Protect your Pipes



Key components of an effective locating wire solution

Cimco-GC SYSTEMS

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Today's Agenda

- The Challenges of Locating Underground Utilities
- The Science Behind Tracer Wire
- How to Create a Complete Locating System
  1. Conduct
  2. Connect
  3. Ground
  4. Access
  5. Locate
- The Dos and Don'ts of Tracing Systems

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Puyallup, Washington

- *40+ Years Serving the Waterworks and Irrigation Industries in the Pacific Northwest.*
- *Independent Manufacturer's Representative:*

CLA-VAL · Cimco-GC PACKAGED SYSTEMS · Copperhead INDUSTRIES · ECHOLOGICS a MUELLER brand · Link-Seal · Garlock RANGER II · GPT · HYDRO-GUARD a MUELLER brand · IPEX by aliaxis · MAXADAPTOR ONE&DONE · SAFE-T-COVER · VAL-MATIC · WELD-ON · TEMPO COMMUNICATIONS

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The Challenges of Locating Underground Utilties



"Where did we put that mainline again?"

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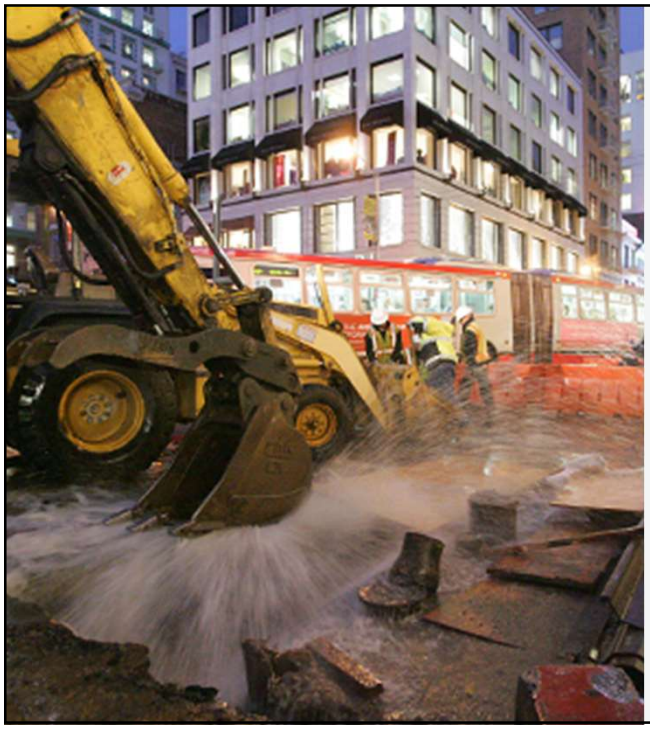
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Why do we put utilities underground?

5



What happens when we can't find them?

6

Industry Damages

$30 billion

construction costs associated with underground facility damages in the U.S.

34%

of damages are due to 'locating practices not being sufficient'

217,123

Number of reported U.S. damages in 2021

Top 5 Damaged Utility Markets

1) Natural Gas
2) Telecommunication
3) Electric
4) Cable TV
5) Water and Sewer

Source: DIRT Report for 2021, Common Ground Alliance

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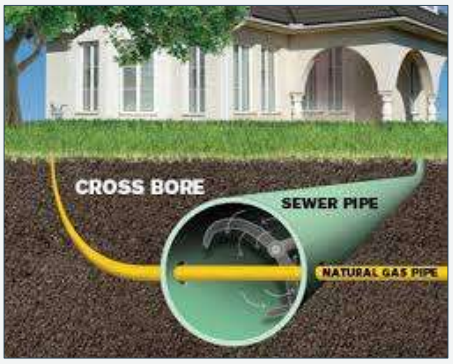
Worst-case scenario…



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Directional Drill Cross Bore





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Locating 101



How do we protect our utilities?

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You cannot protect what you can't find



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Methods for locating underground utilities



Signs



Markings/flags



Metal detection

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Metal Detection

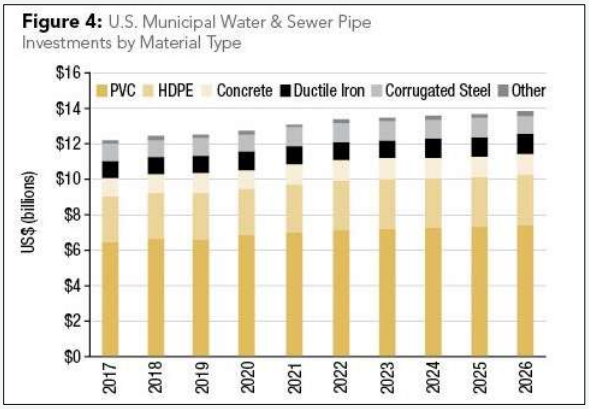
- Works with large metal pipes close to the surface
- Smaller, and deeper pipes more difficult (or impossible) to detect
- Detects any pipe or metal object, hard to identify what is detected
- Does not detect plastics



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Water market insights

- Bluefield forecasted that **new and replaced pipe and hardware infrastructure** would make up more than **57% of municipal utilities total capital spend through 2026.**
- New spending on pipes is showing a strong preference for plastic pipes, largely because of cost.



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Methods for locating underground utilities



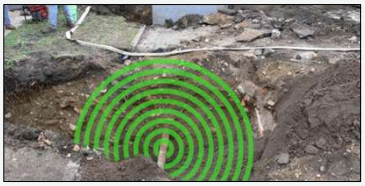
Signs



Markings/flags



Metal detection



Detect an electrical current conducted by pipe

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Detecting Electrical Currents Conducted by Pipe

- Works well with copper water lines (conductive material)
- Does not work well with iron or steel
- Isolation gaskets cut off the signal
- Poor conductivity results in shorter less accurate locates
- Signal can jump away from intended pipe
- Does not work with plastic materials



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Methods for locating underground utilities



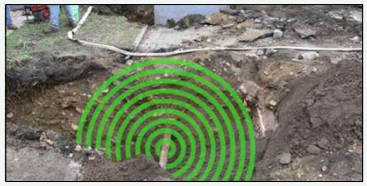
Signs



Markings/flags



Metal detection



Detect an electrical current conducted by pipe



Marker Balls

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Marker Balls for Locating

- Retrofittable and Modular
  - Use passive coils for detection
  - Allow retrofittable locating
  - Specific to the service type for differentiation
  - Makes plastics, nonconductive metal, deep, and pipes with isolations gaskets locatable
  - **Early marker ball technology had hazardous chemicals, needed to be level, and had limited bury depth (5ft)**



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Choose an Effective Marker Ball Solution

- No hazardous chemicals
- Does not need to be level
- No batteries / power source
- Stack for depths beyond 5 feet
- Retrofit or use in conjunction with Tracer wire for most robust solution
- 9 industry standard frequencies



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RFID Marking Balls



- Read/write capability for custom data storage and retrieval
- Compatible with all industry-standard frequencies
- Unique serial number for reliable identification

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Methods for locating underground utilities



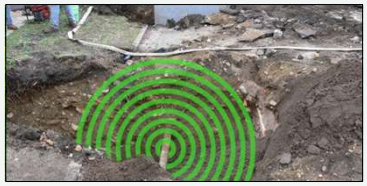
Signs



Markings/flags



Metal detection



Detect an electrical current conducted by pipe



Marker Balls



Tracer wire

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Detecting Electrical Currents Conducted by a Tracer Wire

- Tracing wire conducts the signal
  - Made from conductive copper
  - Thin to reduce cost (8-20 gauge)
  - Coated to prevent signal from jumping
  - Specific to the pipe it travels with for differentiation
  - Makes plastics, nonconductive metal, deep, and pipes with isolations gaskets locatable



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The Science Behind Locating Electrical Currents



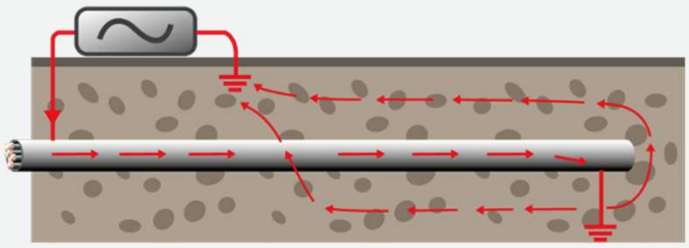
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The Theory Behind Locating

- Signals are created by the current flowing from the transmitter, along the conductor and back to the transmitter, ***but only when a ground, or complete circuit exists.***
- The current typically uses the earth/moist soils to complete the circuit, from where the signal goes to ground back to the ground rod at the transmitter.

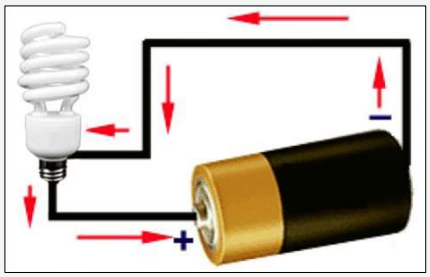


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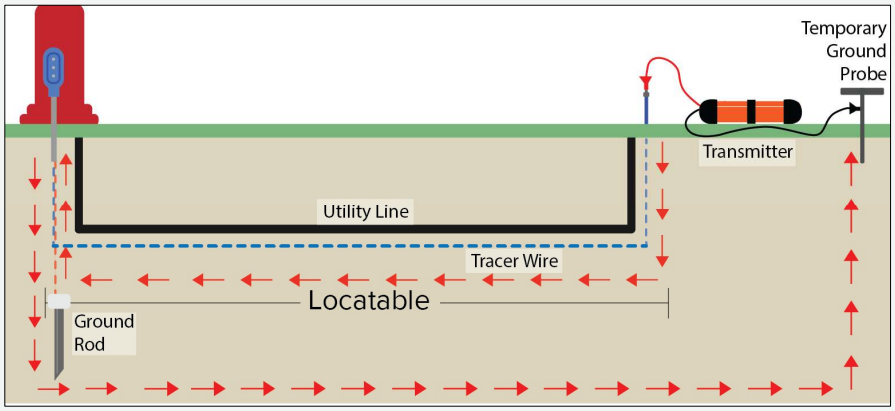
Common Circuits





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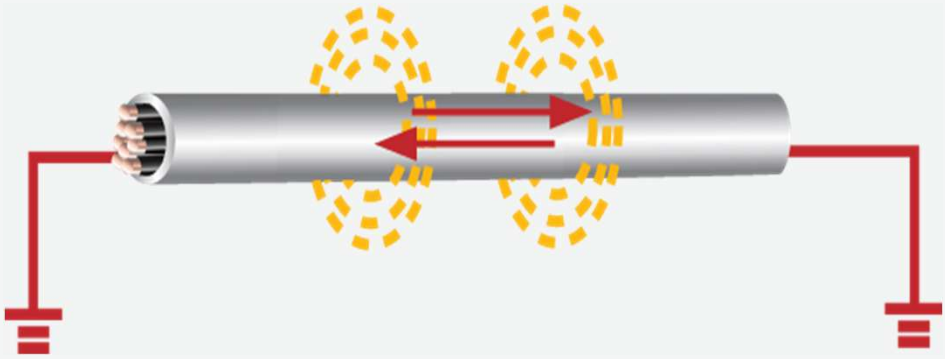
Tracing Wire Circuit



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The Locating Signal

Produced by the flow of the alternating current (AC) which creates an electromagnetic field that radiates from the line and is known as the signal.



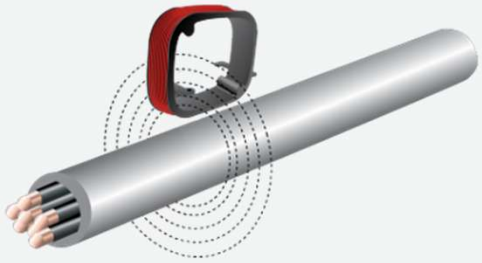
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Detecting the Locating Signal

- The locator receiver contains sensors, known as **antennas**, that detect the electromagnetic field/signal.
- The signal induces a “response” in the antennas by electromagnetic induction.





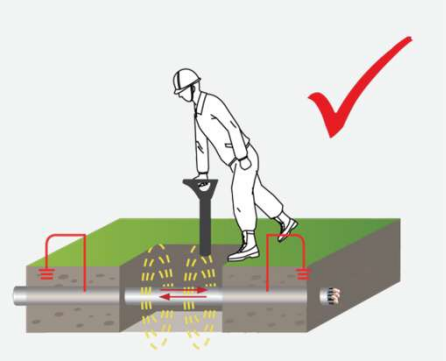
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The Locating Signal

If there isn't any ***AC CURRENT FLOWING***, there will not be a ***LOCATING SIGNAL***.



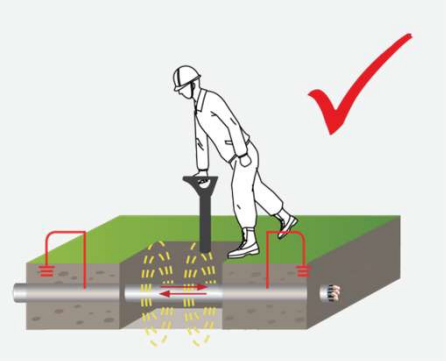


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The Locating Signal

Locators do ***NOT*** locate buried cables or pipes.
They ***DETECT*** electromagnetic ***SIGNALS*** radiating from conductive cables or pipes.





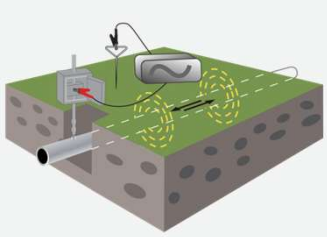
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Signals Used for Locating

Passive Locating – Signal passively exists from a variety of sources and can be located using only the receiver.

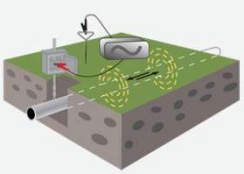


Active Locating – Signal produced by transmitter and located using the receiver.

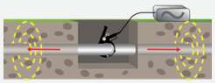


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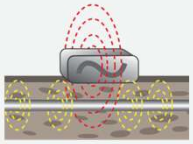
3 Ways to Apply Active Locating Signal



Direct Connection – one cable to the target line, the other to the ground



Clamp – induces a signal onto a cable or pipe without making a direction connection



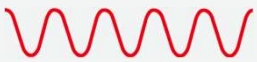
Induction – induces a signal onto a cable or pipe by placing the transmitter on the surface or target line

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Active Signal Frequency



High Frequency (83 kHz)
- Direct connection, clamp induction
- Shortest distance
- Highest distortion and/or bleed off



Medium Frequency (8.19 kHz)
- Direct connection and clamp
- Reasonable distance
- Increased distortion and/or bleed off

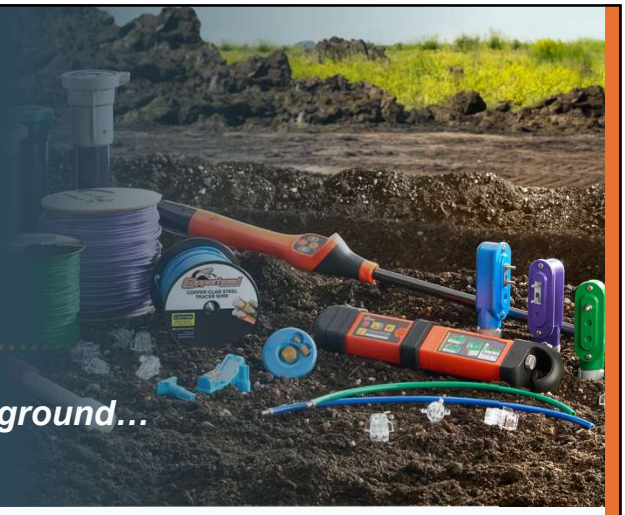


Low Frequency (512 kHz)
- Direct connection
- Longest distance
- Lowest distortion and/or bleed off

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Create a Complete Locating System



More than just putting a wire in the ground…

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Create a Complete Locating System

The Goal: Create a locating system that ***lasts the lifetime of the pipeline***.

Five Steps:

1. Conduct
2. Connect
3. Ground
4. Access
5. Locate

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1. Conduct

The right tracing wire matters

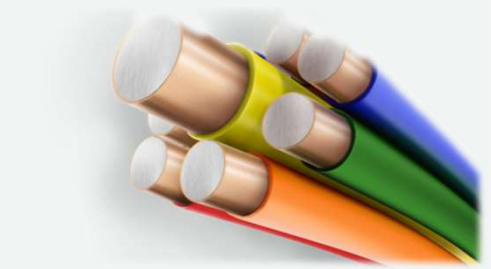
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The Right Tracing Wire Matters

You can't use just any wire from the hardware store for locating underground utilities!

Tracing wire must:

- Conduct a signal
- Be strong (sometimes *really* strong)
- Be rated for direct burial
- Be the right color
- Be Installed Correctly



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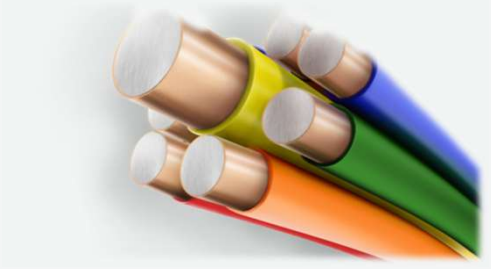
Tracing Wire Must Conduct a Signal

- Steel or iron wire does not conduct a signal well
- The current industry-standard is solid copper for high conductivity

- **Fact** or **Myth**?

The bigger the wire gauge, the stronger the signal…"

Myth!

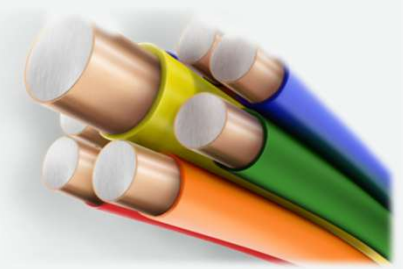


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Tracing Wire Must Conduct a Signal

- Larger diameter wires are for strength, not the signal-carrying ability
- Electrical currents travel on the outside of the wire, thus size does not affect signal strength
- Breakage is the most common failure during tracer wire installation

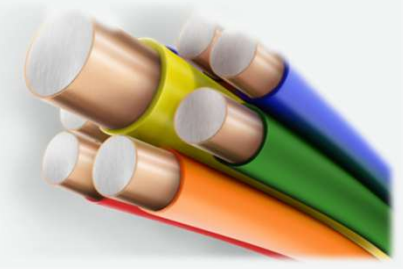


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Tracing Wire Must Be Strong

- **Current Industry Standard:**
  - Solid copper wire
  - 12 Gauge
  - Break load of around 200 pounds

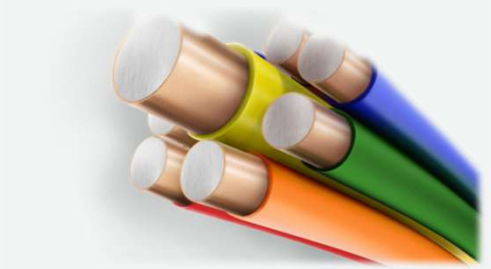


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Tracing Wire Must Be Strong

- **Current Industry Standard:**
  - Solid copper wire
  - 12 Gauge
  - Break load of around 200 pounds
- **Another Option:**
  - Copper-clad steel wire
  - 12 Gauge
  - Break load of around **452 pounds**

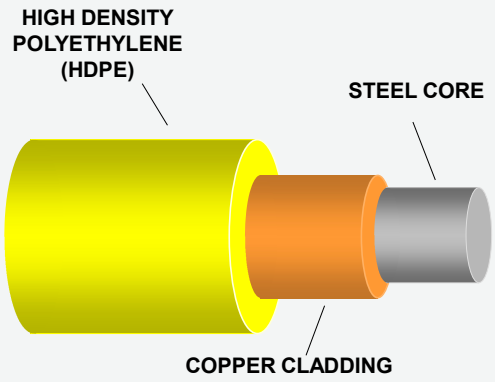


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Copper-Clad Steel (CCS) Tracer Wire

- Copper cladding on the outside to provide conductivity
- Steel on the inside to provide strength
- HDPE Jacket for insulation

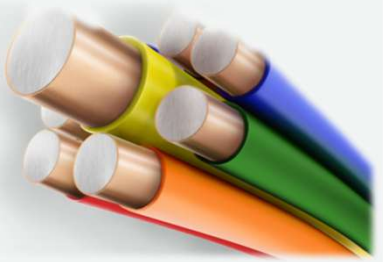


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Copper-Clad Steel History

- CCS was first produced in Rankin, PA in 1915.
- Through the years, it has been used in various markets: Telecommunications, CATV, telephone, and utility grounding applications
- Commercially this product is used in various goods such as antenna wire, trolley cable, vacuum cleaner hoses, detonation wire (TNT), and many other products.



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1055 High-Strength Steel

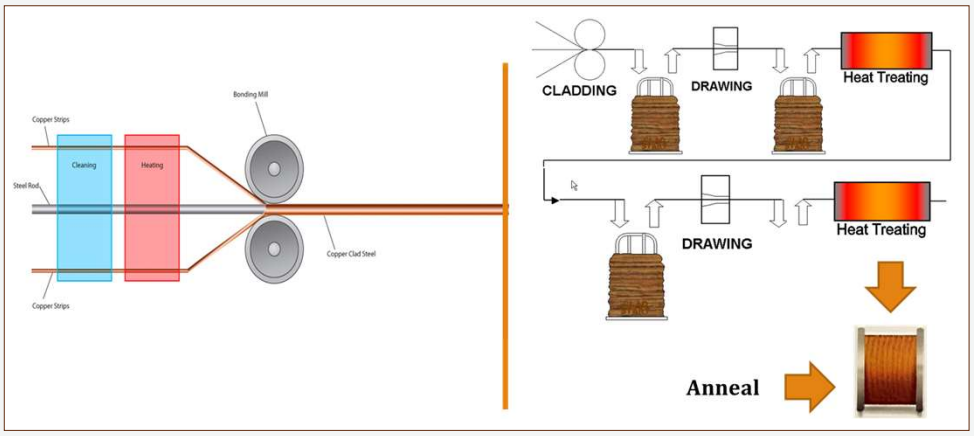


Highly Conductive Oxygen-Free Copper

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CCS Cladding Process



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Corrosion

The most common causes of metal corrosion:

- Moisture
- Air
- Dissimilar metals
- Electrical currents
- Dirt and bacteria

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Corrosion

Correctly clad Copper-Clad Steel wire leaves no room for air or moisture to get between the copper and steel to cause corrosion.

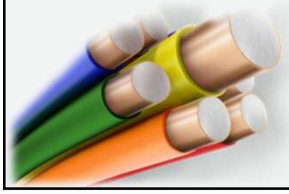
- ASTM B1010 – Standard Specification for Copper-Clad Steel Electrical Conductor for Tracer wire Applications



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Advantages of CCS

- More durable, longer-lasting performance
- Twice the breaking strength of solid copper
- Reduced material cost
- More stable pricing
- Reduced threat of theft due to lack of after-market value
- Lighter weight, resulting in reduced shipping and handling costs
- Fewer breaks during installation, fewer breaks over time



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Tracer Wire Must Be REALLY Strong

- Standard Open Cut installation requires tracing wire to be strong
- Directional boring and pipe bursting requires a tracing wire to be REALLY strong… ***up to 10x stronger!***

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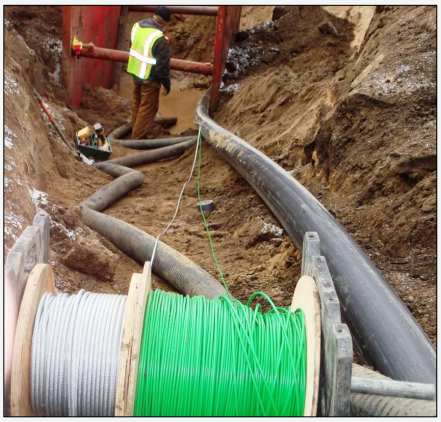
Open Cut





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Direction Drilling/Boring

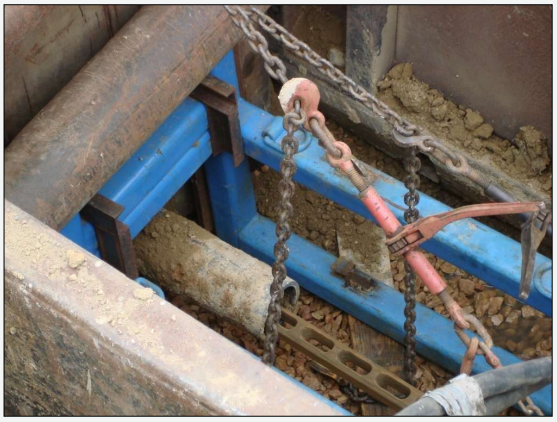




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Pipe Bursting





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Tracer Wire Must Be REALLY Strong

Open Cut

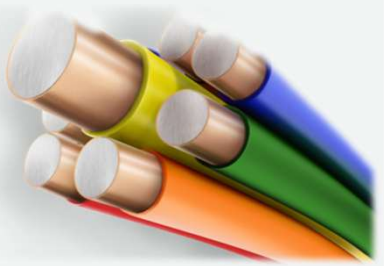
- High Strength: 12 Gauge has a 452-pound break load

Directional Drilling

- SoloShot Extra High Strength: 12 Gauge has a 1,150-pound break load

Pipe Burst

- SoloShot Extreme: 3/16” 7x7 stranded CCS has a 4,700-pound break load

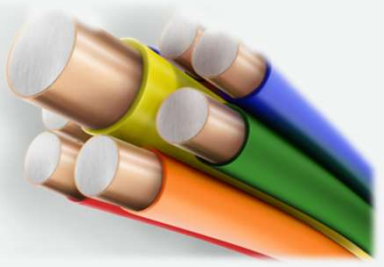


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Tracer Wire Must Be Rated for Direct Burial

- Interaction with dirt and bacteria causes corrosion of tracer wire, leading to failure
- Tracing wire needs protective insulation or jacketing
- Average wire at the department store has a jacket that is not for direct burial, it will corrode in the ground leading to failure



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Tracer Wire Must Be Rated for Direct Burial

Wire Insulation Type

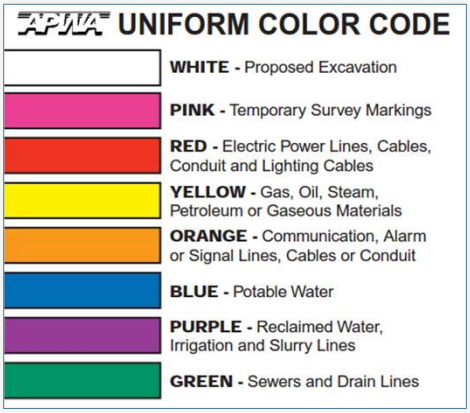
- For direct burial use only:
  - High Density Polyethylene (HDPE) or
  - High Molecular Weight Polyethylene (HMWPE)
- Nylon or THHN (Nylon/PVC) is most common at big-box stores and is **not** designed for direct burial

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Tracer Wire Must Be the Right Color

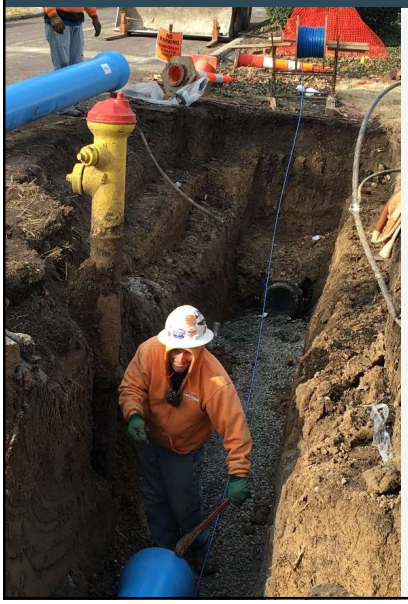
Jacket Color

- Color is simple, follow the APWA uniform color code, without exception – just like the paint used for marking



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Tracer Wire Must Be Installed Correctly



Placement of the wire in regard to the pipe:

- Tracer wire should be placed in the same orientation as all installed pipes
- Install the tracer wire on the bottom half of the pipe, between 3 & 9 o'clock
- Be consistent (east or west side)

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2. Connect

Solid connections are critical

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Connections

Good connections are critical.

- Even if you have the best tracer wire in the ground, it's only as good as the connections
- Good connections:
  - Have dielectric gel for corrosion protection
  - Made of materials that will last underground
  - Protect the connection from moisture in the ground

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Connections

- Connectors:
  - Protect from moisture and corrosion
  - Are essential for proper conductivity and longevity
- The average connectors at the hardware store are not meant for direct burial
- Electrical tape only lasts about a year in the ground

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Connections

- **Moisture displacement connectors**
  - 3-way connectors

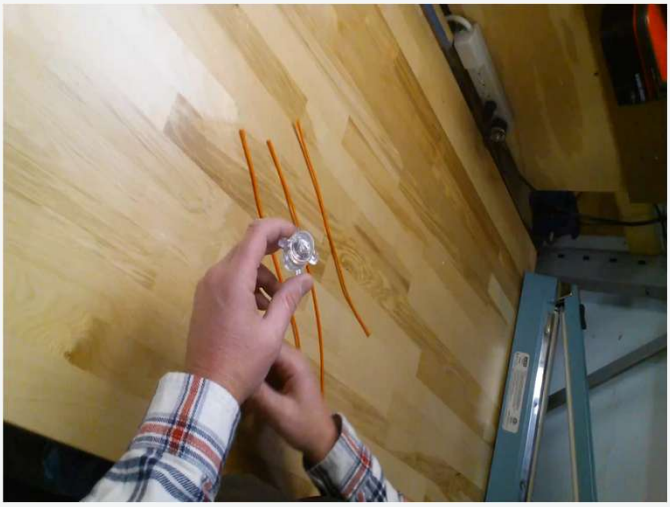
SnakeBite™
Locking Connector



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Connections



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Connections

- **Moisture displacement connectors**
  - 3-way connectors
  - Mainline to lateral connectors





Mainline to Service Connector

63

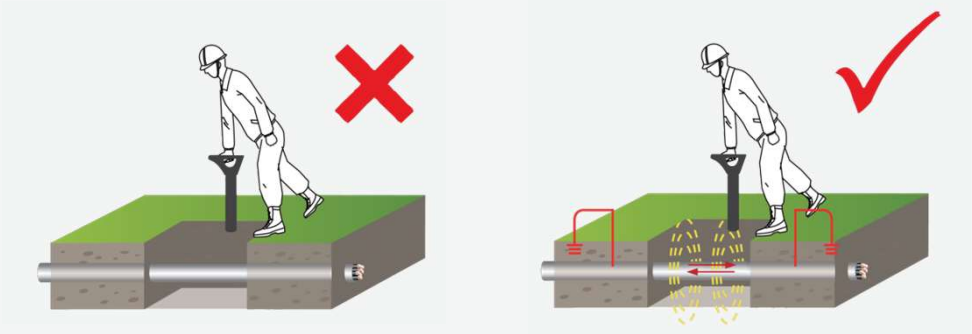
3. Ground

You can't push electricity

64

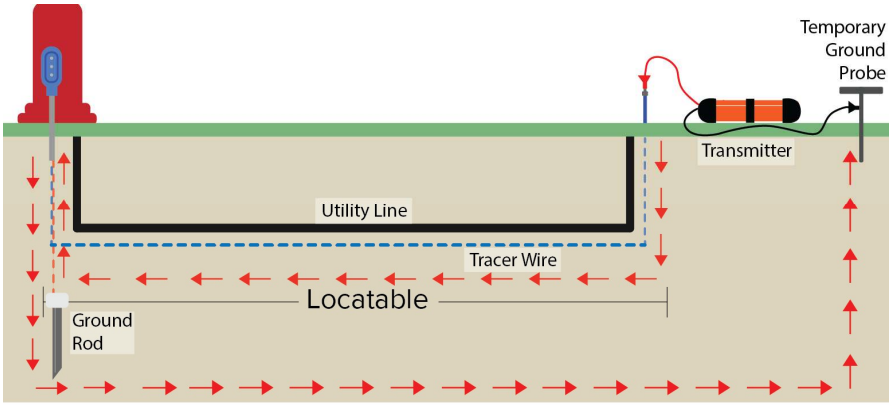
The Locating Signal

If there isn't any ***AC CURRENT FLOWING***, there will **not** be a ***LOCATING SIGNAL***.



65

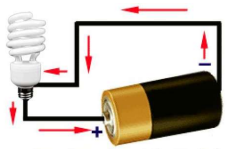
Tracing Wire Circuit



66

Ground

- Proper grounding/terminating of the wire will ensure the quality of the signal
- Industry standard:
  - Add temporary grounds for each dead end needed to be located
  - Or hope the tracing wire ends touch ground and are not corroded





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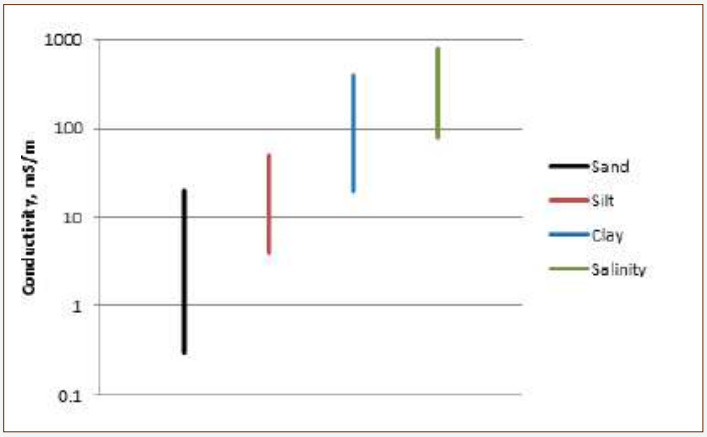


Moving grounds could take all day.

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68

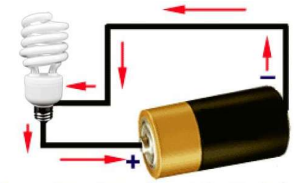
Soil Conductivity



69

Ground

- Industry standard:
  - Add temporary grounds for each dead end needed to be located
- Another option:
  - Add grounding rods to every dead end during construction





70

Ground

- 1.5# Magnesium grounding rod
- Magnesium conducts well and does not corrode from exposure to the ground, can last the life of the pipeline
- Buried at depth of pipe to ensure strong ground connection
- Attached to CCS Tracing wire



71

Failure to Properly Ground

- Current will not want to flow up other services if the dead-end of the tracer wire does not provide a good path to the ground.
- These other services can only be located by moving a temporary ground post to each dead end



72

4. Access

"I'm sorry Dave, I'm afraid I can't do that."

73

Access

- To apply a direct connection, you have to access your tracing wire
- Industry-standard Access
  - Wire stubbed up out of the ground
  - Wire coming up in a valve box
  - Wire wrapped around a fire hydrant

74

Tracing Wire Installations Gone Bad





75

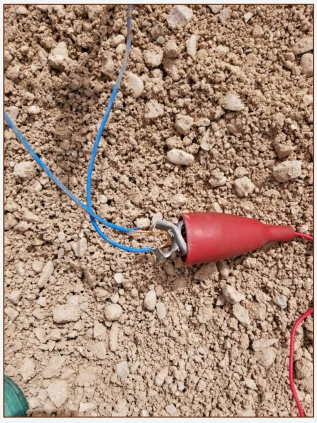
Tracing Wire Installations Gone Bad

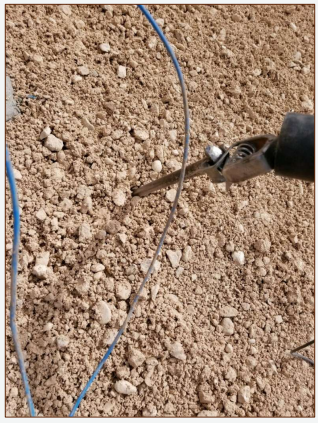




76

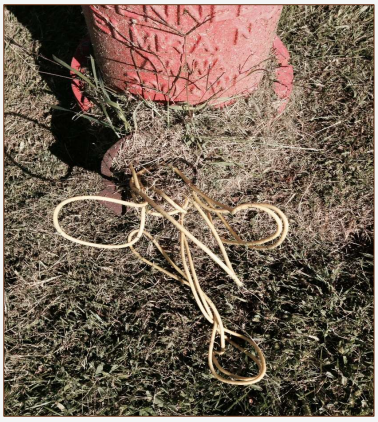
Tracing Wire Installations Gone Bad





77

Tracing Wire Installations Gone Bad





78

Tracing Wire Installations Gone Bad



79

Hazards of Poor Access Points

- Wire can corrode
- Wire can get cut
- Wire can get in the way (Fire Hydrant)
- Wire can become buried
- Wire will not be attached to a proper ground

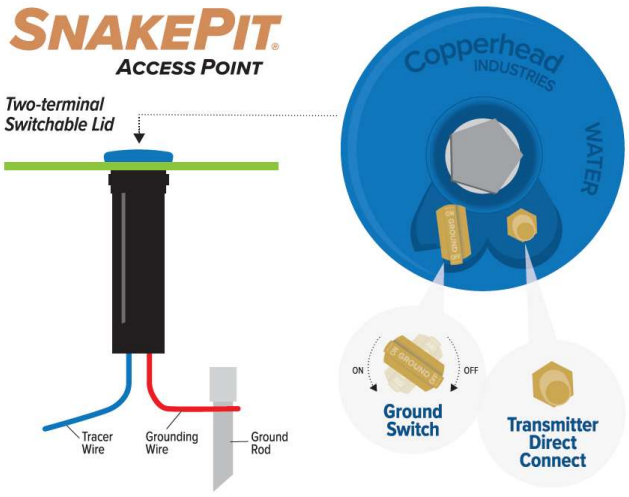
80

Good Access Points

- Protect the wire from corrosion
- Get the wire out of the way and safe from damage
- Provide easy connection points, on the outside
- Are easy to find, and locatable
- Facilitate connection to ground
- Have cool snake names

81

Snake Pit Access Points



82

Snake Pit Access Points

- Ground Level Access
- Two terminal lid available to turn on and off ground
- Magnet in the lid allows detection by metal detector
- Anti-Corrosion gel to protect wires
- Lid color coded to meet APWA standards
- Bracket available to secure to curb box
- Driveway and Roadway models available



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Cobra® Access Points

- Above grade access
- Switchable terminal lid available to turn on and off ground
- Mounts to post, hydrant, or stake
- Can be used with rigid or Flexible PVC Conduit
- Color coded to APWA standards



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Cobra™ Access Point to Building



85

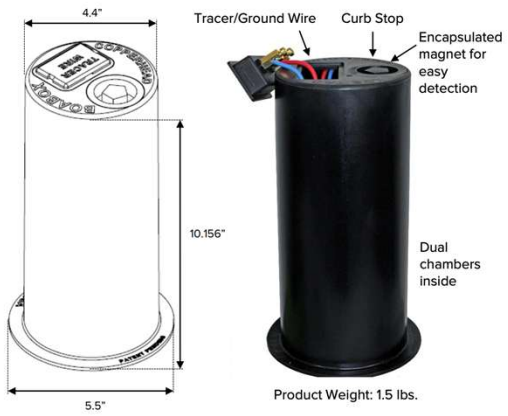
These Cobras Work Well in Cold Climates

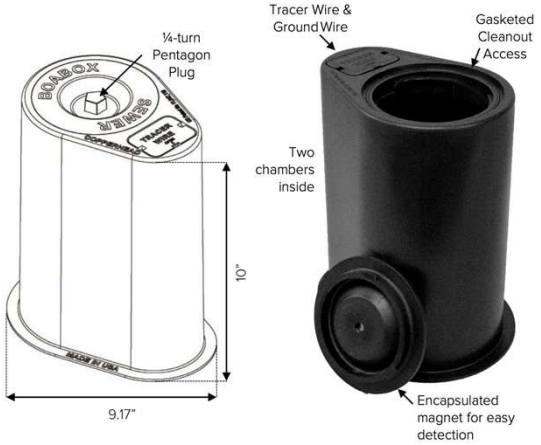




86

NEW! BoaBox Water and Sewer





87

NEW! BoaBox Water and Sewer

Combines both tracer wire access points and curb stop/valve shut-off into one access point.



BoaBox Water Application

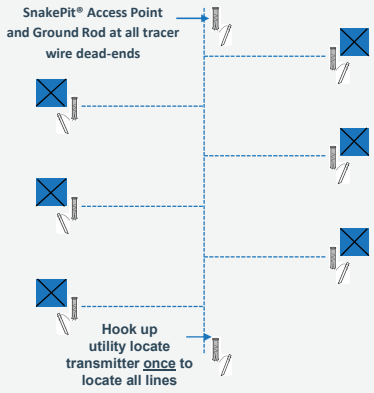


BoaBox Sewer Application

88

Access Points with Grounding Rods

Eliminates the need to remove lids, and allows locators to **isolate targeted sections** of tracer wire *without having to reposition the utility locate transmitter*



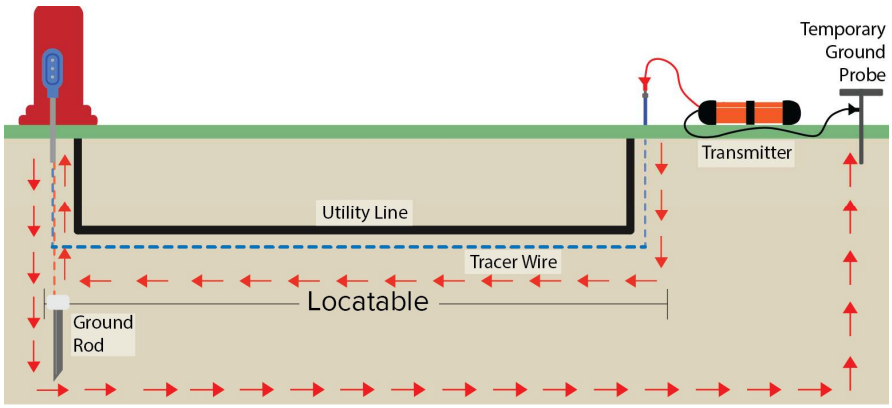
89

5. Locate

Bringing it all together…

90

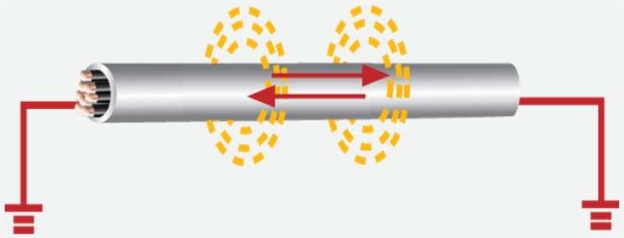
Tracing Wire Circuit



91

The Locating Signal

- Produced by the flow of the alternating current (AC) which creates an electromagnetic field that radiates from the line and is known as the signal.



92

Detect the Locating Signal

- The locator receiver contains sensors, known as **antennas**, that detect the electromagnetic field/signal.
- The signal induces a “response” in the antennas by electromagnetic induction.



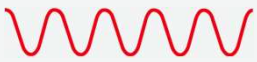
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93

Active Signal Frequency



High Frequency (83 kHz)
- Direct connection, clamp induction
- Shortest distance
- Highest distortion and/or bleed off



Medium Frequency (8.19 kHz)
- Direct connection and clamp
- Reasonable distance
- Increased distortion and/or bleed off



Low Frequency (512 kHz)
- Direct connection
- Longest distance
- Lowest distortion and/or bleed off

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ViperMag Locator

- Active locating frequencies (512 Hz, 8.19 kHz, 83 kHz)
- Passive power locating (60 Hz)
- Conductive or Inductive locating
- Ferrous metal detector – magnetic north/south indicator
- Optional fault find model
- Easy to use, 4 buttons and a screen



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The Dos and Don'ts

"Where oh where could my little pipes be…"

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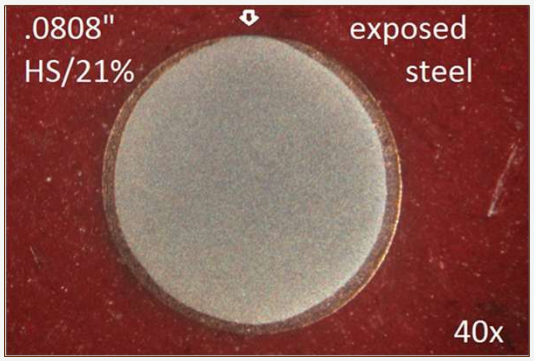
96

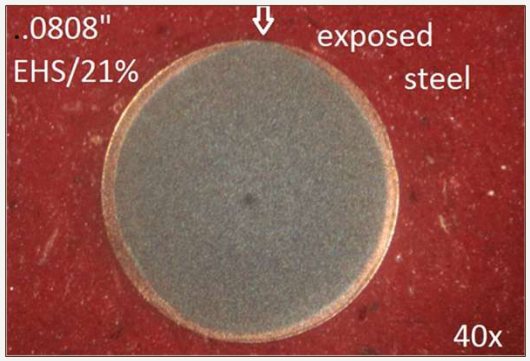
Common Tracing System Mistakes

- Already Covered:
  - Tracing wire not meant for direct burial
  - Non-Conductive wire
  - Poorly Clad Copper-Clad Steel Wire
  - Connectors that are not meant for direct burial
  - Poor access points
  - Wire installed on top of the pipe
  - No grounds

97

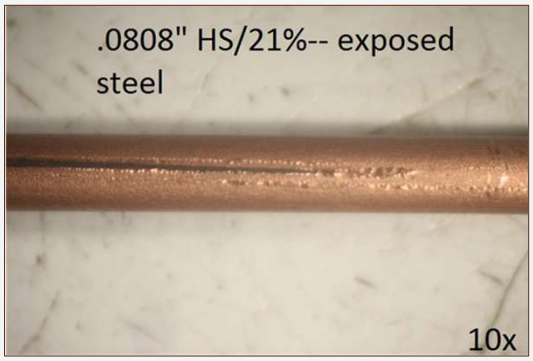
Bad Cladding of CCS





98

Bad Cladding Results in Corrosion and Lost Signal





99

Looping Wire

- Never loop wires
  - Down service from main line, around dead-end, backup service, and continue on main line
- Two AC Currents in close proximity cancel each other out

100

Tracer Wire Testing

- **Important Step**: Testing a new system
  - Make sure the contractor, engineer/inspector and city operator performs a locate in common company
    - At the time that rough grade has been established
    - Prior to final acceptance of the project

- **Continuity testing is not allowed**

101

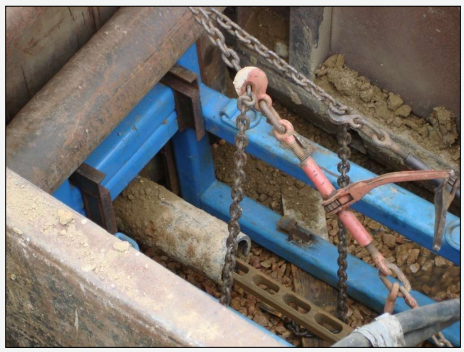
Keep Tracer Wire Access Points Out of the Roadway



102

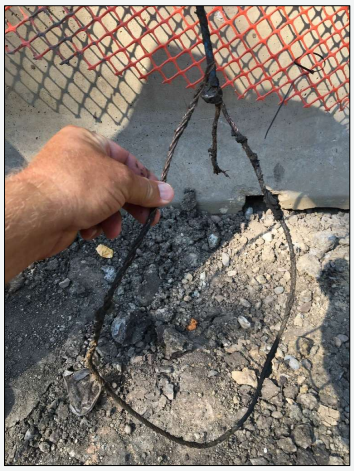
Proper Attachment of Wire to Pulling Head





103

Results of not being properly attached to bursting head



104

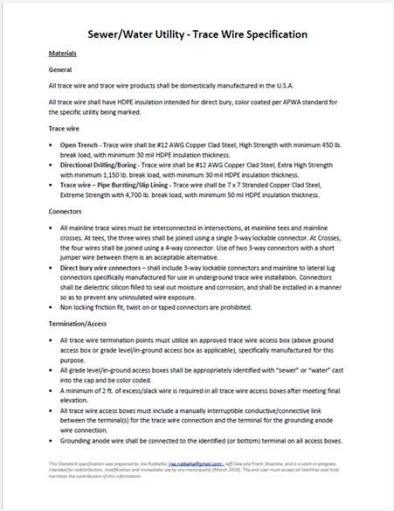
Don’t leave it up to the contractor…

- Most city’s have bare minimum tracer wire specs
- Industry standard spec:
  - *Tracer wire shall be installed, 12-gauge pure copper coated*

105

Improve Your Specifications

- Minnesota Rural Water - The industry standard for Locating wire
  - US Materials
  - Installation
  - Prohibited Items
  - Testing
  - Engineer Drawing standard details



Sewer/Water Utility - Trace Wire Specification

Materials

General

All trace wire and trace wire products shall be domestically manufactured in the U.S.A.

All trace wire shall have HDPE insulation intended for direct bury, color coated per APWA standard for the specific utility being marked.

Trace wire

- Open Trench - Trace wire shall be #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 mil HDPE insulation thickness.
- Directional Drilling/Boring - Trace wire shall be #12 AWG Copper Clad Steel, Extra High Strength with minimum 1,150 lb. break load, with minimum 30 mil HDPE insulation thickness.
- Trace wire – Pipe Bursting/Slip Lining - Trace wire shall be 7 x 7 Stranded Copper Clad Steel, Extreme Strength with 4,700 lb. break load, with minimum 50 mil HDPE insulation thickness.

Connectors

- All mainline trace wires must be interconnected in intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single 3-way lockable connector. At Crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative.
- Direct bury wire connectors – shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground trace wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to prevent any uninsulated wire exposure.
- Non locking friction fit, twist on or taped connectors are prohibited.

Termination/Access

- All trace wire termination points must utilize an approved trace wire access box (above ground access box or grade level/in-ground access box as applicable), specifically manufactured for this purpose.
- All grade level/in-ground access boxes shall be appropriately identified with "sewer" or "water" cast into the cap and be color coded.
- A minimum of 2 ft. of excess/slack wire is required in all trace wire access boxes after meeting final elevation.
- All trace wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the trace wire connection and the terminal for the grounding anode wire connection.
- Grounding anode wire shall be connected to the identified (or bottom) terminal on all access boxes.

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Thank you



Feel free to contact me with any other questions!

Cimco-GC SYSTEMS

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Patrick@cimco-gcsystems.com
253-263-3099

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