and specifications will be made by text and figure updates and incorporated into the conformed documents under Task 6.4.

3. Review Bids: Arcadis shall assist the City in reviewing the qualifications of apparent lowest bidder and the responsiveness of the bid and shall make a recommendation for award to the City, including bid review, checking references, and summarizing findings
4. Post-Bid Award Services: Arcadis shall prepare the conformed contract documents incorporating addenda changes and deliver them to the City. Five (5) sets of drawings and specifications will be updated to reflect addenda issued during the advertisement, recompiled, and delivered.

Deliverable(s):

1. Bidder RFIs Responses / Addenda (up to two Addenda)
2. Conformed Documents.
   - Five (5), hardcopy sets of Final (100%) specifications on standard 8-1/2" X 11" size paper
   - Five (5), full-size hardcopy sets of Final (100%) drawings shall be supplied in full size (22" x 34")
   - Five (5), half-size hardcopy sets of Final (100%) drawings shall be supplied in full size (11" x 17")
   - Electronic specifications will be provided in a compiled PDF and Word 2019 or later.
   - Electronic copy of all drawings will be provided in PDF and AutoCAD 2019.

SCHEDULE

Arcadis' services shall commence upon receipt of written authorization from the City, which will constitute ATP. Submittals will be made in accordance with requirements under Design Phase Services and in accordance with the project schedule provided below. Arcadis estimates that the overall scope of services will be completed in approximately 52 weeks from receipt of the City's ATP. The design and permitting efforts are estimated to be completed within 43 weeks from ATP. The remaining 9 weeks are reserved for the advertisement period by the City from receipt of Final Bid Documents and post-bid support activities (actual duration will depend on the City's procurement schedule).

Arcadis shall prepare a project milestone schedule following Project Kickoff, which will be updated and reported on during the monthly progress meetings. Estimates for completion of key milestones are as provided in the following table:

Project Tasks	Estimated Duration to Completion from ATP
Task 1 – Project Management (Kick-off Meeting)	2 weeks
Task 2 – 60% Design Documents	24 weeks
Task 3 – 90% Design Document	32 weeks
Task 4 – Final Bid Documents	43 weeks
Task 5 – Permitting (start)	33 weeks
Task 6 – Bid Support	52 weeks

Note: The preliminary project milestones are based on normal working schedules. Travel and schedule restrictions caused by national, state, and local government directives (e.g., Covid-19) may impact this schedule, as well as City procurement schedule).

Disclaimer: Per the City of Hollywood Building Division website, the processing of permits is performed within a maximum of 30 working days after the plans and / or specifications are submitted. This period does not include review time for Planning and Zoning, Engineering, and Fire Departments. Therefore, this work order schedule is contingent on permitting approval within the allotted time. Any delays or extended permitting time is beyond the control of Arcadis and will need to be added to the overall milestone.

BUDGET AND INVOICING

The terms of compensation shall be in conformance with the Professional Services Agreement for General Engineering Consulting Services dated November 11, 2017 between the City and Arcadis. The proposed lump sum fee for this project is $372,679.00. A breakdown of this lump sum fee is enclosed as Attachment A. A monthly billing schedule will be a developed and submitted for acceptance during project kick-off.

The task breakdown for the lump sum fee is as follows:

Task	Fee
Task 1 – PM, Kick-off Meeting; Data Collection & Review	$37,706.00
Task 2 – 60% Design Documents	$183,568.00
Task 3 – 90-% Design Documents	$80,637.00
Task 4 – Final Bid Documents	$37,659.00
Task 5 – Permitting	$12,760.00
Task 6 – Bid Support	$20,349.00
Total	**$372,679.00**

Arcadis is excited about this opportunity to assist the City developing the design and construction documents for conversion to four-log virus treatment using free chlorine at the City's WTP. We understand the importance of this critical unit process and have dedicated staff ready to deliver this

project. Should you have any questions regarding this work order proposal, please do not hesitate to contact me via email (tung.nguyen@arcadis.com) or telephone (954.246.0936).

Sincerely,

Arcadis U.S., Inc.

Tung Nguyen, PE, PMP
Project Manager

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Copies:
Wilhelmina Montero, PE, MS (City of Hollywood)
Leah Richter (Arcadis)
Plantation Files (Arcadis)

Enclosures:

Attachment A - Detailed Lump Sum Fee Breakdown

Attachment B – Sub-consultant Proposals

ATTACHMENT A
DETAILED LUMP SUM FEE BREAKDOWN

	Contract Labor Category	Hours	Billing Rate ($ / hr)	Cost		Fee / Task	Total Fee
							$ 372,679.00
					Arcadis Labor	$ 259,305.00	
					Subconsultant Costs	$ 110,370.00	
					Other Direct Expenses (Reimbursable)	$ 3,004.00	
					Contingency		
Task 1 – PM, Kick-off Meeting; Data Collection & Review						$ 37,706.00	
Labor Subtotal					$ 29,045.00		
Leah Richter, PE	Company Officier	1	$ 240.00	$ 240.00			
Tung Nguyen PE	Project Manager	94	$ 220.00	$ 20,680.00			
Stephanie Bishop, PE	Senior Project Engineer	12	$ 180.00	$ 2,160.00			
Lia Dombroski	Project Engineer 2	8	$ 130.00	$ 1,040.00			
Danielle McKenna	Senior Technician	15	$ 115.00	$ 1,725.00			
Mindy Mondesir	Administrative 3	32	$ 100.00	$ 3,200.00			
Subcontractor Labor Subtotal					$ 8,397.00		
McKim & Creed	-		$ -	$ 8,397.00			
Corrosion Probe	-		$ -				
Bloodhound, LLC	-		$ -				
Other Direct Expenses	-				$ 264.00		(Reimbursable)
Travel	-		$ -	$ 120.00			
Printing				$ 144.00			
Miscellaneous Expenses	-		$ -				
Task 2 – 60% Design Documents						$ 183,568.00	
Labor Subtotal					$ 101,240.00		
Leah Richter, PE	Company Officier	2	$ 240.00	$ 480.00			
Tung Nguyen PE	Project Manager	38	$ 220.00	$ 8,360.00			
Stephanie Bishop, PE	Senior Project Engineer	136	$ 180.00	$ 24,480.00			
Lia Dombroski	Project Engineer 2	208	$ 130.00	$ 27,040.00			
Frank Sidari III, PE	Technical Expert	26	$ 240.00	$ 6,240.00			
Rebecca Slabaugh, PE	Technical Expert	4	$ 240.00	$ 960.00			
Sam Hobi, PE	Principal Engineer	16	$ 240.00	$ 3,840.00			
Shantanu Dandane	Project Engineer 2	80	$ 130.00	$ 10,400.00			
Chris Matthews	Technical Expert	16	$ 240.00	$ 3,840.00			
Andrea Guzman	Chief Technican	104	$ 150.00	$ 15,600.00			
Subcontractor Labor Subtotal					$ 81,128.00		
McKim & Creed	-		$ -	$ 18,778.00			
Corrosion Probe (Tank Inspections)			$ -	$ 29,800.00			
Bloodhound, LLC (Utility Survey)	-		$ -	$ 32,550.00			
Other Direct Expenses	-				$ 1,200.00		(Reimbursable)
Travel	-		$ -	$ 450.00			
Printing			$ -	$ 750.00			
Miscellaneous Expenses	-		$ -	$ -			
Task 3 – 90-% Design Documents						$ 80,637.00	
Labor Subtotal					$ 67,380.00		
Tung Nguyen PE	Project Manager	30	$ 220.00	$ 6,600.00			
Stephanie Bishop, PE	Senior Project Engineer	76	$ 180.00	$ 13,680.00			
Lia Dombroski	Project Engineer 2	150	$ 130.00	$ 19,500.00			
Frank Sidari III, PE	Technical Expert	9	$ 240.00	$ 2,160.00			
Rebecca Slabaugh, PE	Technical Expert	4	$ 240.00	$ 960.00			
Sam Hobi, PE	Principal Engineer	11	$ 240.00	$ 2,640.00			
Shantanu Dandane	Project Engineer 2	60	$ 130.00	$ 7,800.00			
Chris Matthews	Technical Expert	4	$ 240.00	$ 960.00			
Andrea Guzman	Chief Technican	84	$ 150.00	$ 12,600.00			
Subcontractor Labor Subtotal					$ 12,457.00		
McKim & Creed	-		$ -	$ 12,457.00			
Corrosion Probe			$ -	$ -			
Bloodhound, LLC	-		$ -				
Other Direct Expenses	-				$ 800.00		(Reimbursable)
Travel	-		$ -	$ 300.00			
Printing			$ -	$ 500.00			
Miscellaneous Expenses	-		$ -	$ -			
Task 4 – Final Bid Documents						$ 37,659.00	
Labor Subtotal					$ 30,200.00		
Tung Nguyen PE	Project Manager	11	$ 220.00	$ 2,420.00			
Stephanie Bishop, PE	Senior Project Engineer	38	$ 180.00	$ 6,840.00			
Lia Dombroski	Project Engineer 2	88	$ 130.00	$ 11,440.00			
Frank Sidari III, PE	Technical Expert	3	$ 240.00	$ 720.00			
Sam Hobi, PE	Principal Engineer	4	$ 240.00	$ 960.00			
Shantanu Dandane	Project Engineer 2	8	$ 130.00	$ 1,040.00			
Chris Matthews	Technical Expert	2	$ 240.00	$ 480.00			
Andrea Guzman	Chief Technican	42	$ 150.00	$ 6,300.00			
Subcontractor Labor Subtotal					$ 7,339.00		
McKim & Creed	-		$ -	$ 7,339.00			
Corrosion Probe			$ -	$ -			
Bloodhound, LLC	-		$ -				
Other Direct Expenses	-				$ 120.00		(Reimbursable)
Travel	-		$ -	$ 120.00			
Printing			$ -	$ -			
Miscellaneous Expenses	-		$ -	$ -			
Task 5 – Permitting						$ 12,760.00	
Labor Subtotal					$ 12,760.00		
Tung Nguyen PE	Project Manager	4	$ 220.00	$ 880.00			
Stephanie Bishop, PE	Senior Project Engineer	20	$ 180.00	$ 3,600.00			
Lia Dombroski	Project Engineer 2	60	$ 130.00	$ 7,800.00			
Rebecca Slabaugh, PE	Technical Expert	2	$ 240.00	$ 480.00			
Subcontractor Labor Subtotal					$ -		
McKim & Creed	-		$ -	$ -			
Corrosion Probe			$ -	$ -			

	Contract Labor Category	Hours	Billing Rate ($ / hr)	Cost		Fee / Task	Total Fee
							$ 372,679.00
					Arcadis Labor	$ 259,305.00	
					Subconsultant Costs	$ 110,370.00	
					Other Direct Expenses (Reimbursable)	$ 3,004.00	
					Contingency		
Bloodhound, LLC	-		$ -				
Other Direct Expenses	-				$ -	(Reimbursable)	
Travel	-		$ -				
Printing			$ -				
Miscellaneous Expenses	-		$ -	$ -			
Task 6 – Bid Support						$ 20,349.00	
Labor Subtotal					$ 18,680.00		
Tung Nguyen PE	Project Manager	8	$ 220.00	$ 1,760.00			
Stephanie Bishop, PE	Senior Project Engineer	16	$ 180.00	$ 2,880.00			
Lia Dombroski	Project Engineer 2	48	$ 130.00	$ 6,240.00			
Andrea Guzman	Chief Technican	52	$ 150.00	$ 7,800.00			
Subcontractor Labor Subtotal					$ 1,049.00		
McKim & Creed	-		$ 1,049.00	$ 1,049.00			
Corrosion Probe			$ -	$ -			
Other Direct Expenses	-				$ 620.00	(Reimbursable)	
Travel	-		$ -	$ 120.00			
Printing			$ -	$ 500.00			
Miscellaneous Expenses	-		$ -	$ -			

ATTACHMENT B
SUB-CONSULTANT PROPOSALS

CITY OF HOLLYWOOD FOUR-LOG DISINFECTION
SCOPE TO ARCADIS
December 15, 2020

McKim & Creed will provide the following engineering services to Arcadis Inc, for the City of Hollywood 4-Log Disinfection project.

Major Scope Elements Include:

Task 1 - Electrical and I&C Project Management, comprising of coordination with Arcadis project management, virtual project meetings, correspondence, scheduling, budget invoicing and limited site visits.

Task 2 – 60% Design - Electrical design services including all drawings, specifications, estimates of probable costs. Design coordination with Process and Mechanical disciplines and City staff.

Task 3 – 90% Design Instrumentation design services including all drawings, specifications and estimates of probable costs. Design coordination with Process and Mechanical disciplines and City staff. Permitting document support and coordination with Arcadis to produce the submittal to permitting Agencies.

Task 4 - Final Issue for Bid Construction Documents and Construction Costs.

Task 5 – Bid Phase assistance, and Recommendation of Award.

Defining the above Scope elements:

Task 1 will consist of providing input to Arcadis for meeting minutes, support in scheduling deliverables to the City, and providing timely invoicing for inclusion with Arcadis's invoicing to the City. Arcadis will provide a comment tracking spreadsheet for McKim & Creed to address comments related to the electrical and I&C portion of the project. Site visits will be limited to two, for the startup services and final completion. Substantial Completion inspection and punch list site visit will coincide with Startup services.

Task 2 will provide 60% Construction Documents for the electrical portion of the project. This effort will include the necessary communication and coordination with Arcadis design staff to bring the electrical design to a 60% level. Review of the appropriate Arcadis equipment specifications as it pertains to the electrical designed will be performed. Estimate of Probable Construction Cost (EOPCC)

will also be provided as part of this submittal. Comments from the City will be incorporated for the 100% design effort.

Task 3 comprises of 90% documents essential to the permitting and bidding process. McKim & Creed will assist Arcadis in providing the necessary documentation as it pertains to the electrical and I&C portion of the project in order to obtain any of the required permits for the project.

Task 4 will consist of signed and sealed Issue for Bid documents that incorporates 90% and final comments from Arcadis and the City. Additionally, a final EOPCC will be provided for the electrical and I&C portions of the project.

Task 5 will assist Arcadis in the bidding process, with attending a pre-bid meeting, answering Contractor questions, assist with addendums, and assisting in the recommendation of award to the low bid contractor.

The Work described herein will be performed for the Not to Exceed Fee Amount of $48,020.00. If directed in writing by Arcadis, additional Work can be performed using an hourly rate fee of $200.00 plus expenses. Thank you for considering McKim & Creed for this project.

A. Haudricourt, P.E., PM
McKim & Creed Inc.

Date: 12/15/2020

Tung Nguyen P.E, PMP
Arcadis Inc.

Date: _____

McKIM&CREED

ENGINEERS

SURVEYORS

PLANNERS

CITY OF HOLLYWOOD												
4-LOG DISENFECTION												
ARCADIS												
TASK ID	COMMENTS	ENGINEER MANAGER	Project Engineer IV	Project Engineer I	I&C Specialist	Sr. CAD Technician	Sr. Project Admin.	LABOR HOURS	LABOR DOLLARS	OTHER ODC's	TOTAL ODCs	TOTAL COSTS
TASK 1	PROJECT MANAGEMENT											
	Subtotal Task 1	0.0	5.0	28.0	2.0	2.0	6.0	43.0	$ 7,897.00	$500.00	$500.00	**$8,397**
Task 2	60% Design											
	Subtotal Task 2	0.0	14.0	44.0	36.0	48.0	4.0	146.0	$ 18,778.00	$0.00	$0.00	**$18,778**
Task 3	90% Design Permit Set											
	Subtotal Task 3	0.0	7.0	28.0	12.0	52.0	8.0	107.0	$ 12,457.00	$0.00	$0.00	**$12,457**
Task 4	ISSUE FOR BID											
	Subtotal Task 4	0.0	5.0	16.0	8.0	24.0	8.0	61.0	$ 7,339.00	$0.00	$0.00	**$7,339**
Task 5	Bidding Assistance											
	Subtotal Task 5	0.0	1.0	2.0	0.0	4.0	2.0	9.0	$ 1,049.00	$0.00	$0.00	**$1,049**

ASSUMPTIONS:

- One Site visit is planned during design period. If more is requested it will be done at time and expenses rate.
- All project meetings will be virtual.
- CA services not included and will be a separate contract.

CORROSION PROBE, INC.

THE COMPLETE ENGINEERING APPROACH – FROM DETECTION TO CORRECTION

December 15, 2020

Via email: tung.nguyen@arcadis.com

Mr. Tung Nguyen, P.E., PMP
Arcadis
8201 Peters Rd
Suite 3200
Plantation FL 33324

Subject: PROPOSAL FOR FRP TANK INSPECTIONS AT HOLLYWOOD, FL SITE (REV 2)

Dear Mr. Nguyen:

At your request, we are submitting this proposal for Corrosion Probe, Inc. (CPI) to perform multiple internal and external inspections of the sodium hypochlorite day and bulk tanks located at Hollywood, FL site. The following cost and scope of work is listed below:

Nine (9) total tanks comprised of seven (7) side entry tanks and two (2) vertical entry only tanks.

- In order to inspect all nine (9) tanks, four (4) separate trips to the site will be needed. Each inspection trip will include two (2) side entry tanks.
- The vertical entry only tanks will be inspected externally only.
- For the horizontal tanks with side entry, a full internal and external inspection of the tank will be performed.
- All inspections will be performed per applicable sections of TAPPI TIP 0402-28, Corrosion Probe's internal best practice for inspection of fiberglass reinforced plastic equipment, and FRPI's Aboveground Storage Tank Inspector Certification and Licensing Manual.
- Written report of findings to include recommendations for repairs and statement on continued use.
- Pricing includes all travel, travel expenses, onsite labor, and labor for report preparation.
- This quote is for one day on-site per trip by a local CPI engineer/consultant with review of results by CPI's Ross Pittman, P.E. (see attached resume). CPI will also provide a hole watch for the work.

TOTAL T&M ESTIMATED COST …… **$29,800**

Qualifications

- Inspections will be performed by CPI engineers and consultants in that respective state to limit any need for quarantine or other COVID-19 precautions associated with global travel.
- The above scope of work and cost assume CPI personnel will provide appropriate entrant PPE, including harness, retrieval lanyard, and an 8-ft ladder for access. CPI will also provide a field safety plan that addresses confined space entry permitting, atmospheric testing. A confined space attendant will be provided by CPI.
- Safe access shall be provided by others for inspection including, but not limited to, removal of access covers, internal cleaning, equipment group lockout, and returning the tank back to service (reinstalling covers with new gaskets and bolting hardware, unlocking, etc.).
- Should there be a change in scope, CPI will first submit a scope change in writing to you and have your written approval prior to proceeding with the additional/changed work.

We at CPI appreciate the opportunity to provide this type of engineering support to Arcadis. This quote is submitted for your review and consideration by,

The Staff of Corrosion Probe, Inc.

Jason M. Hinely, P.E.
Director of Mechanical Integrity Services
hinelyj@cpiengineering.com
(912) 663-0833

cc: C. Ponte (CPI)

Attachment: Resume - Pittman

CORROSION PROBE, INC.

THE COMPLETE ENGINEERING APPROACH – FROM DETECTION TO CORRECTION

Ross Pittman, P.E.

Staff Metallurgist

Registered Professional Engineer

State of Georgia, PE041566

State of Florida, PE089036

Member of ASTM and NACE

pittmanr@cpiengineering.com

(912) 580-1849

EDUCATION

B.S. Materials Science & Engineering, Georgia Institute of Technology, Atlanta, GA – 2011

PROFESSIONAL LICENSURE

Registered Professional Engineer – State of Georgia – License # PE041566

Registered Professional Engineer – State of Florida – License # PE089036

Certified FRP Aboveground Storage Tank Inspector – FRPI SP8310-001 & SP8210-001

PROFESSIONAL STRENGTHS

Mr. Pittman has 8+ years of experience in mechanical integrity programs specific to the pulp & paper industry. He has participated in numerous tank inspections covering multiple process environments and materials of construction (metal and non-metal), including Kamyr and batch digesters, evaporators, and deaerators. He has participated in structural surveys of existing infrastructure to determine repair needs. He has created inspection plans for brick & tile as well as metallic tanks/pressure vessels. He has performed quality verification for the repair and construction of steel storage tanks as well as FRP tanks and pressure vessels. He has led failure analysis investigations for numerous pieces of fixed and rotating equipment. He has performed material selection analysis and repair planning for equipment in a variety of chemical service.

EXPERIENCE PROFILE

Staff Metallurgist – Pulp Mill (Corrosion Probe)

- Lead engineer for condition assessments and repair planning for high-risk metal tanks and pressure vessels, including continuous digesters, batch digesters, evaporators, and deaerators.
- Responsible for creating risked-based inspection plans for fixed equipment primarily in the pulp & paper industry.
- Reviews inspection data provided by NDT contractors and utilizes that information, along with 1st person inspection, to determine if the equipment is fit for continued service.
- Provides material recommendations for new construction tanks/vessels and for repairs of damaged/corroded tanks/vessels.
- Provides on-site failure investigation and overseas further metallurgical laboratory analysis to determine root cause of failure and alleviate similar future damage.
- Lead engineer on fiberglass reinforced plastics (FRP) equipment inspections and condition assessments for various mills, including bleach tower, crossovers, ClO2 storage tanks, and bleach plant scrubbers.
- Considered company subject matter expert in regards to fiberglass reinforced plastics (FRP), including shop and field quality verification of FRP constructed equipment.
- Provides shop and field quality verification of steel tank and vessels including new construction and repairs.
- Provides recommendations and analysis of materials for corrosive service.

TRAINING

FRP 301 – Introduction to Design and Condition Assessment (FRP Institute)

FRP 831 – Field Inspection of Aboveground Chemical Bulk Storage Tanks (FRP Institute)

OSHA 10-Hr Construction Safety and Health

OSHA 29 CFR 1910.146 – Permit & Non-Permit Confined Space Entry

Blood Hound
750 Patricks Place
Brownsburg, IN 46112

ESTIMATE

Created Date 2/26/2021

Estimate Number 59522

Customer	Arcadis US, Inc.	Name	Mr. Daniel Garcia
Billing Phone	786-384-7012	Phone	786-384-7012
Billing Address	1000 NW 57th Ct., Suite 770 Miami, FL 33126 US	Email	daniel.i.garcia@arcadis.com
Job Site Location	City of Hollywood Water Treatment Plant: SUE work, 3441 Hollywood Blvd, Hollywood, Florida, 33021		

Product	Quantity	Sales Price	Total Price
Advantage Locate (hourly)	40.00	$195.00	$7,800.00
Vacuum Excavation (Hourly)	90.00	$275.00	$24,750.00
		Grand Total	$32,550.00

Scope of Work

Customer SOW water treatment plant renovations

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 Blue shaded areas and as discussed and adjusted during a site walk on 2/26/2021.**
- **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 @ $48.75 per increment, not to exceed 40 hours.**
- 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.
- BHUG is not responsible for, moved, altered, obliterated or maintaining marks. BHUG will impose an additional fee to relocate/remark facilities.

Blood Hound
750 Patricks Place
Brownsburg, IN 46112

ESTIMATE

Created Date 2/26/2021

Estimate Number 59522

- 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 to be determined by the engineer of record. Based on this exhibit and site walk it is assumed that up to (40) excavations of varying surfaces may 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 @ $68.75 per increment, not to exceed 90 hours.**
- **Estimated time on site is based on 40 test holes. Determining the number of test holes prior to performing horizontal locates is not always accurate. The number of test holes being assumed for this project is for budgetary purposes. The time and fees associated with this estimate are based solely on the above referenced number of test holes. Actual number of test holes may be less than estimated which would decrease time on site and actual invoice however, if more test holes are required than estimated above, time on site would be increased which would require renegotiations or additional estimates.**
- 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

Blood Hound
750 Patricks Place
Brownsburg, IN 46112

ESTIMATE

Created Date 2/26/2021

Estimate Number 59522

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.
- 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: _____

Blood Hound
750 Patricks Place
Brownsburg, IN 46112

ESTIMATE

Created Date	2/26/2021
Estimate Number	59522

Phone #: 888-858-9830 **Fax #:** 888-858-9829 **Email:** BHI@bhug.com **Website:** bhug.com

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 is 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 **Office # 888-858-9830**
Brownsburg, IN 46112 **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.