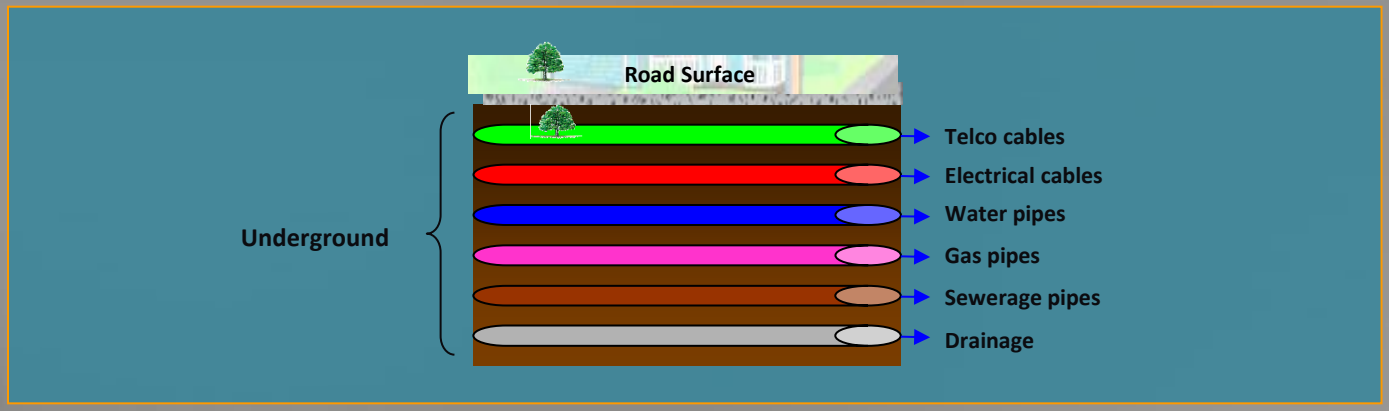
Prinsip Asas dan Garis Panduan Pemetaan Utiliti

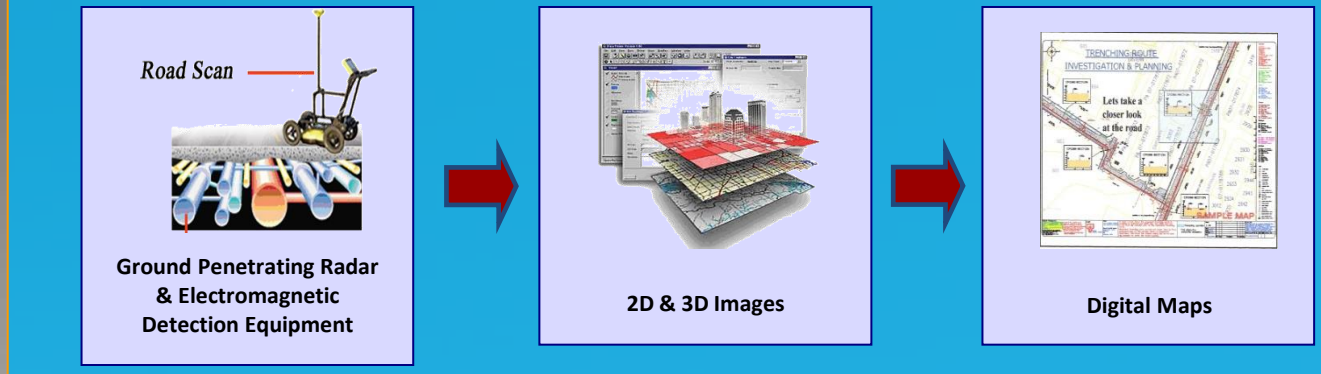
We will cover;

1. What is sub-surface detection and mapping
   - Underground utility detection technique
2. Electromagnetic locator
   - Method of Deployment
3. Ground Penetrating Radar
   - Control survey
4. Guidelines for underground utility mapping

What is Sub-Surface Detection and Mapping



All the underground utility network as indicated above are detected and surveyed using specialized equipment.



These information are then converted into digital maps with 2D or 3D images.

What is Sub-Surface Detection and Mapping

Images / Data Recorded 2D and 3D

1. Surface
2. Telco cables
3. Electrical cables
4. Water pipes
5. Gas pipes
6. Sewerage pipes
7. Drainage

Identify all buried cables
Depth
Right of way
Diameter of pipes
Length of cables
Material type
Voltage of electrical cables
Date of installation
Colour coded

Surface features included in a utility map:

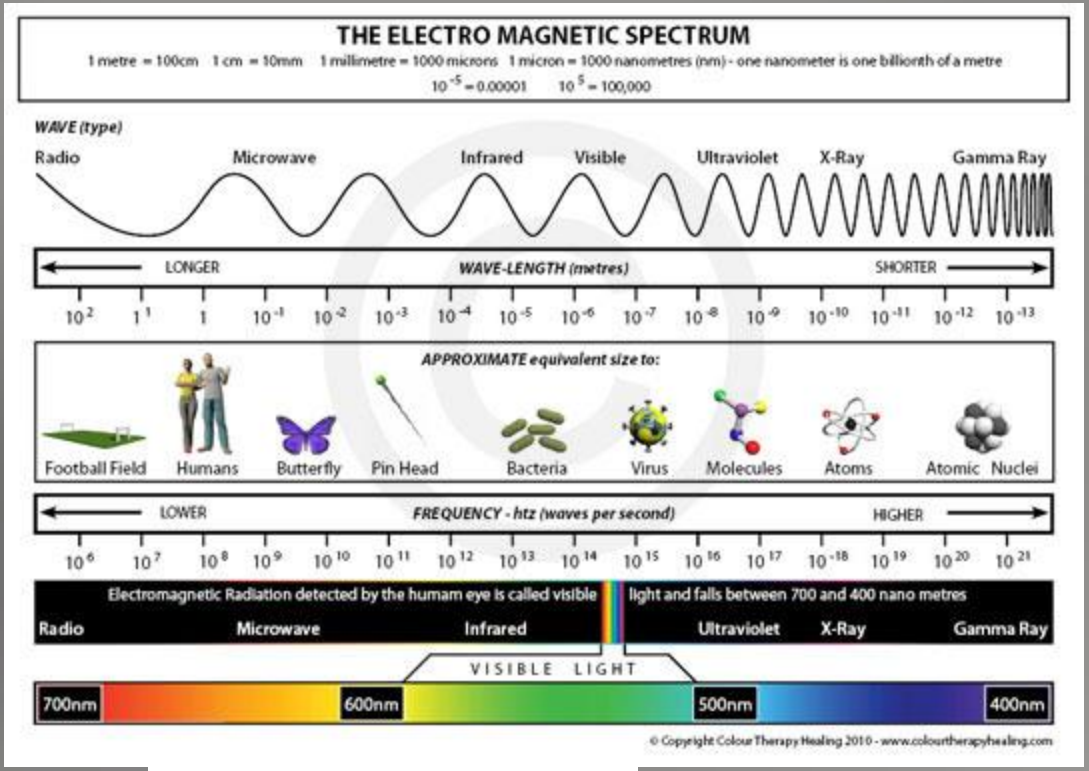
- Elevation points
- GPS points
- Building Outline
- Shelter roofs / Bus stands
- Telephone booths
- Traffic lights
- Drainage manhole covers
- Chamber covers
- Trees
- Road edges
- Traffic signages
- Station points
- Valve covers
- Water statues
- Water chamber covers
- Telecom statues
- Gas statues
- Sewage manhole covers
- Electric cable statues
- Lamp posts
- Electric poles
- Transformer poles
- Electric chamber covers
- Fire hydrants
- Valves
- Drains

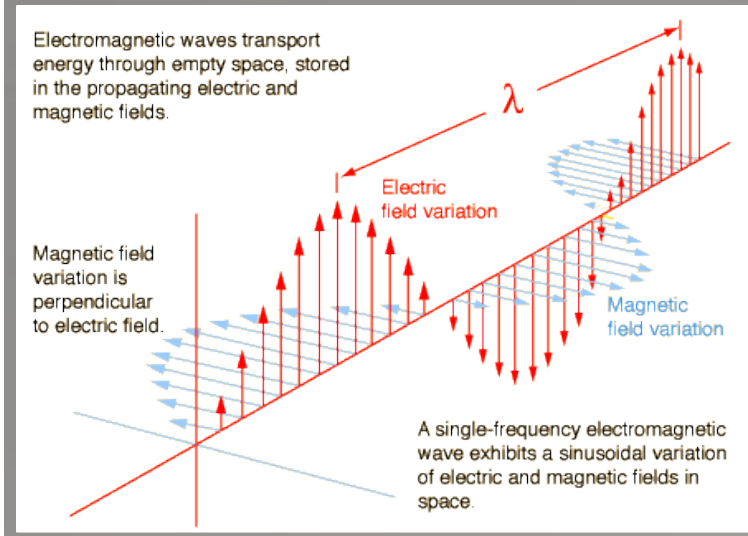
Optional Products available :

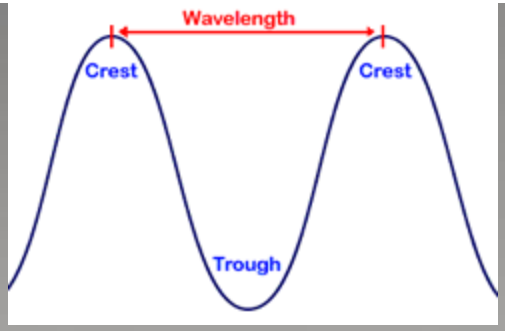
- Robotic CCTV
- Pipe rehabilation / lining
- Detection of WASTE Leakage
- Early Landslide detection

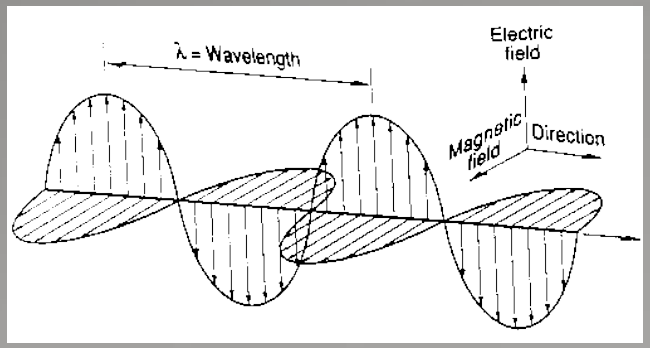
These information collected and the digital maps produced are very comprehensive in nature.

Electromagnetic Spectrum





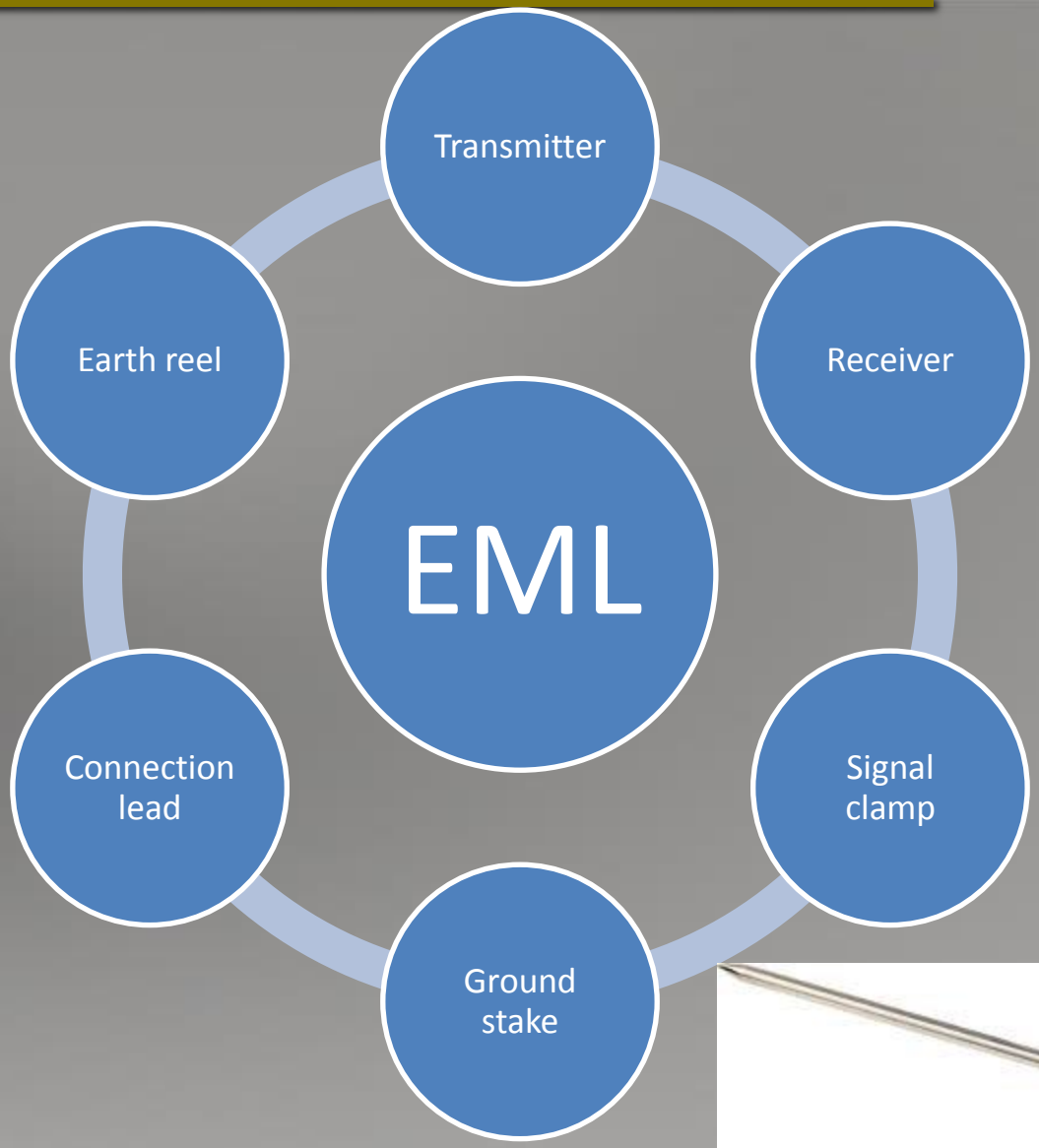




Underground utility detection technique

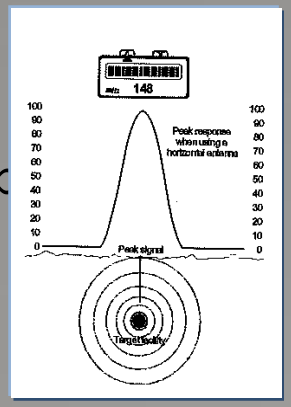
- Non-invasive technique
  - Detecting buried utilities without disturbing target
  - Technique employing electromagnetic principle
  - Quality level B
  - Improve quality by verifying using test holes

Electromagnetic locator (EML)

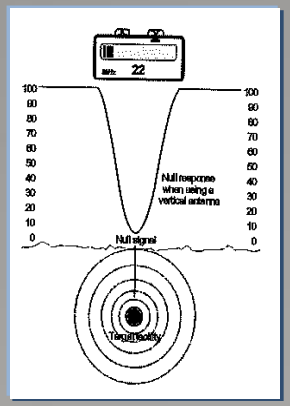


Electromagnetic locator (EML)

- Detection of metal pipes
- Equipment applies current to create a magnetic field which is detected by its receiver.
- Null and Peak response on receiver
- The strongest response occurs when the antenna is directly ab
  utility
- Techniques
  - Direct connection
  - clamping
  - induction
  - passive sweep and etc.



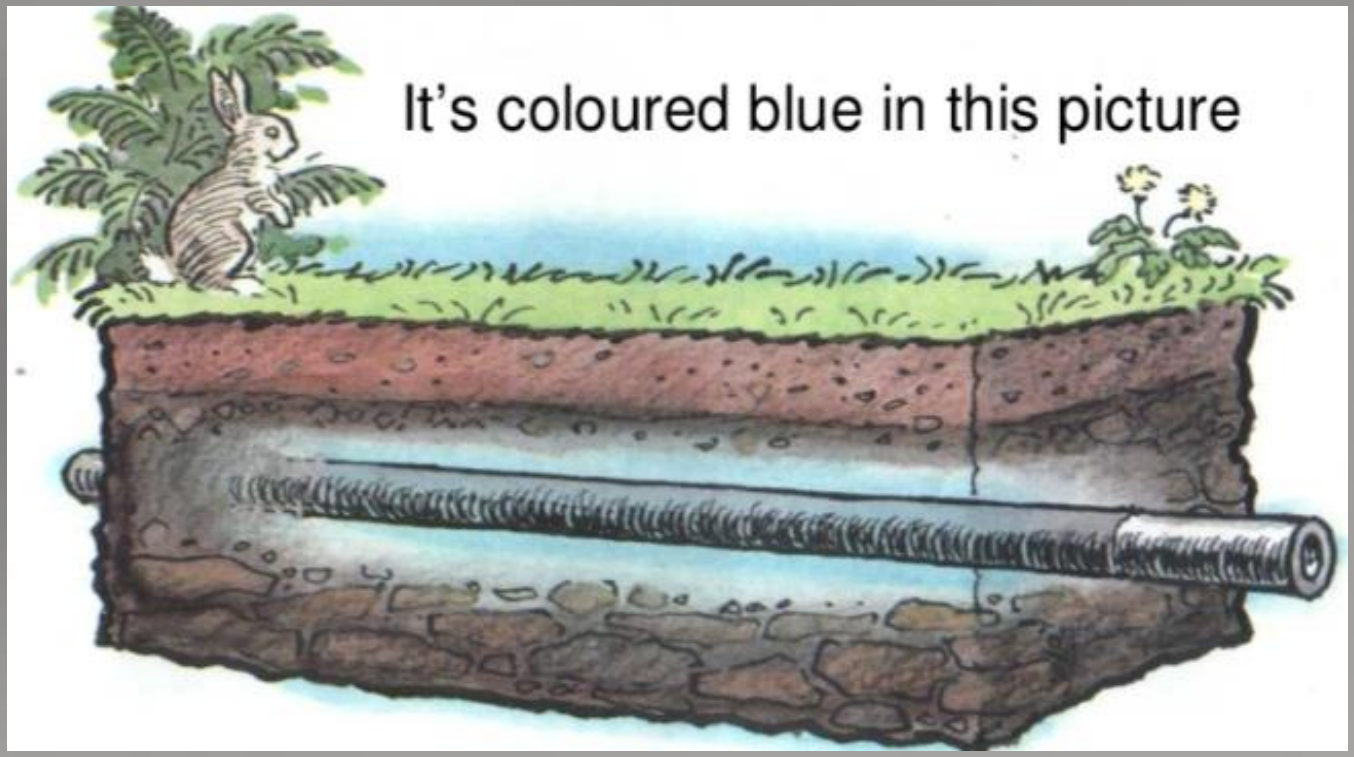
Horizontal antenna



vertical antenna

Electromagnetic Locator

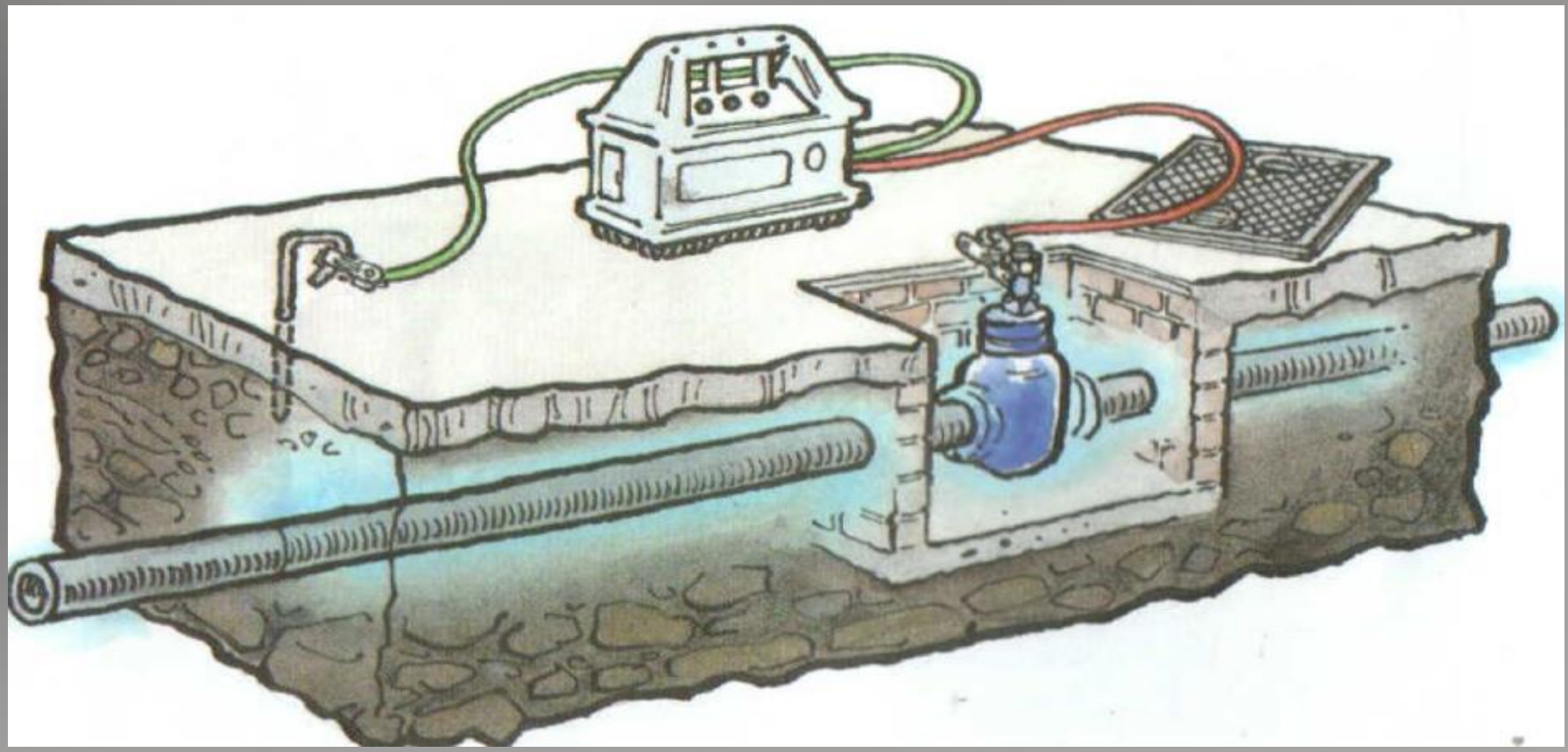
Receiver's DO NOT find utilities
But they detect the electromagnetic field which is produced around any CONDUCTIVE linear feature of the utilities



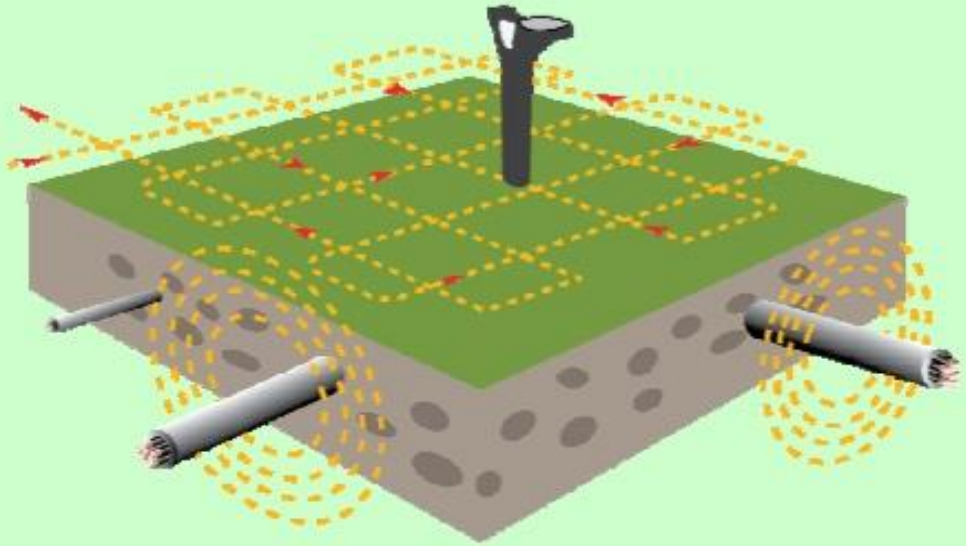
Receivers locate 2 types of signal

Active and Passive

Active signal is produced by transmitter and applied directly to the pipe or cable which requires locating; by the locating operative

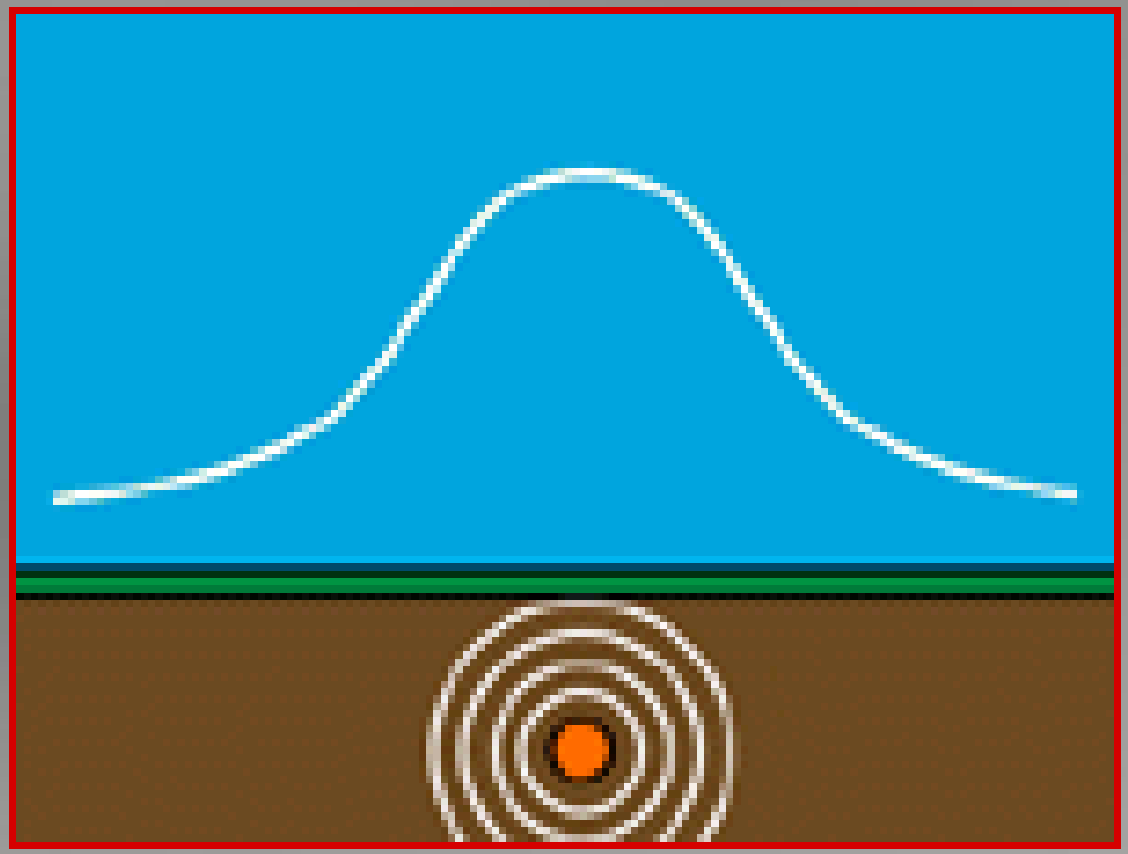


Passive locating

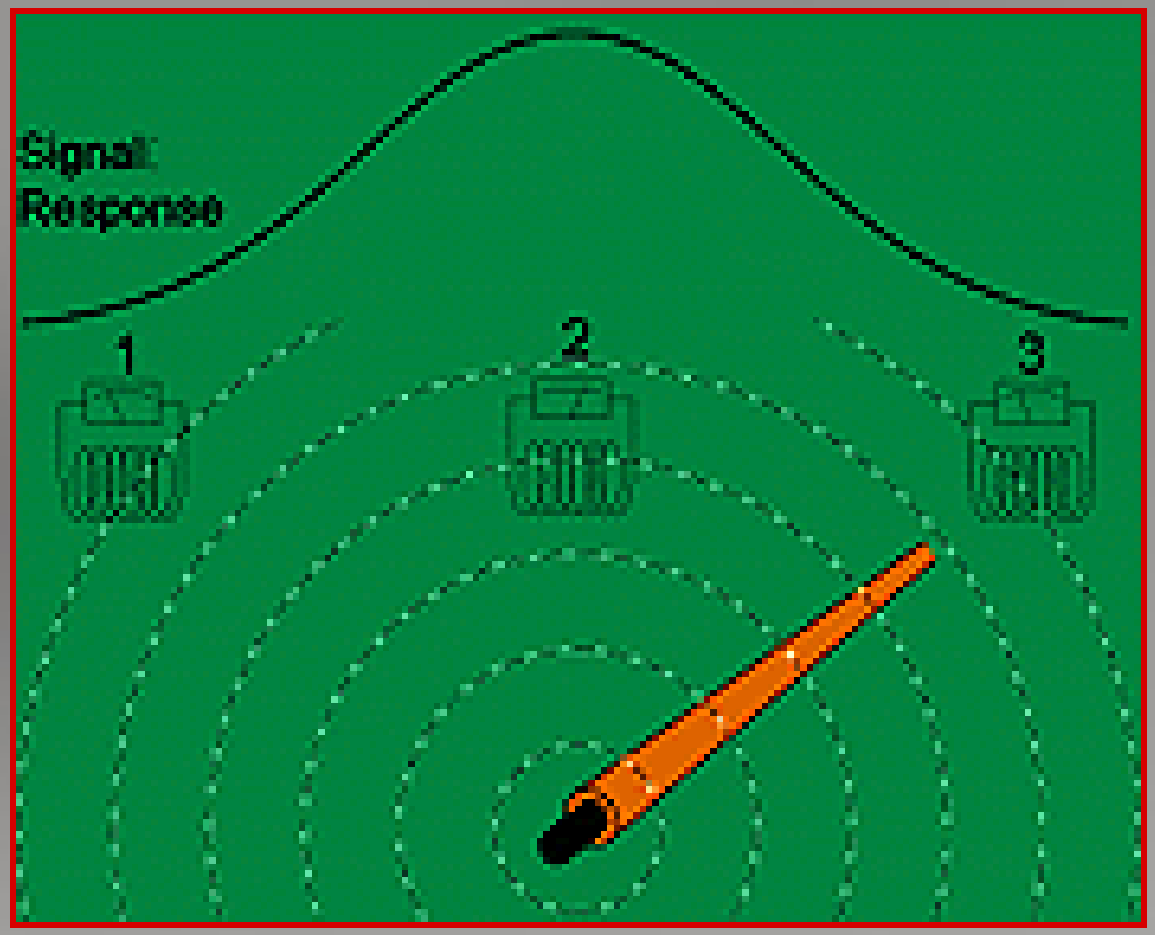


- Passive locating is generally used to AVOID rather than identify buried lines.
- Using only the receiver, sweep the area in the search pattern shown.
- Sweep in “Power” mode, then “Radio” mode.

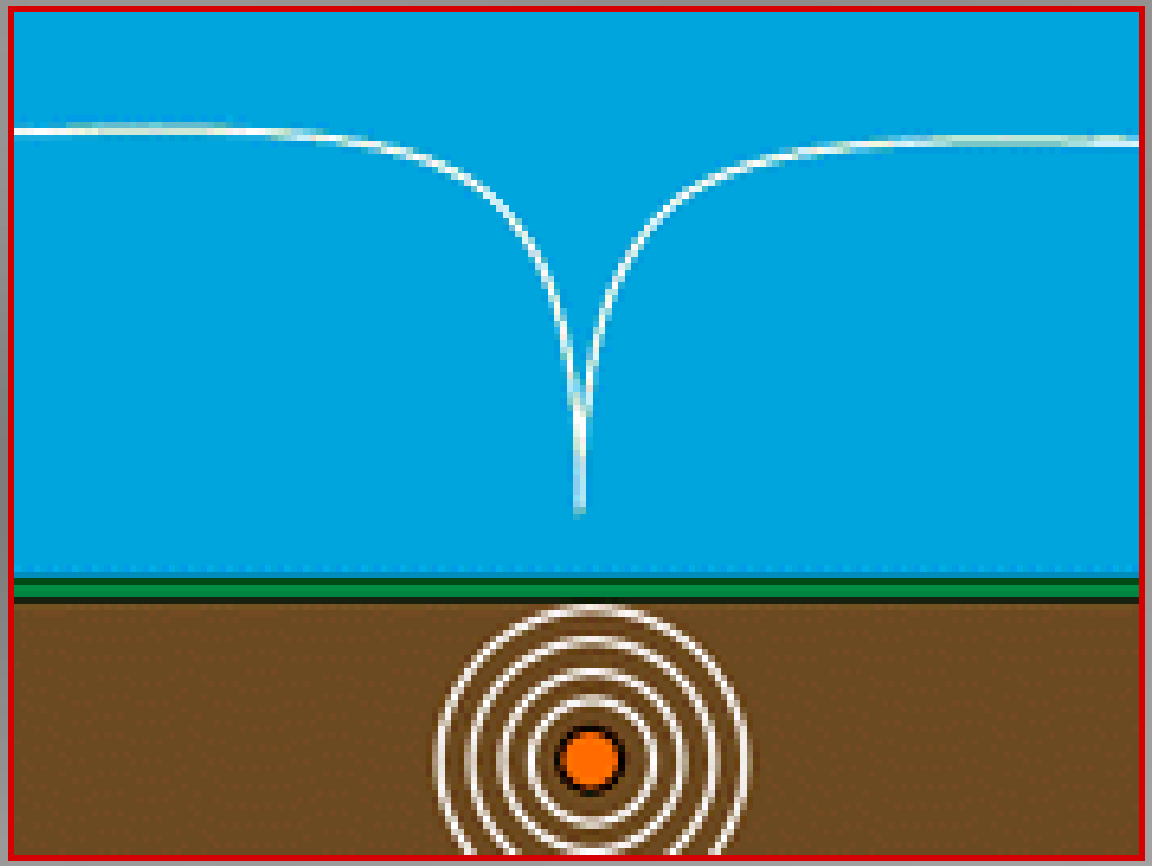
Peak Response



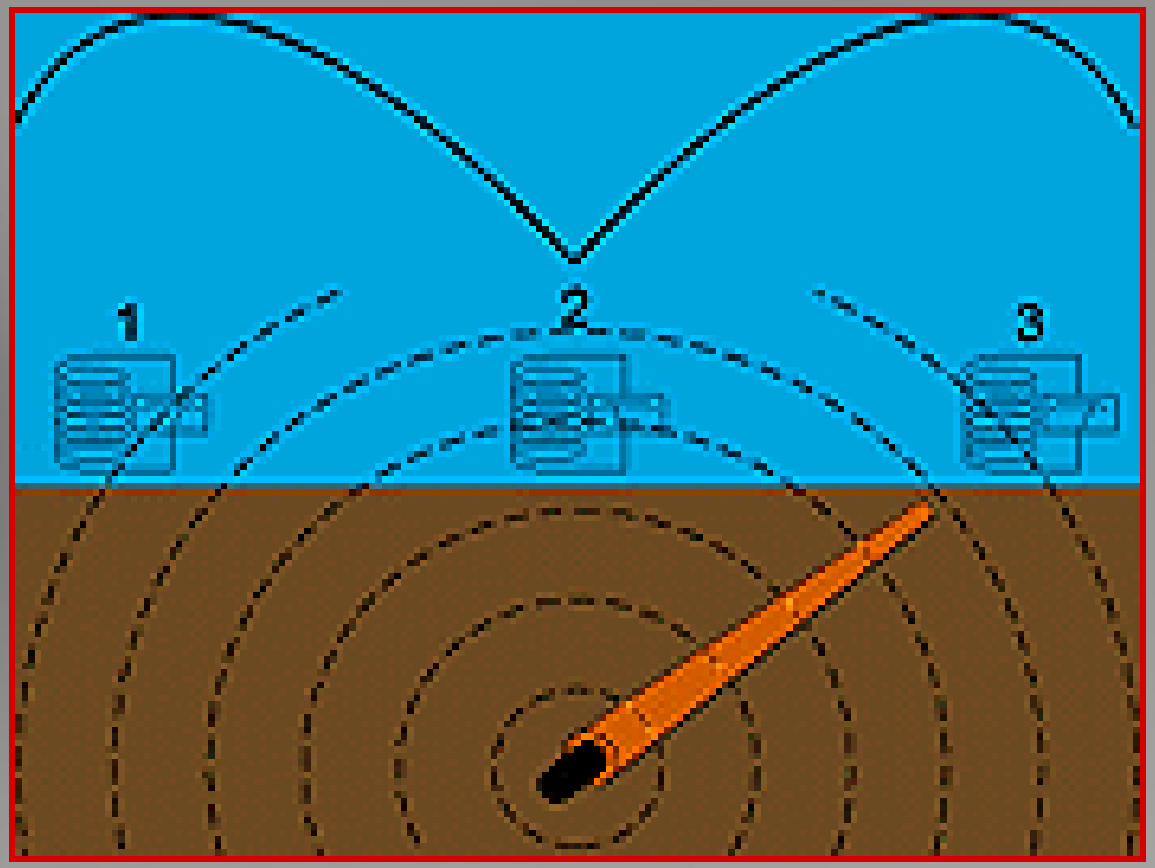
Peak Response



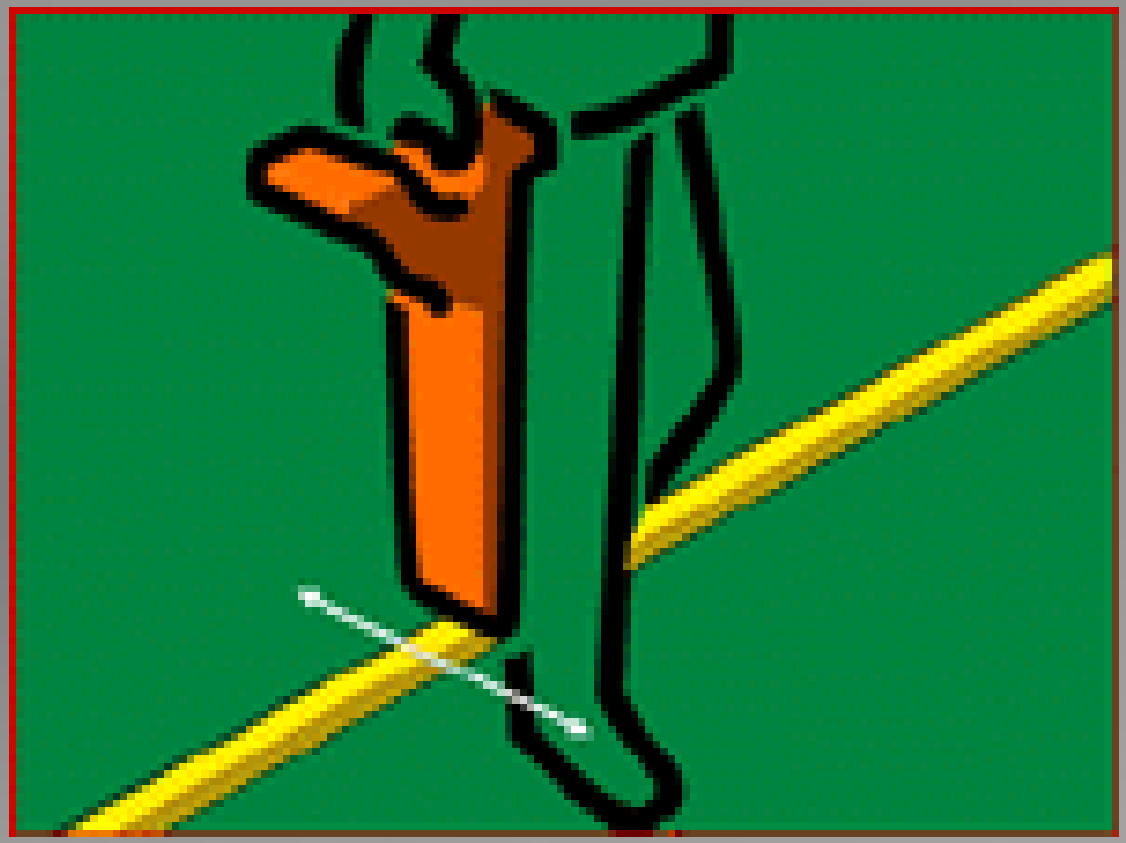
Null Response



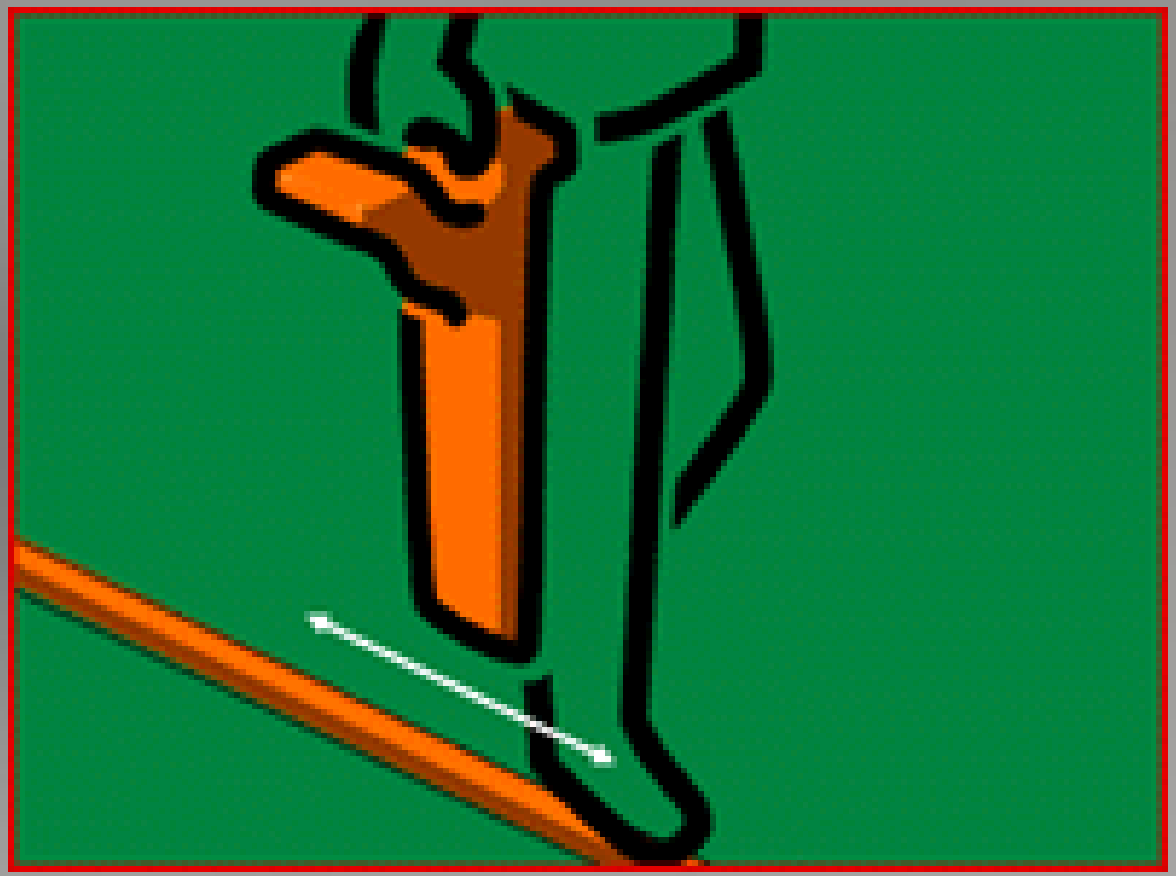
Null Response



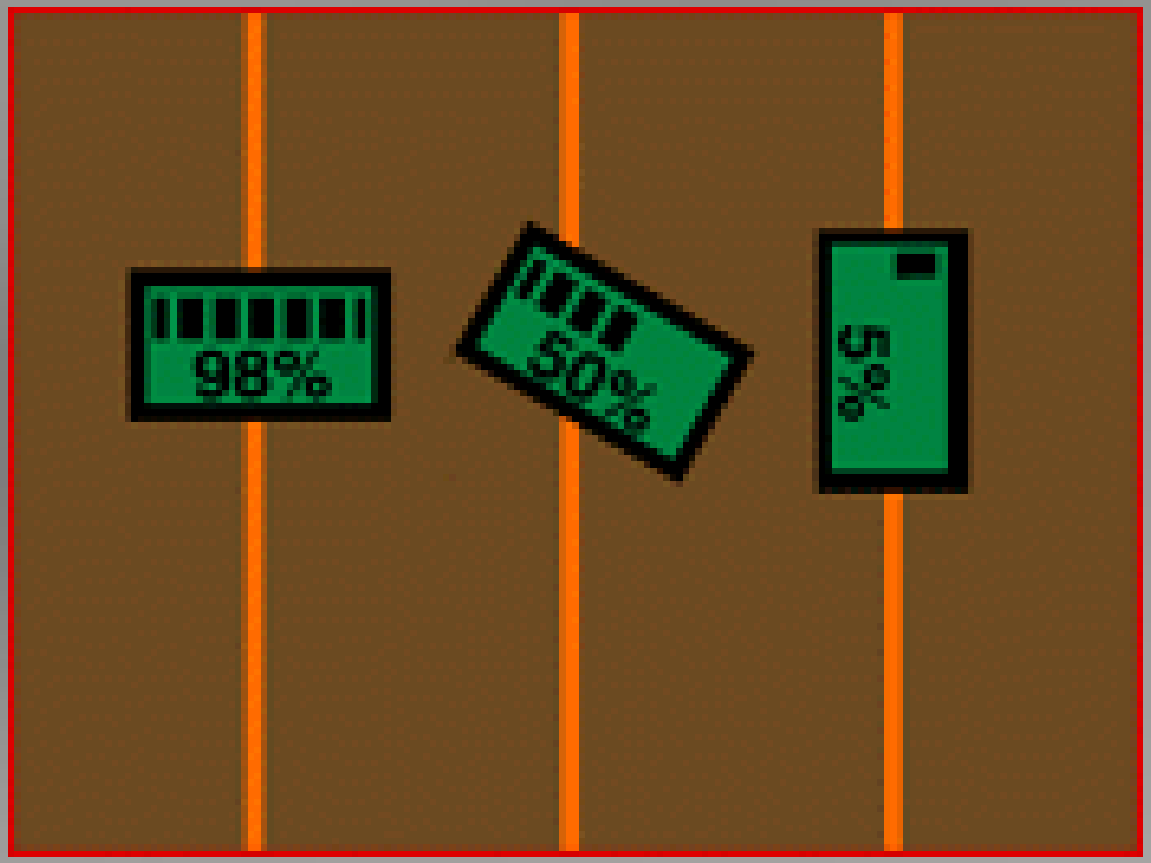
Locating



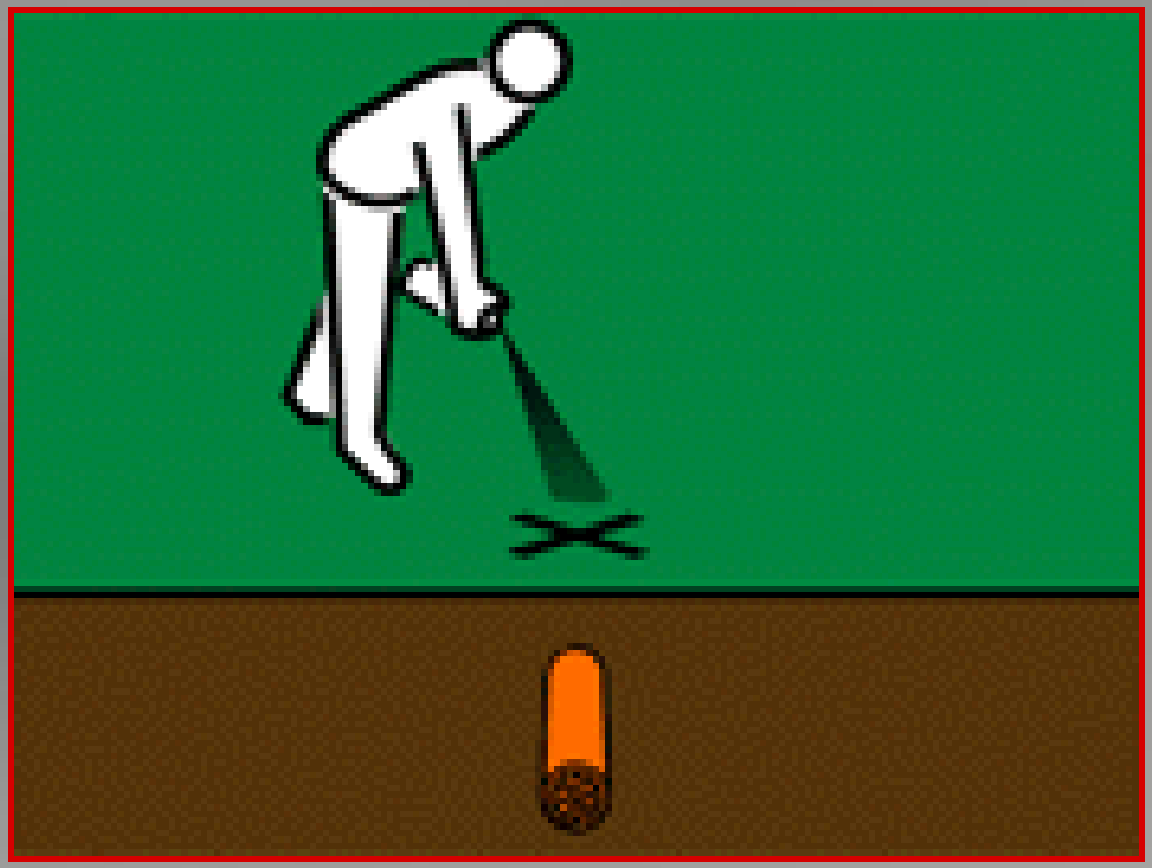
Pipe or Cable Direction



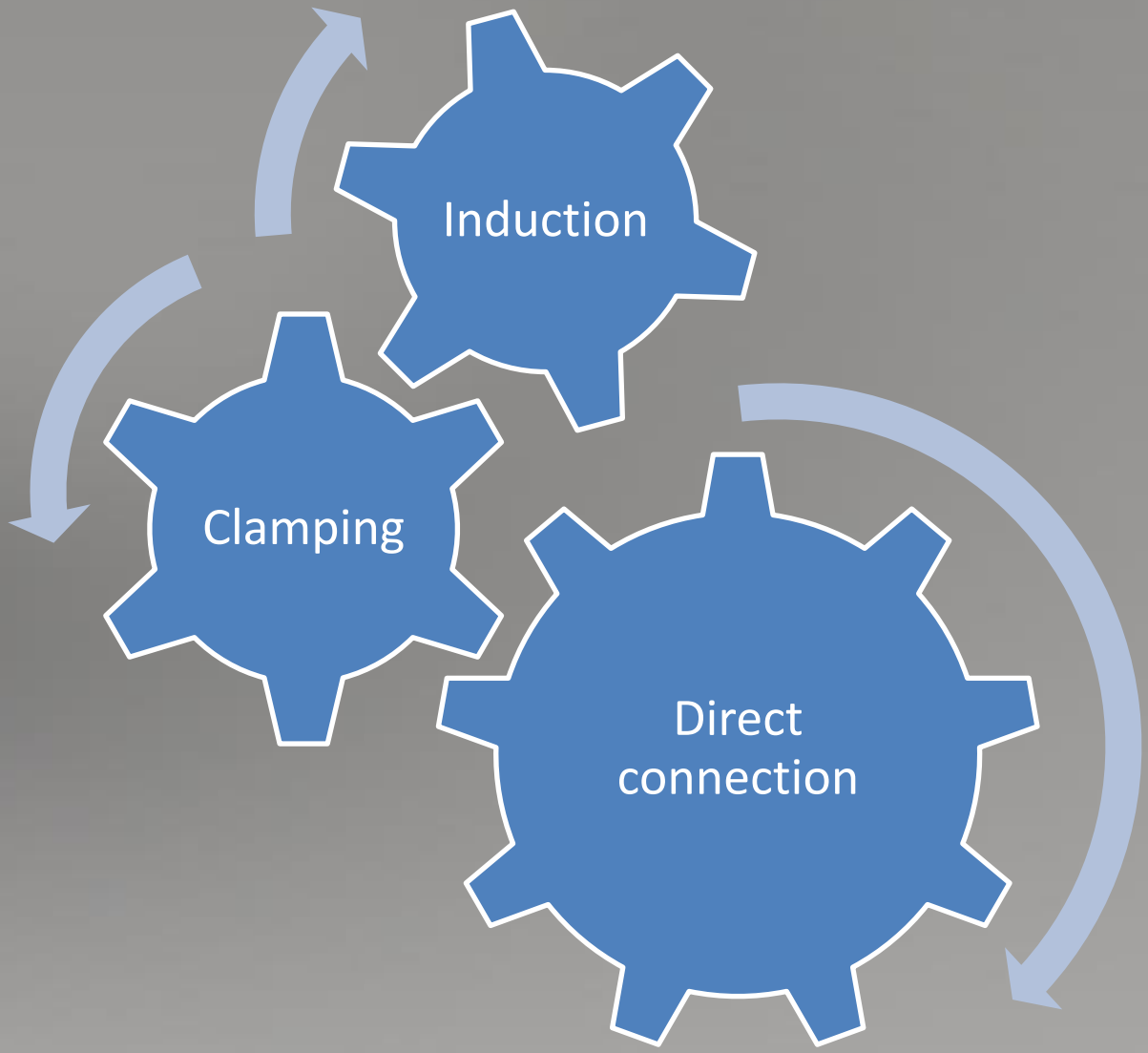
Pipe or Cable Direction



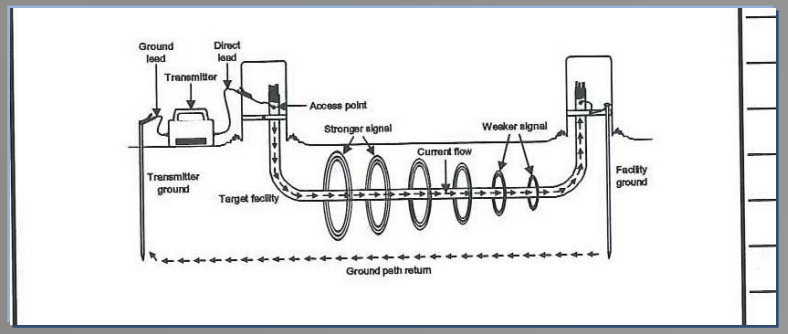
Marking



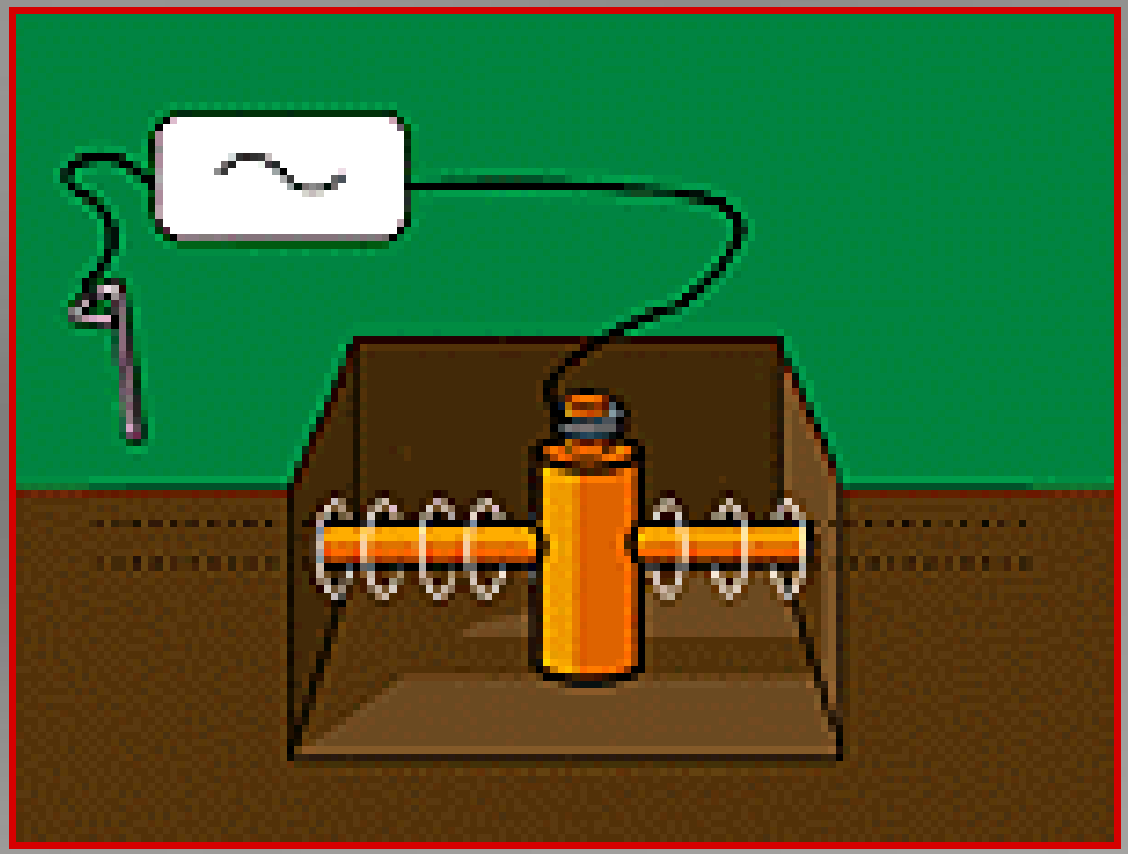
Methods of Deployment



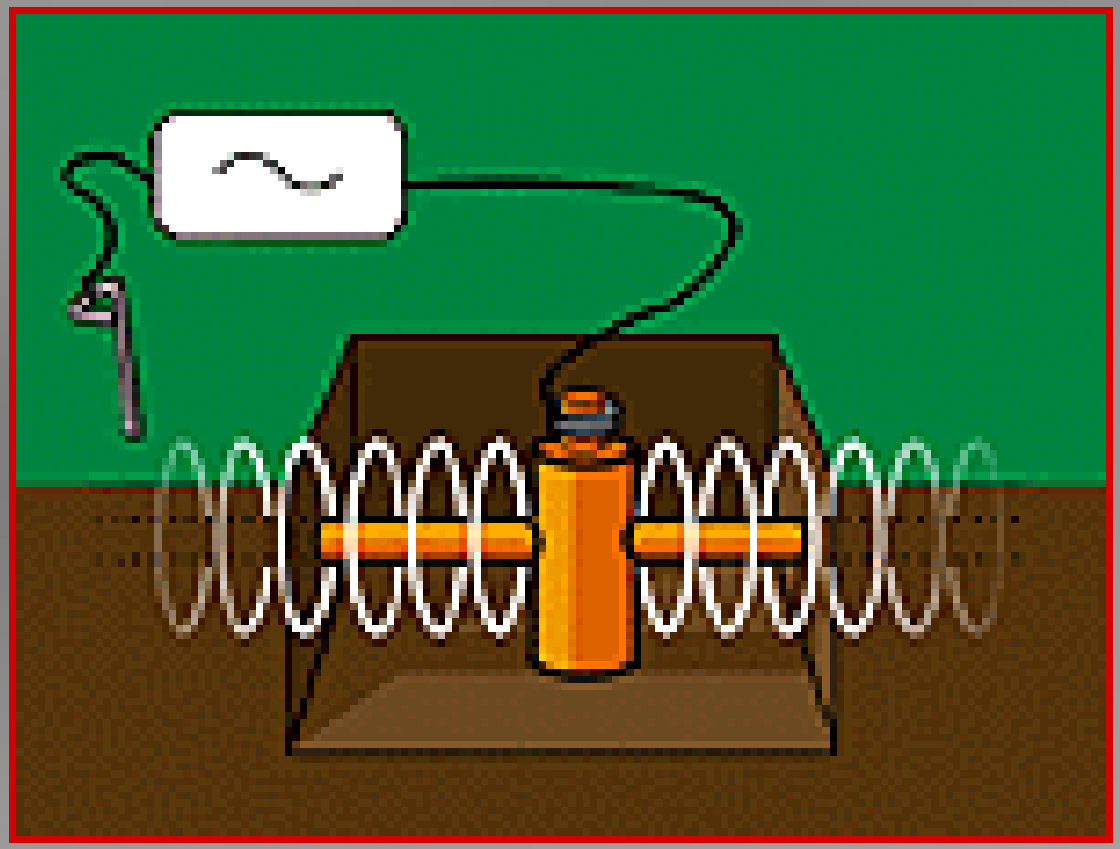
Direct connection method



Direct Connection



Direct Connection



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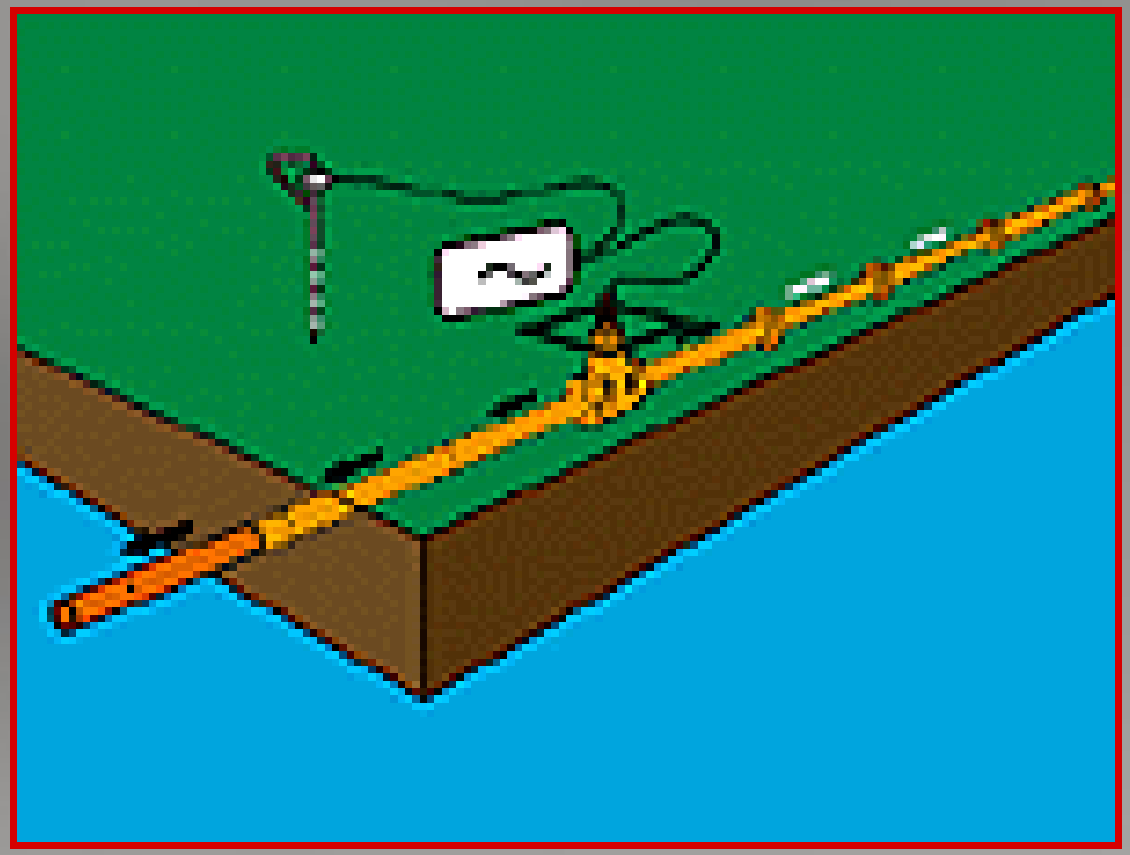
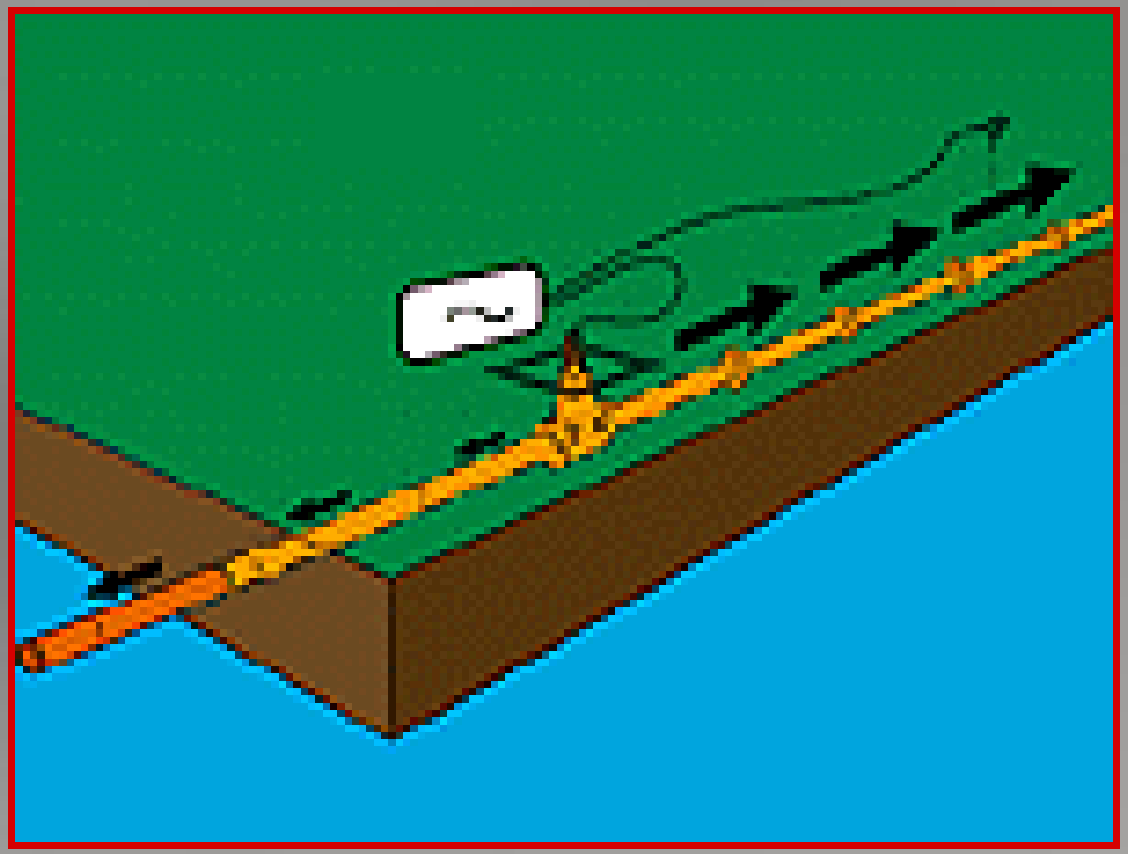
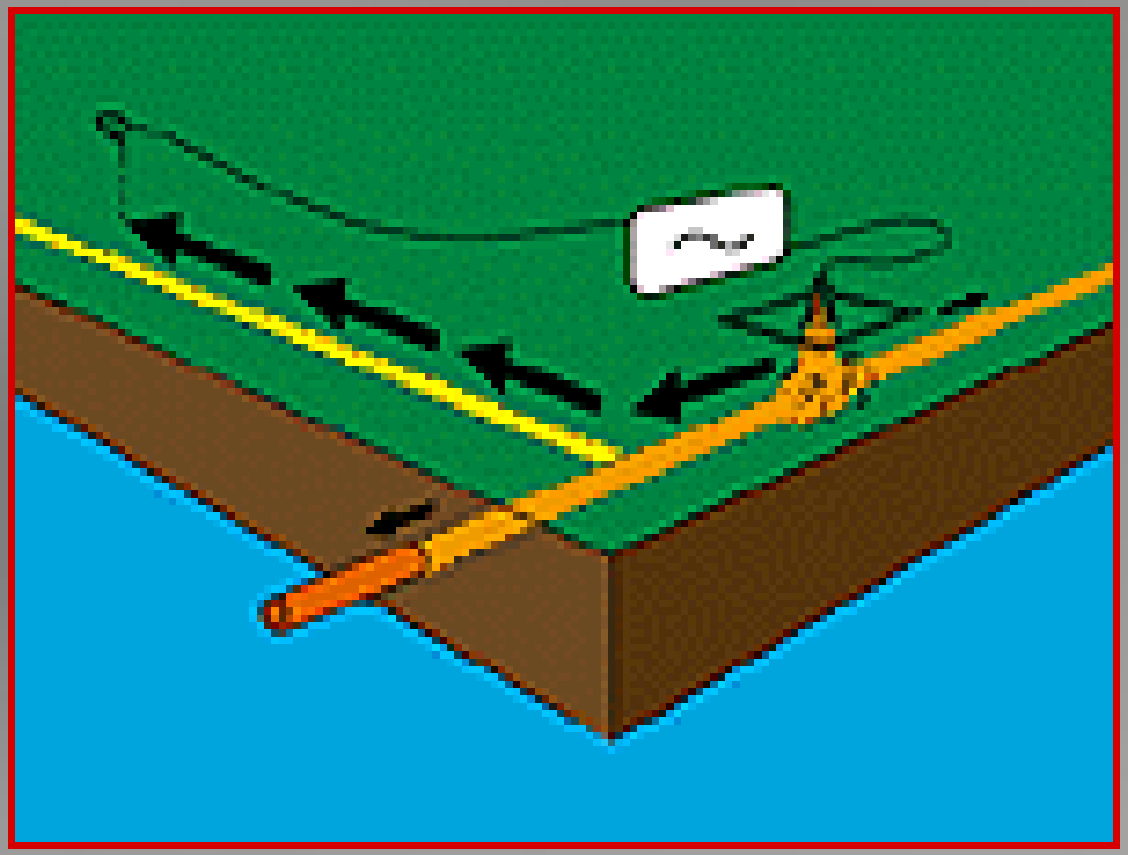


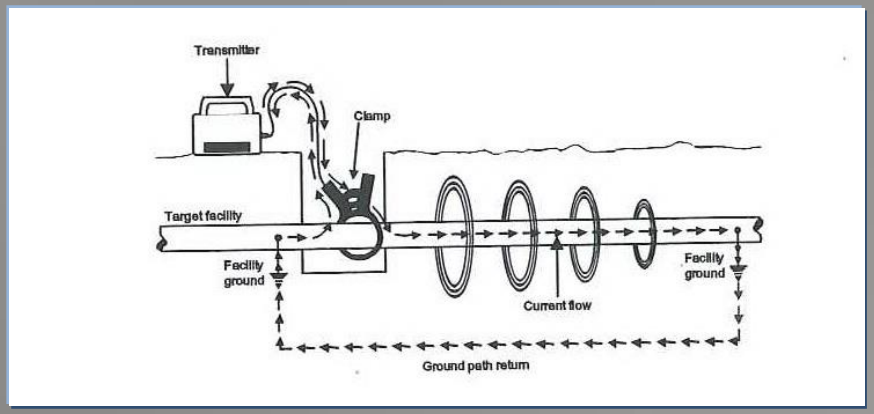
Direct Connection

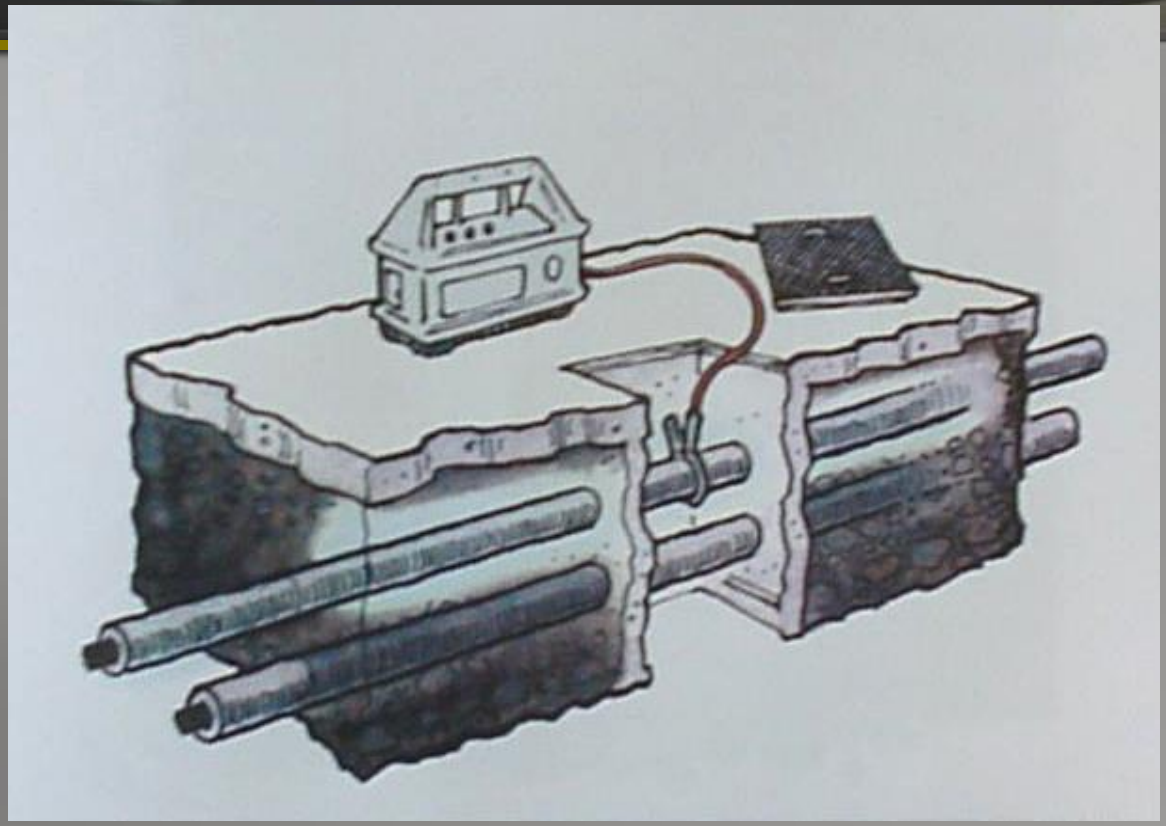


Direct Connection



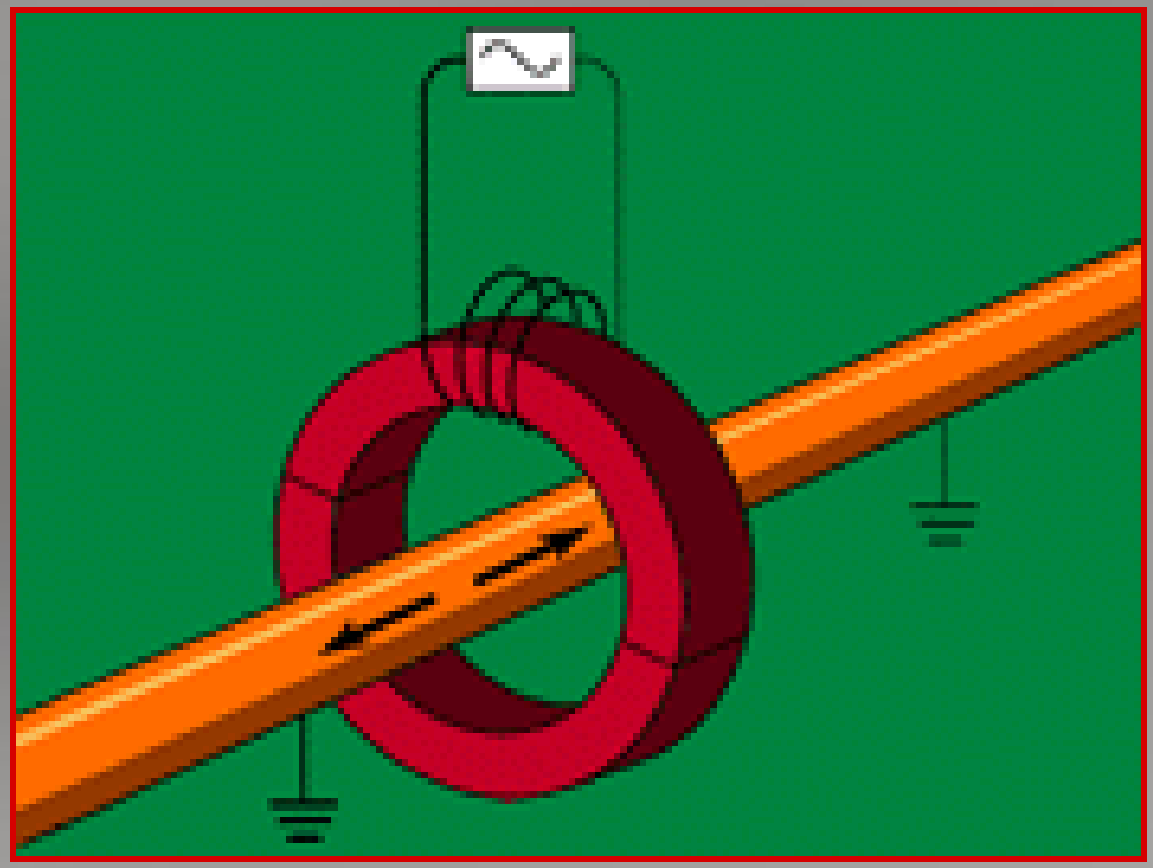
Clamping method



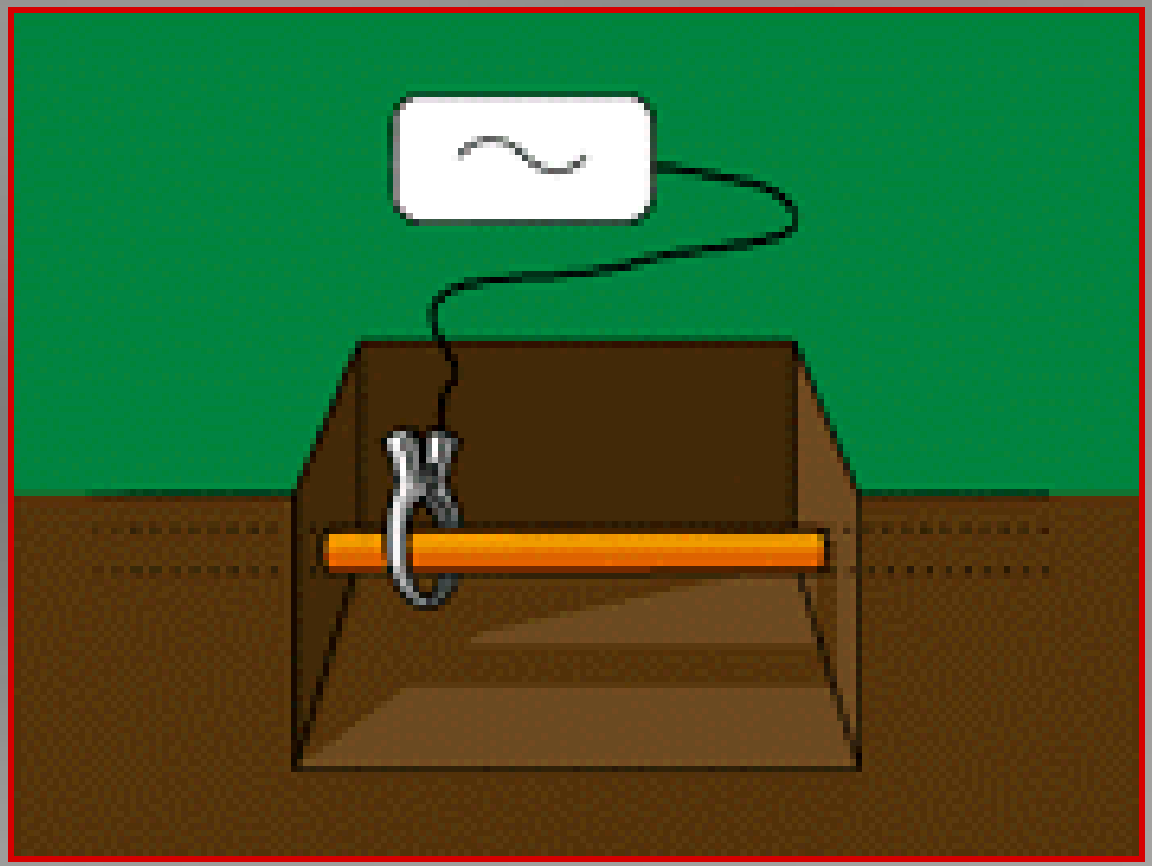


SIGNAL CLAMP

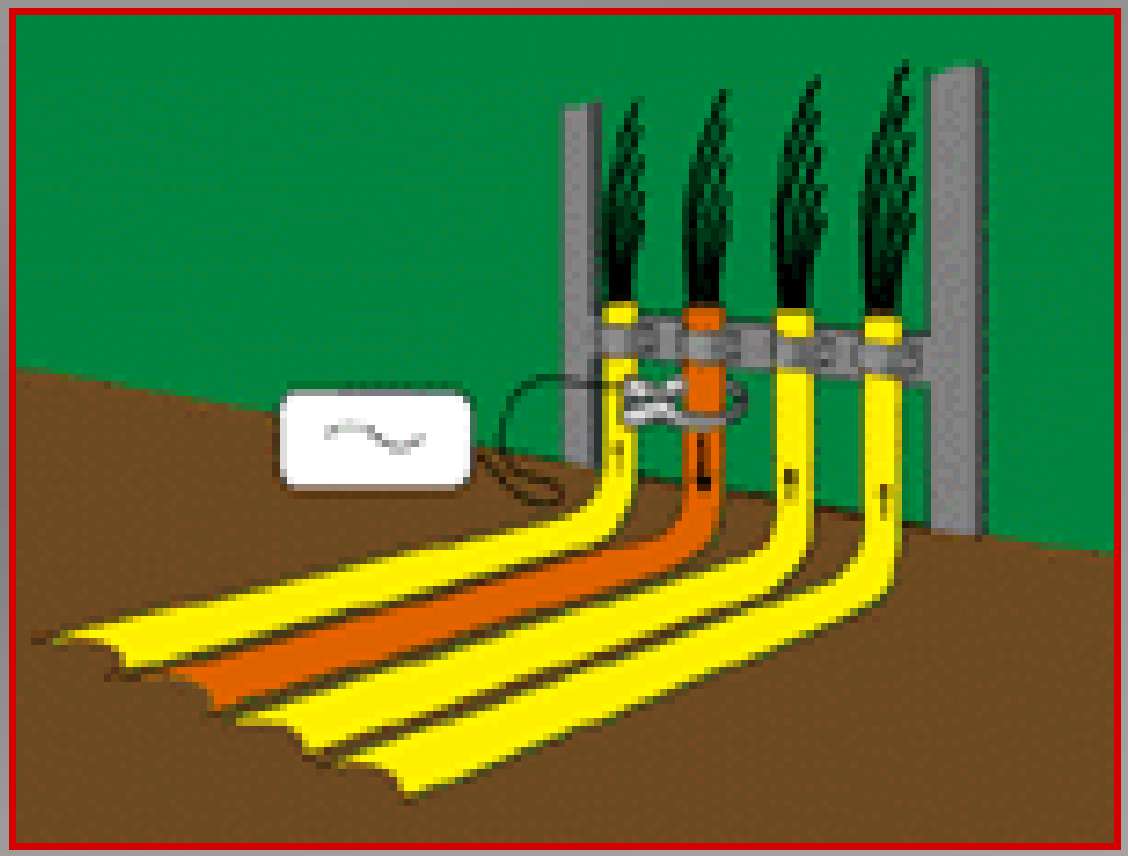
Signal Clamp



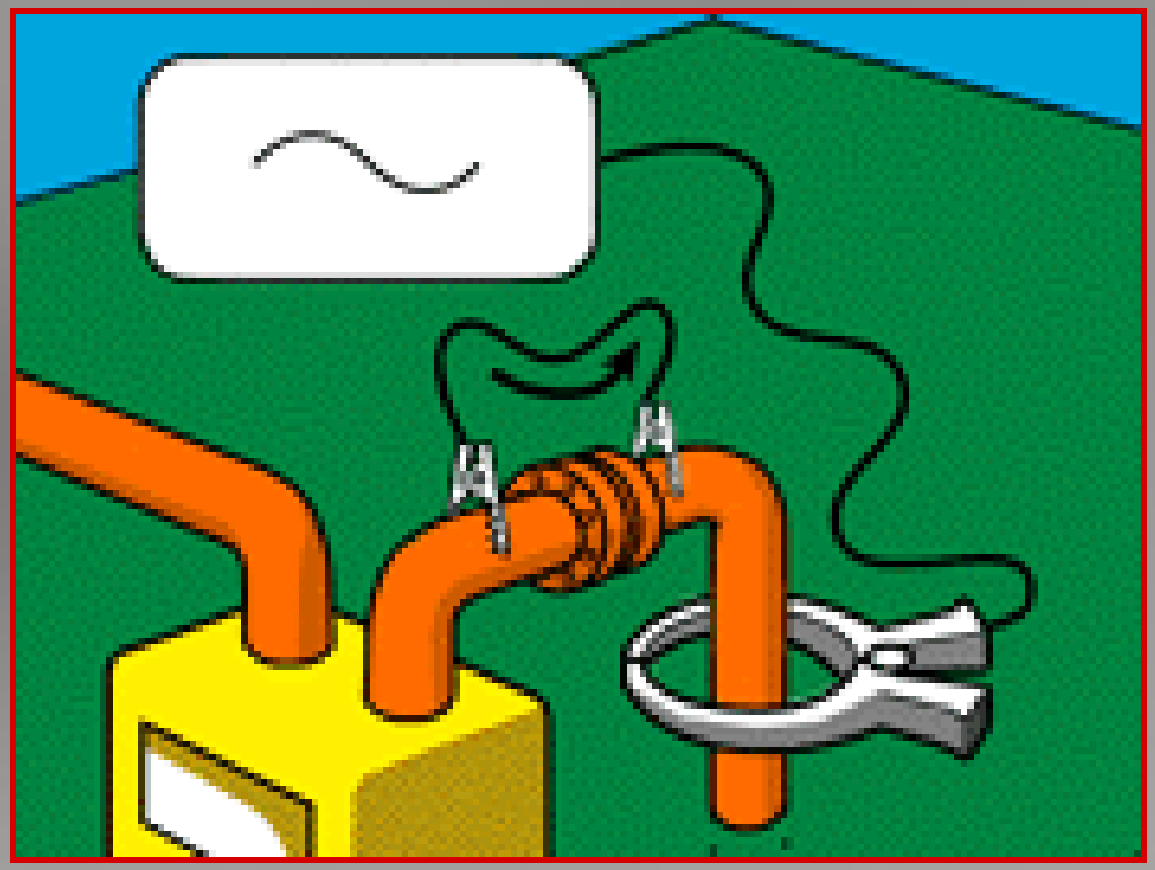
Signal Clamp



Signal Clamp



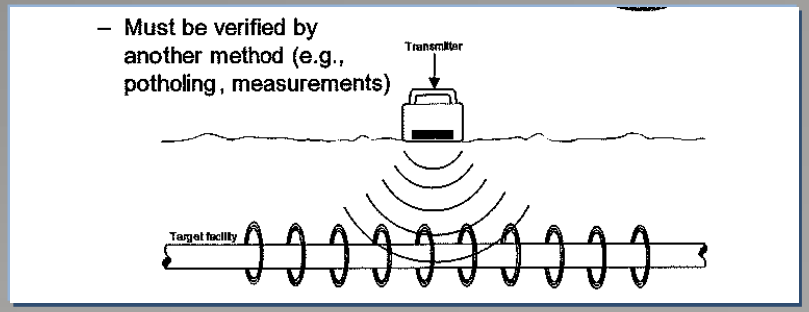
Signal Clamp

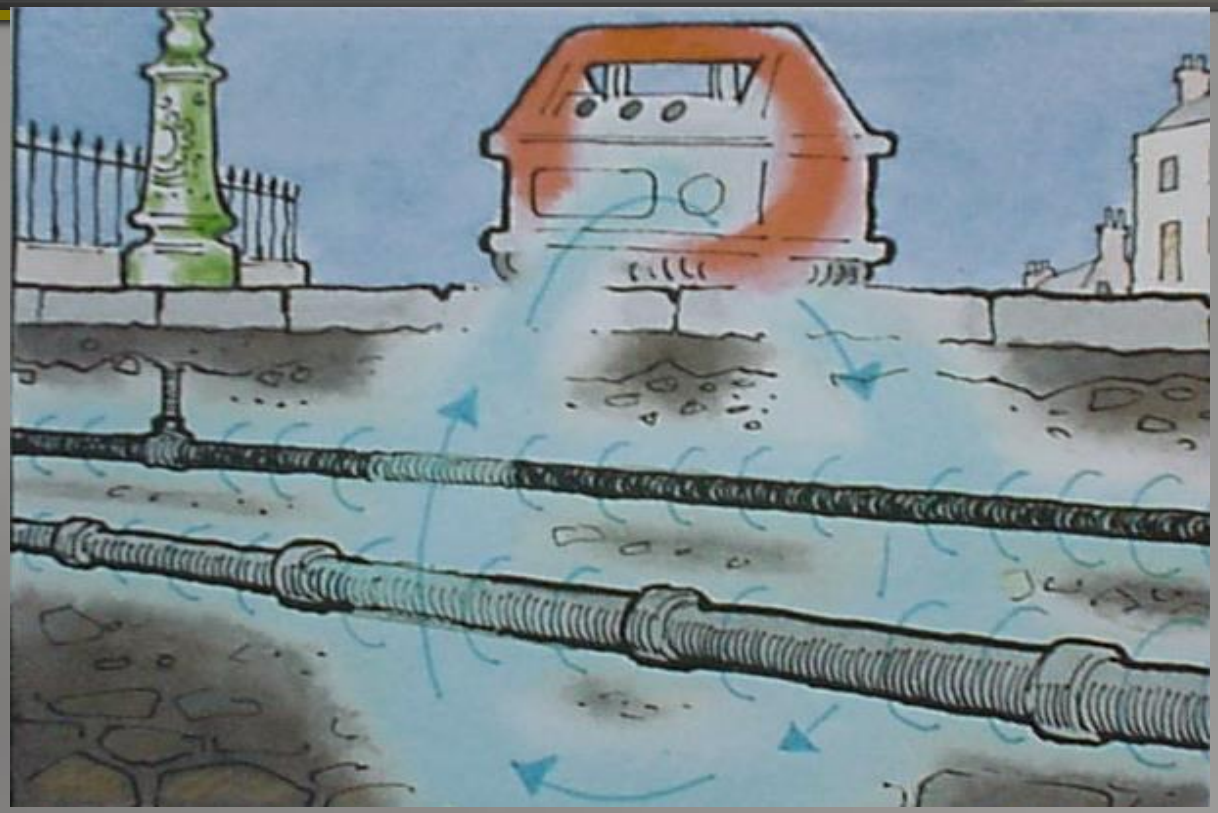


Inductive locating method

- Place transmitter at logical point to achieve desired results and perform complete sweep using receiver

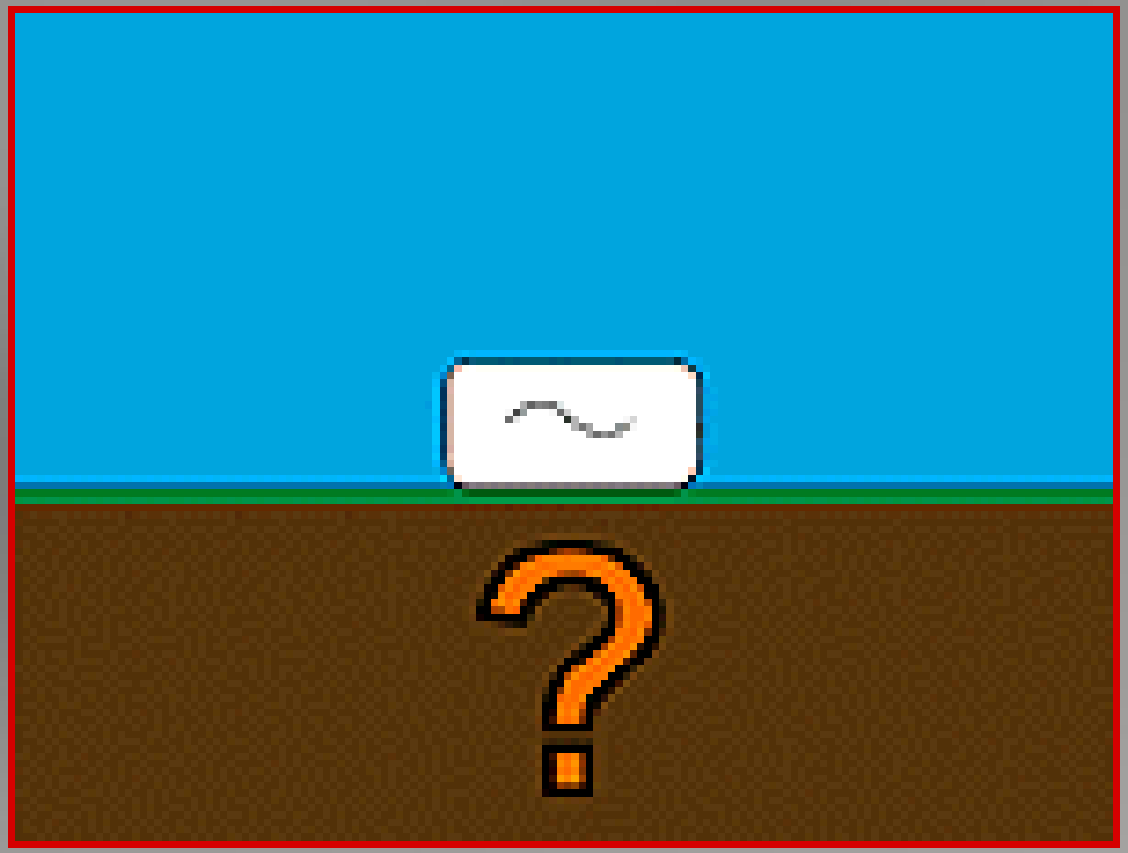
- Disadvantage
  - Less reliable
  - Less accurate
  - In congested areas, signal may jump to nearby utilities
  - Used when no other method available



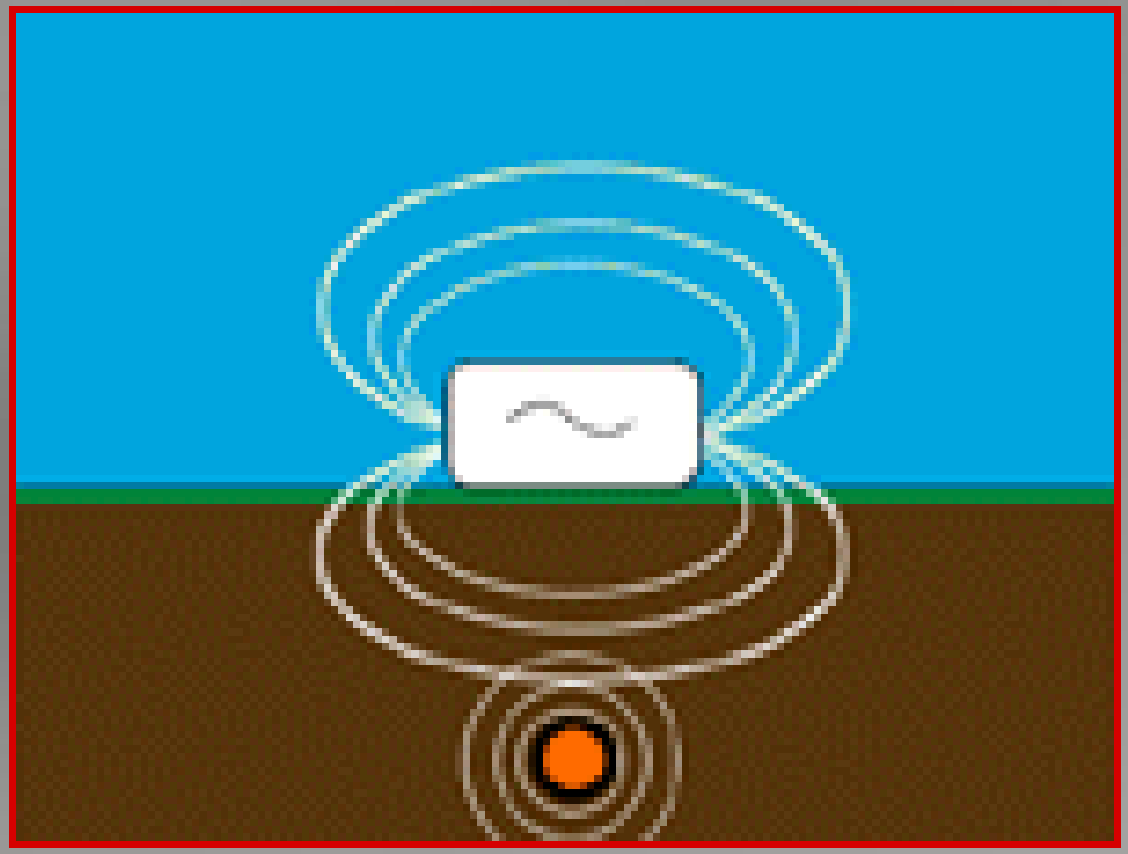


INDUCTION

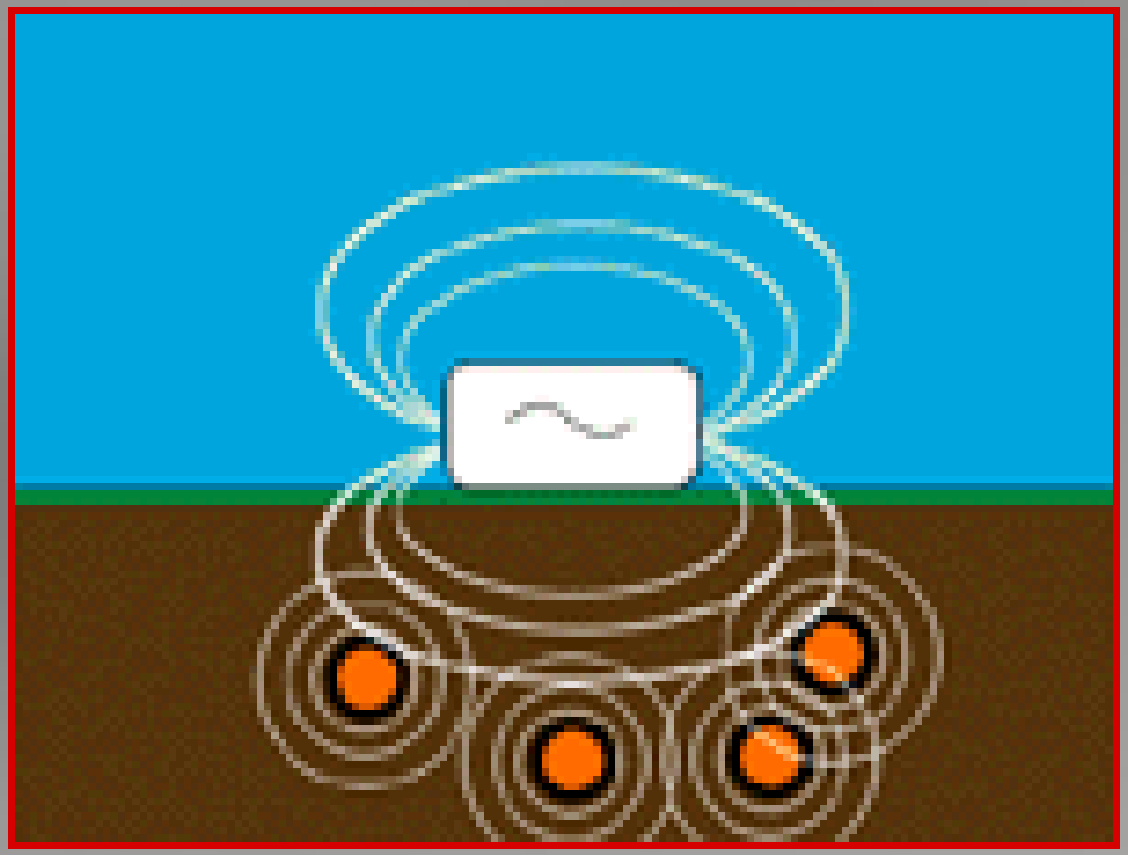
Induction



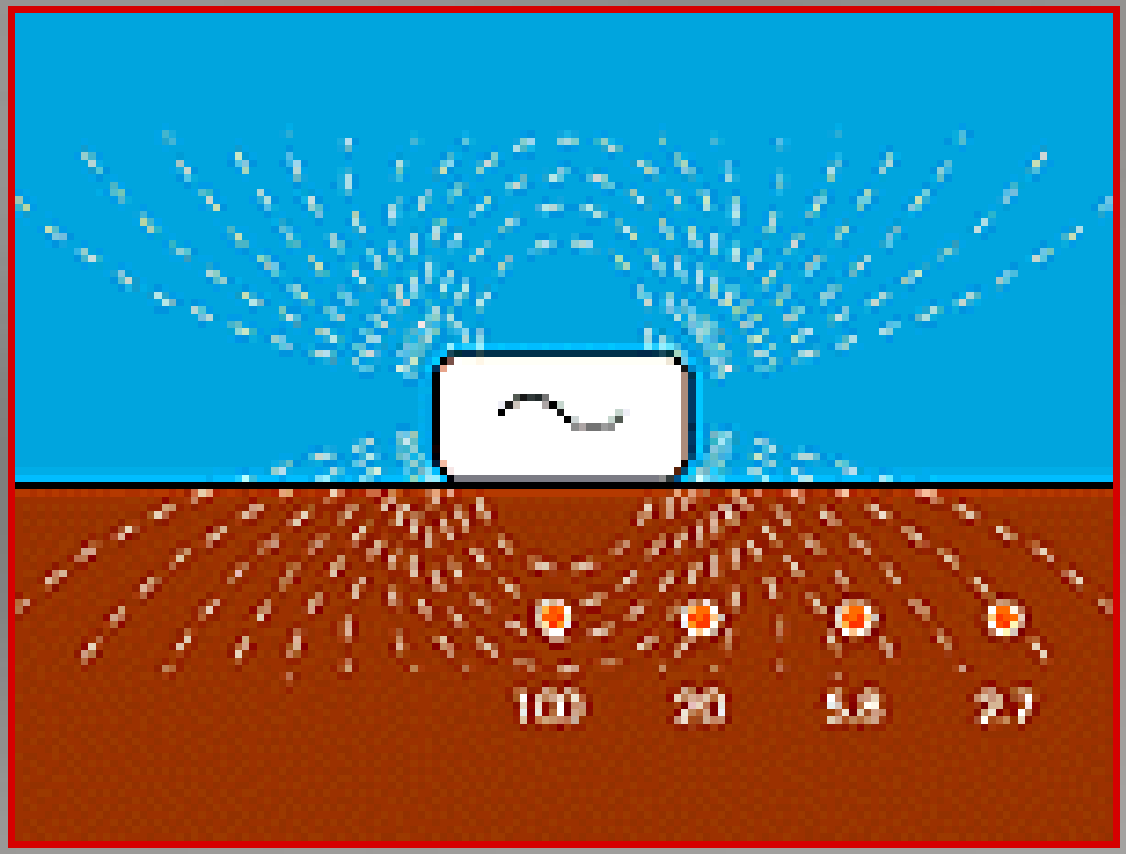
Induction



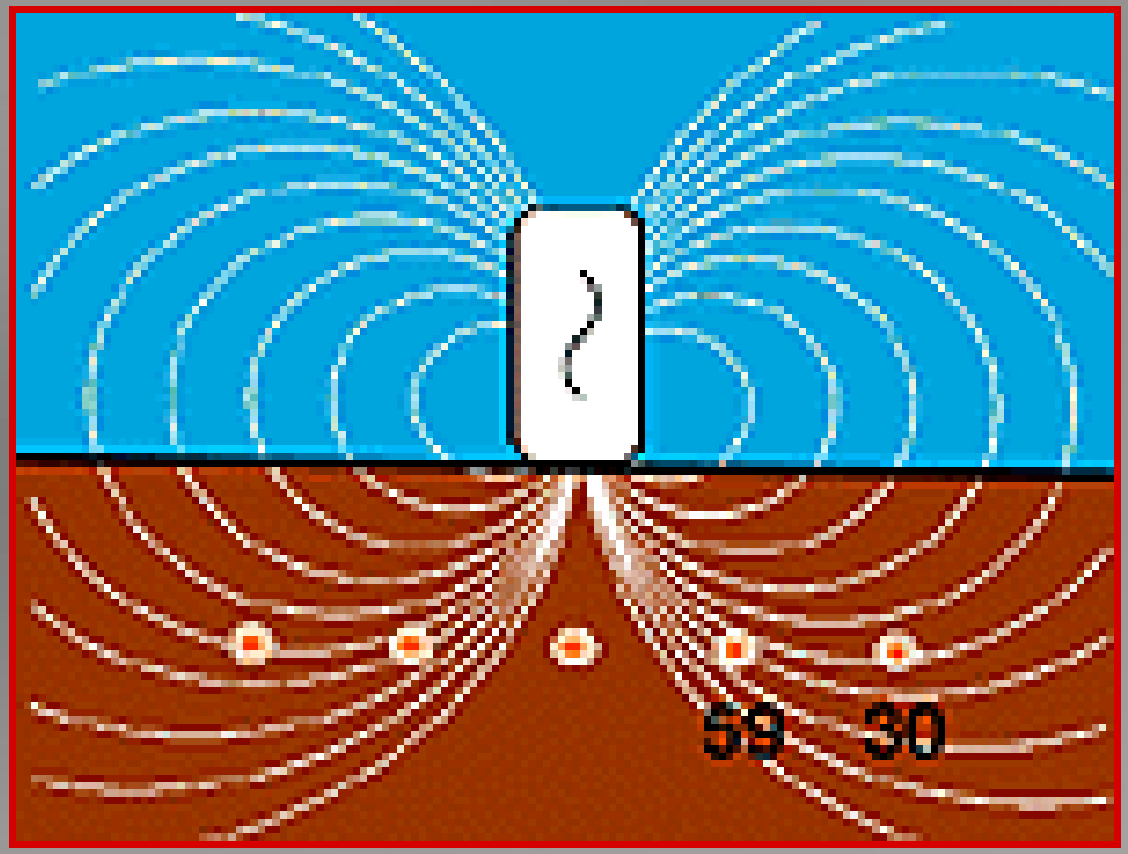
Induction



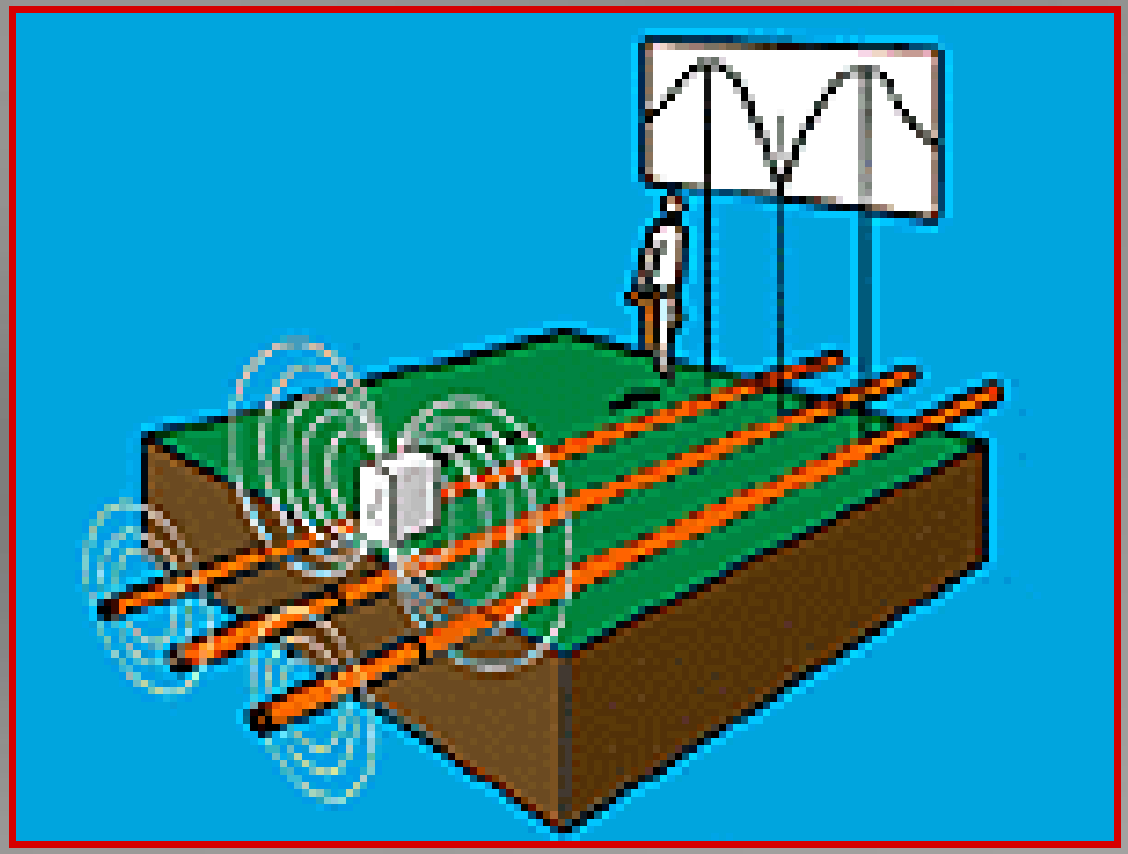
Induction - Signal Strength



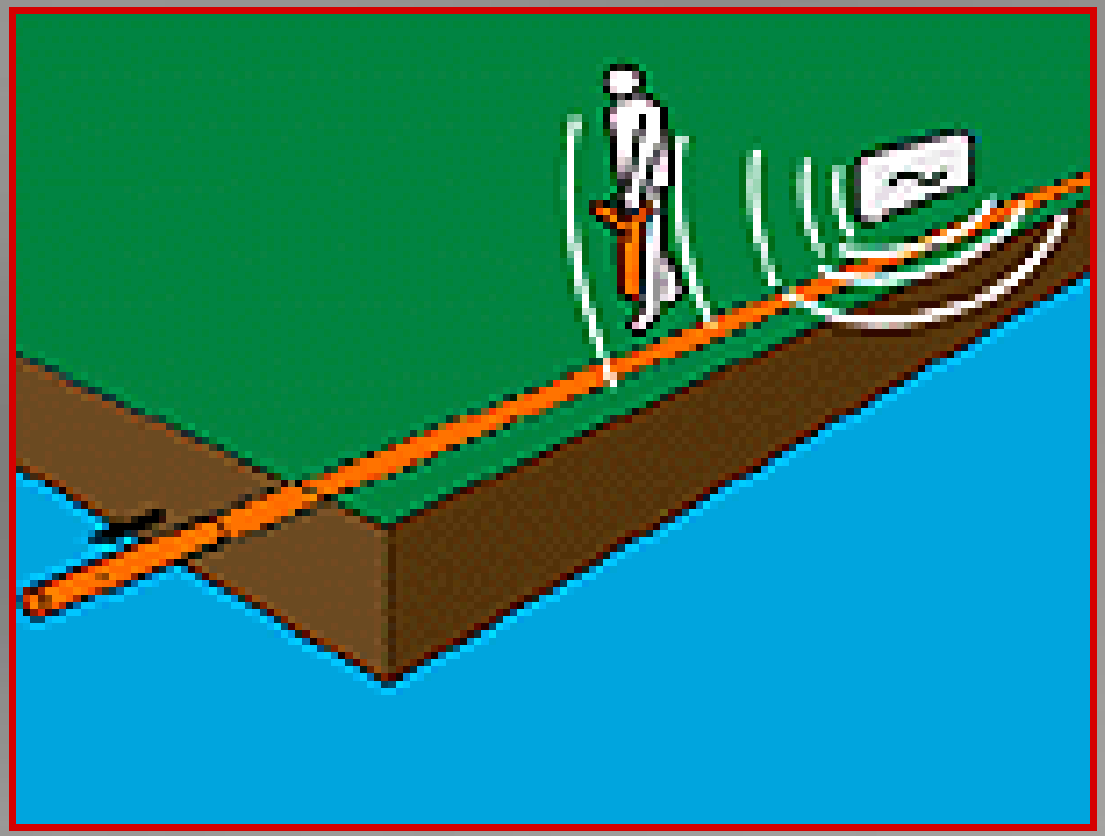
Induction - Identification



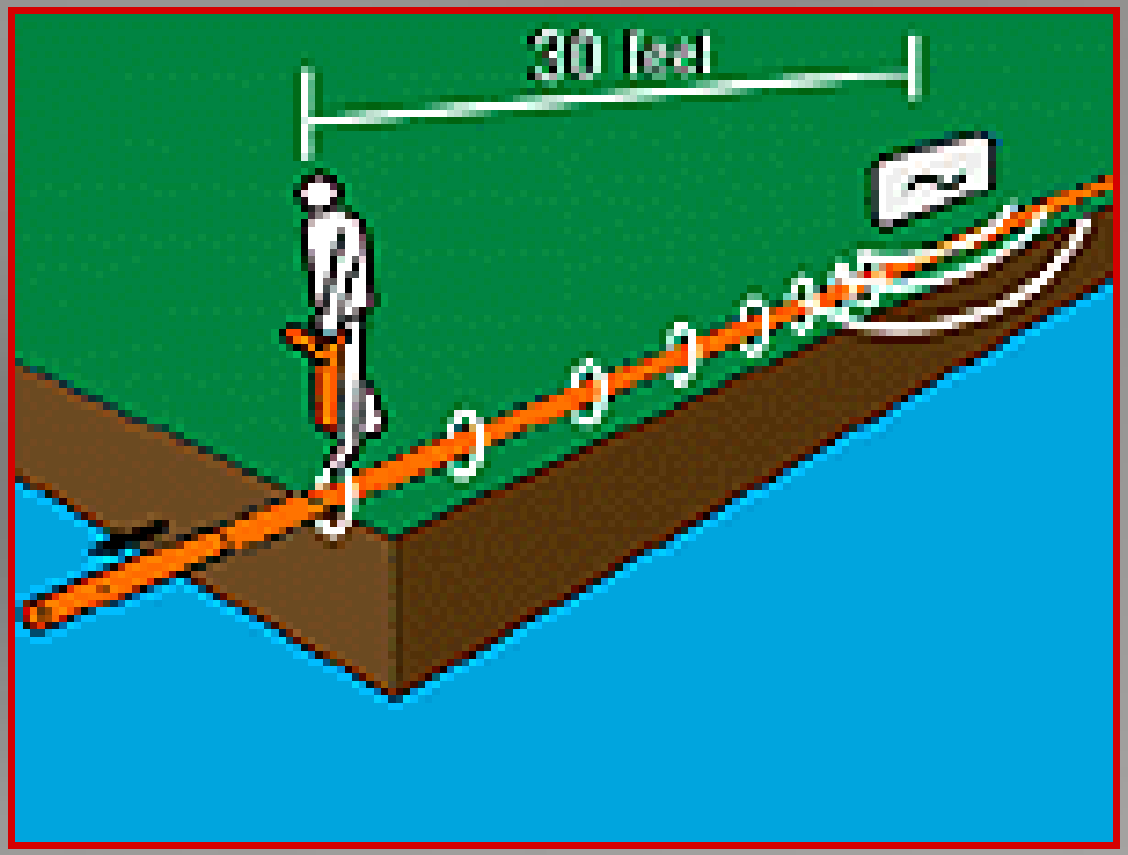
Induction - Identification



Induction - Never Locate Near To The Transmitter.



Min 10 paces away from the transmitter.

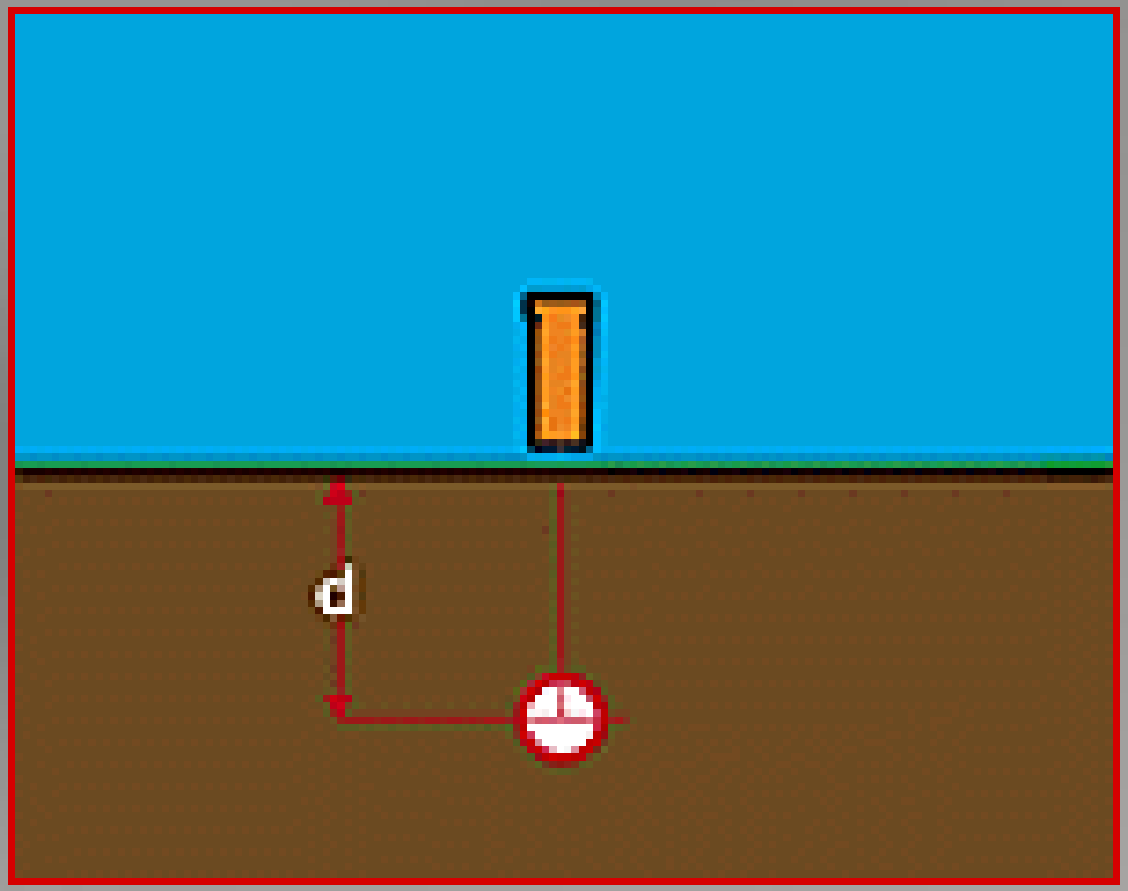


Passive signal sweep

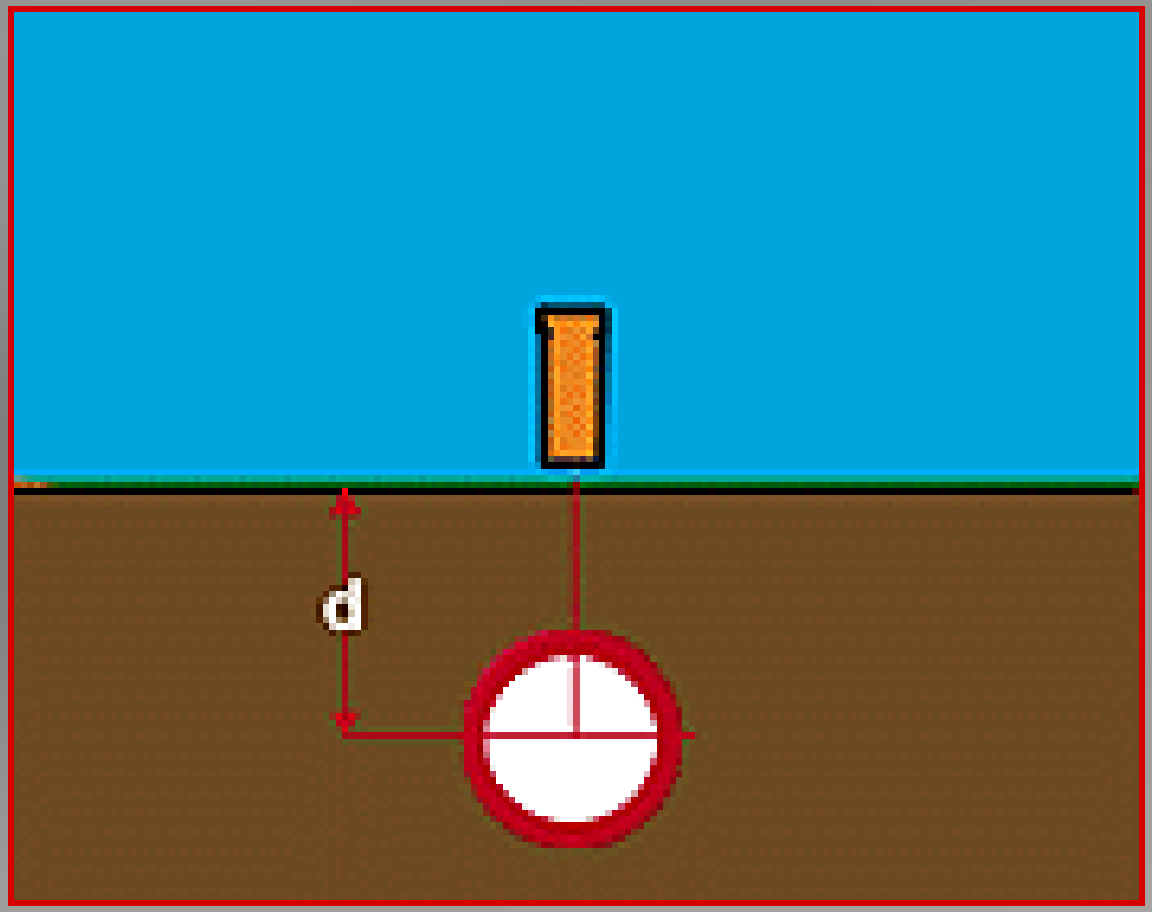
- Sweep for a signal (60 Hz) using the receiver.
- Technique allows detection of live cable transmitting electromagnetic wave.

HOW TO TAKE DEPTH MEASUREMENT?

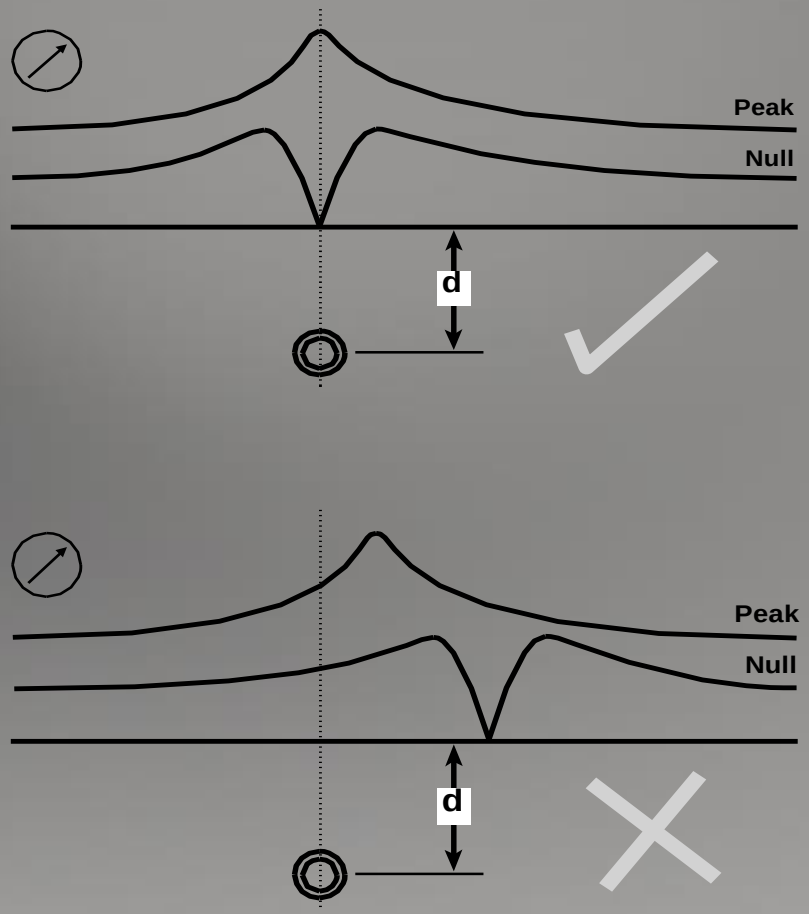
Depth Measurement



Depth Measurement



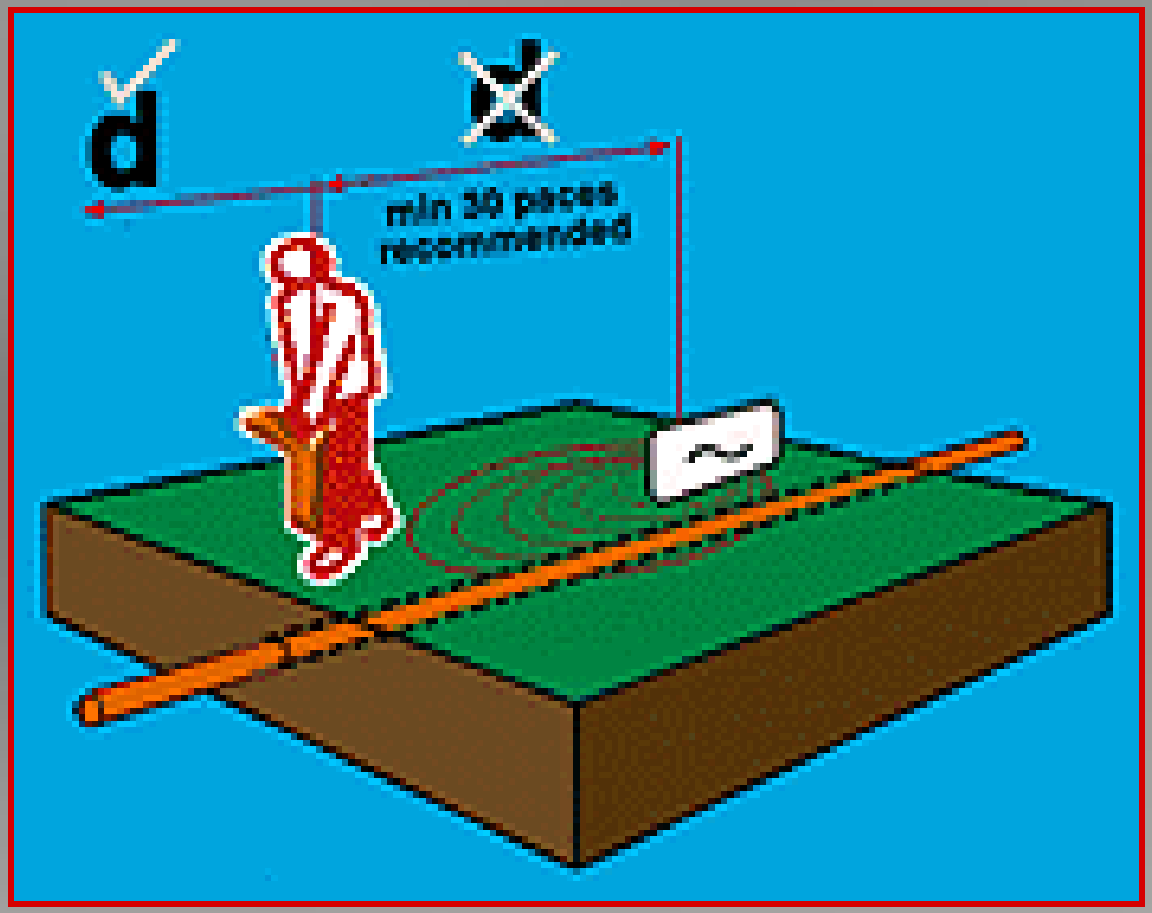
DISTORTION AND DEPTH



When there is a discrepancy between the aerial responses the following must be observed.

1. The Peak response will always be more accurate.
2. Push button depth estimation should not be used until the two responses agree.

Depth Measurement



Depth measurement by PCL

- Two antennas required
- Difference in signal strength between top and bottom and known distance between antennas allows computation of depth.
- Displays depth to 95% accuracy

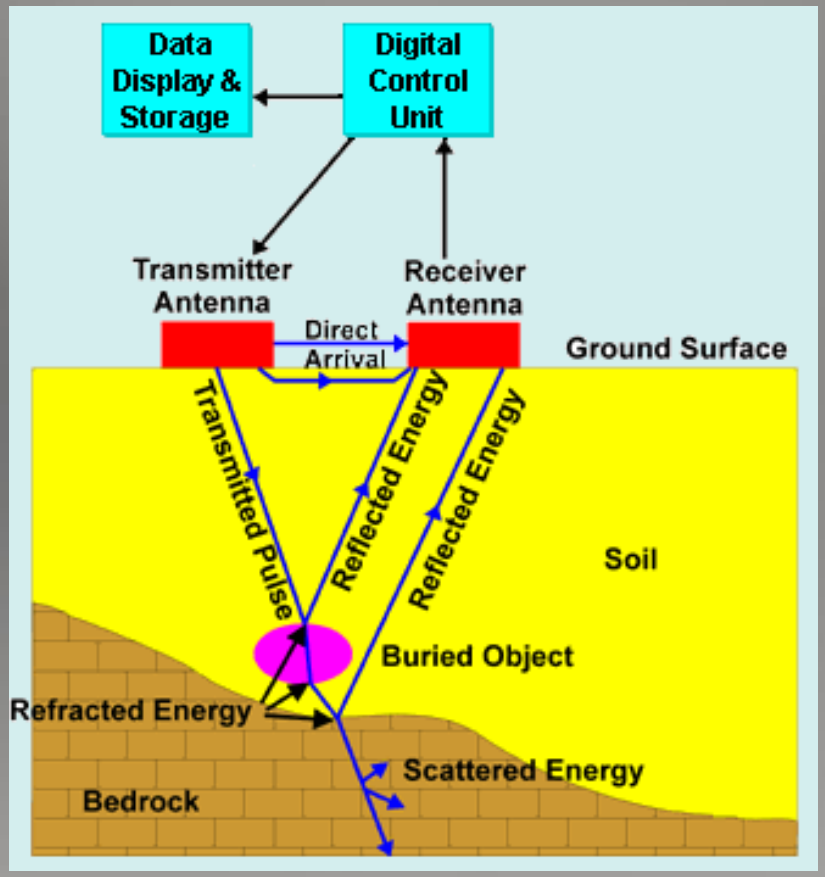
Ground Penetrating Radar (GPR)

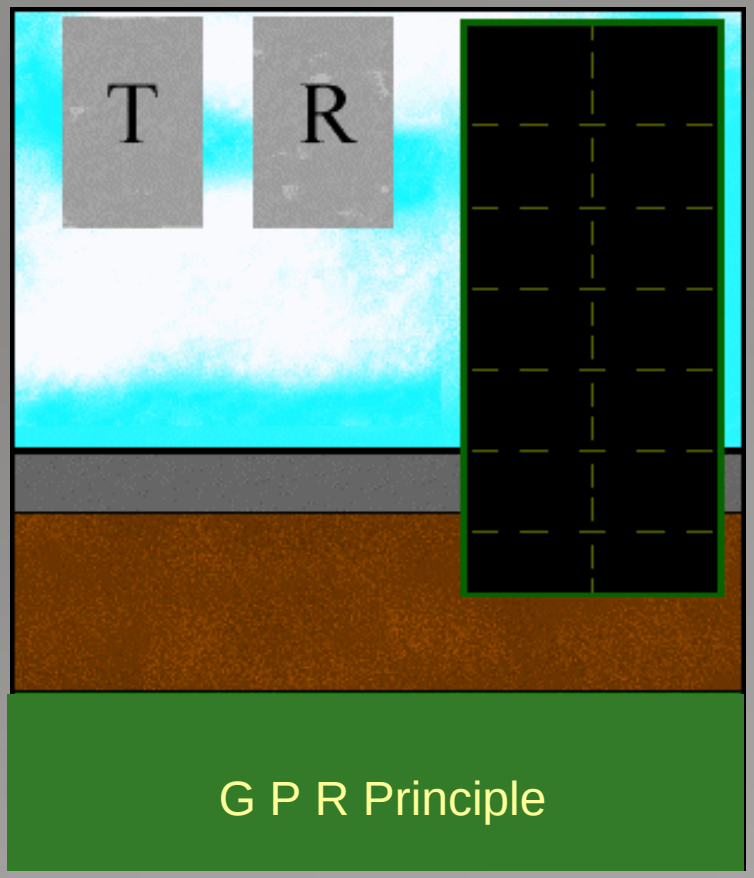
Ground Penetrating Radar (GPR)

- GPR – geophysical imaging technique for subsurface mapping
- RADAR - an acronym coined in 1923 for **Ra**dio **D**etection **a**nd **R**anging
- The most available system commercially is the impulse GPR system.

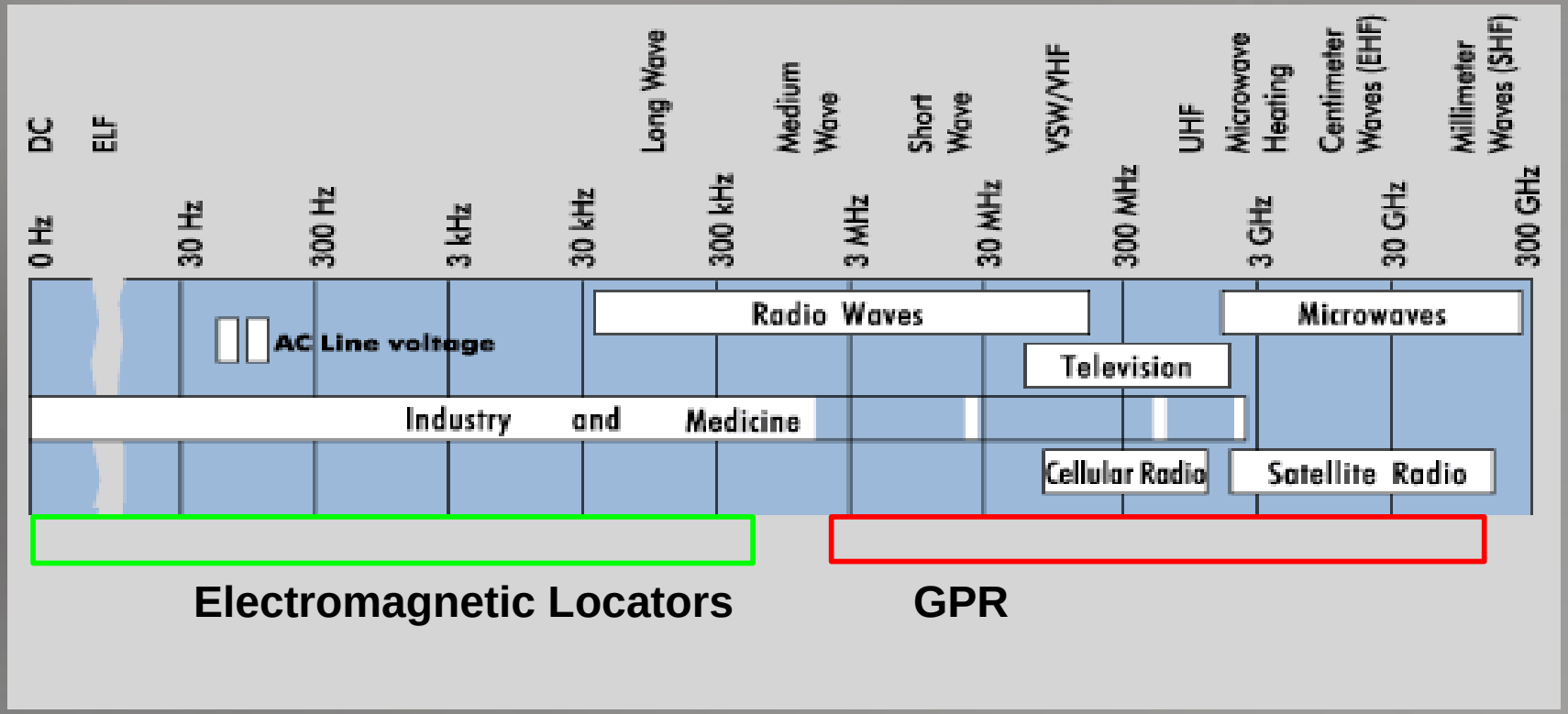
GROUND PENETRATING RADAR (GPR)

GPR is a method developed for shallow, high-resolution, subsurface investigations of the earth. GPR uses high frequency pulsed electromagnetic waves (from 25 MHz to 2,000 MHz) to acquire subsurface information.





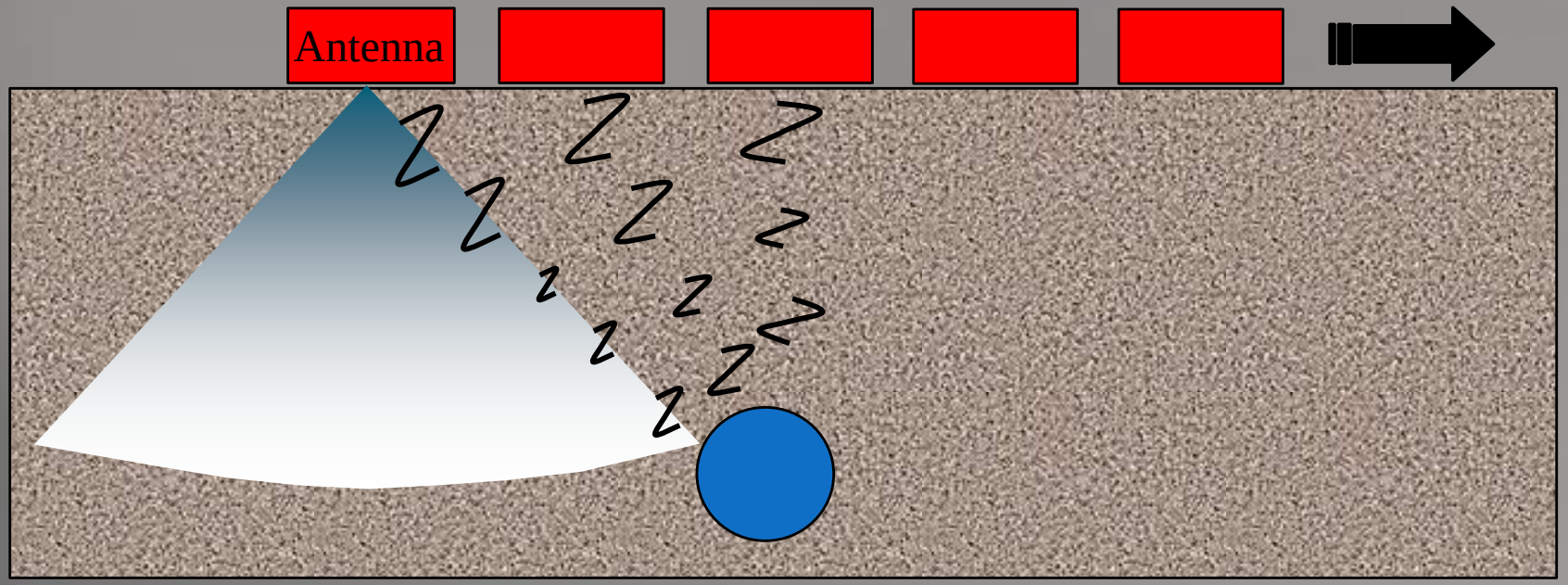
Frequency Range

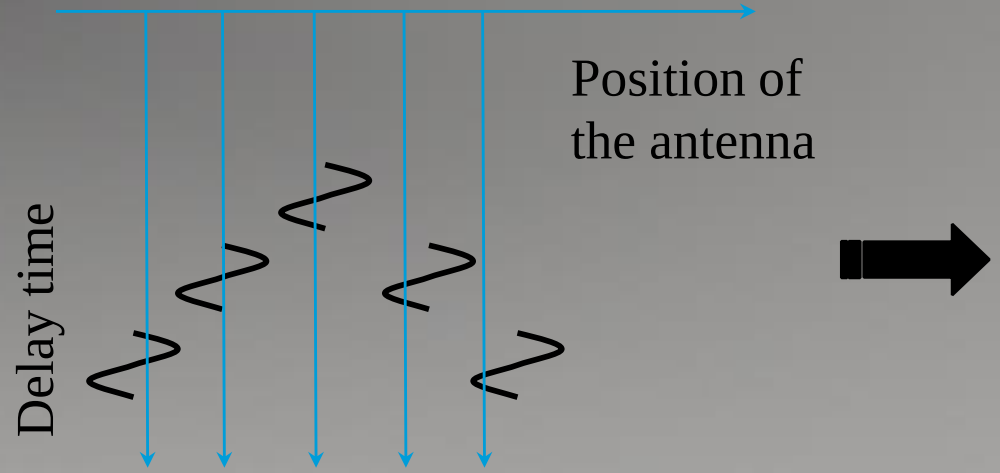


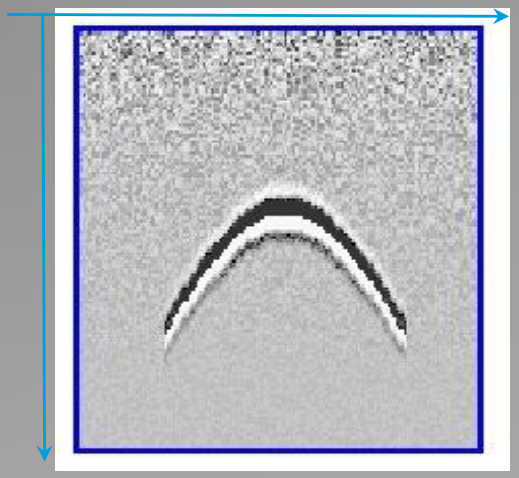
GPR operational frequencies are overlapping the TV and cellular ones for this SHIELDED antennas are used

Electromagnetic Locators operational frequencies are in the range of EM noise associated to industrial activities.

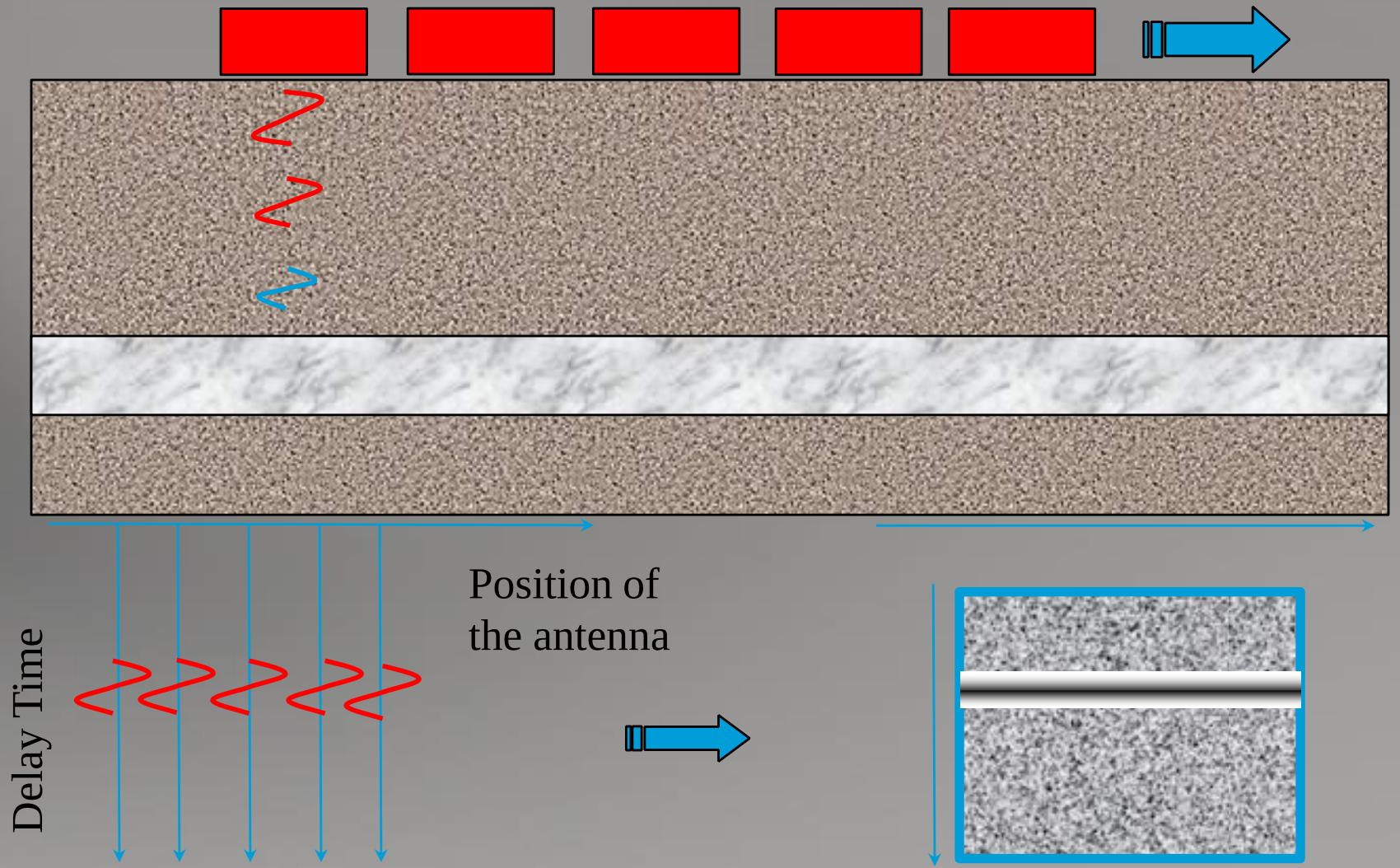
PRINCIPLE OF FUNCTIONALITY





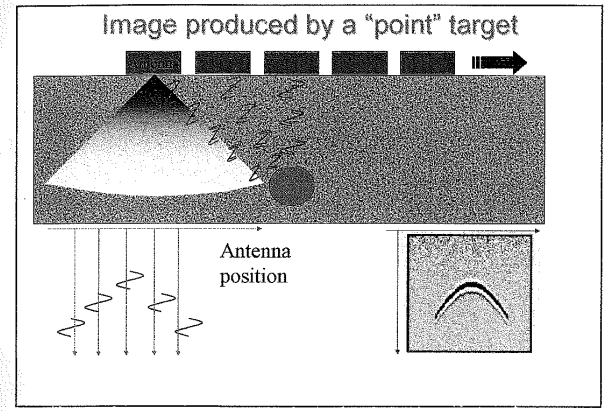


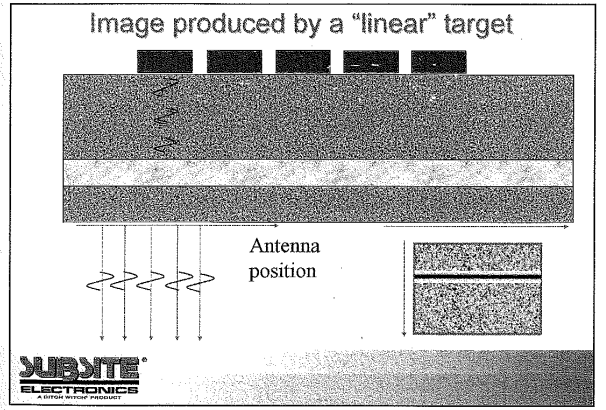
PRINCIPLE OF FUNCTIONALITY



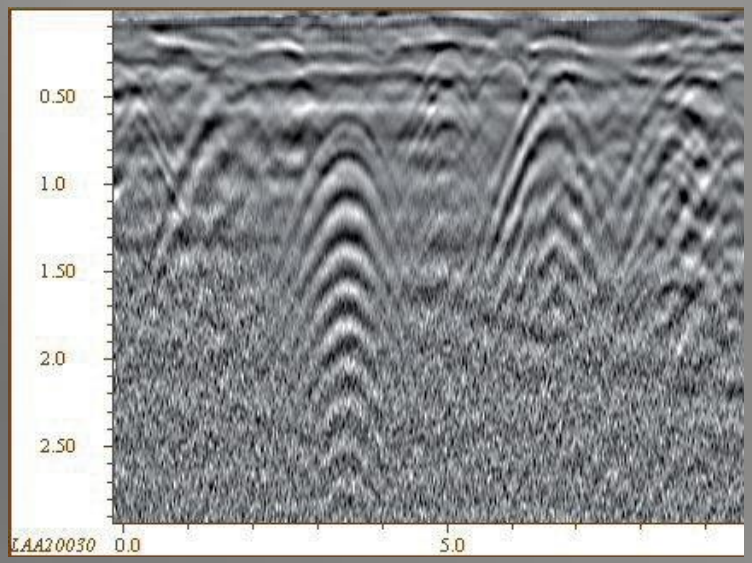
GPR

- impulse GPR works by sending electromagnetic energy in very short pulse into the ground.
- Reflected signal captured by the receiver after hitting an object in the ground is process to produce a hyperbolic image.
- Depth is obtained from the calibrated radar two way travel time between the transmitter and the utility





GPR



- Depth, range and resolution depends on factors below:
  - Radar frequency
    - High freq. good for shallow

    (700 MHz ~ 2 m ~ min. target size of 1 cm)
    - Low freq. good for deep

    (250 MHz ~6 m ~ min. target size of 5 cm)
  - Transmitted power
  - medium electromagnetic properties – how conductive?
  - Shape and characteristic of target

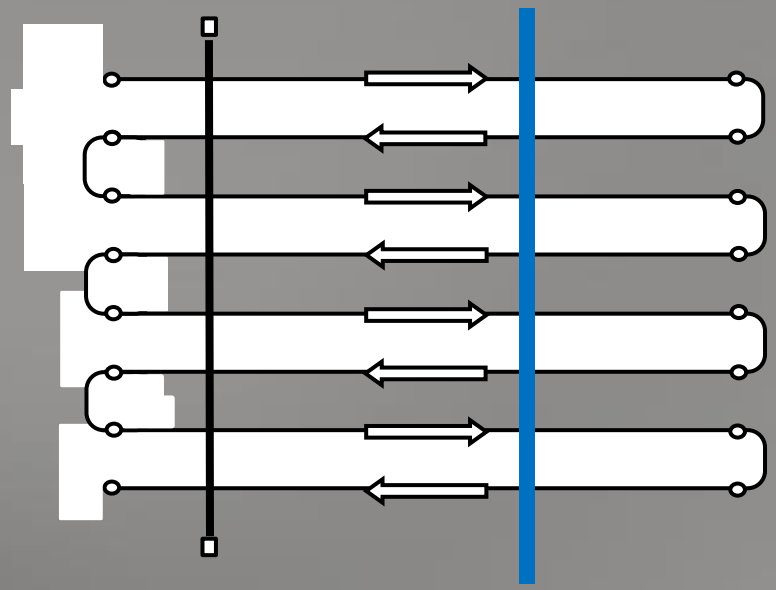
Depth vs Frequency

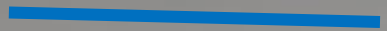
Sensor	Frekuensi	Depth
Frekuensi Tinggi	> 1000 MHz	< 0.5 m
Frekuensi Sederhana Tinggi	400 – 600 MHz	0.5 m – 1.5 m
Frekuensi Sederhana Rendah	200 – 400 MHz	1.5 m – 2.0 m
Frekuensi Rendah	< 200 MHz	2.0 m – 3.0 m

Detection Capabilities of Different Techniques

Equipment	Mode	Depth Range	Depth Determination	Minimum Size	Notes
Electromagnetic locators and signal generators	Passive	Up to 3m	No	N/A	Depth depends on signal on service and length of service. May not detect well balanced electricity cables
	Induction	Up to 3m	Yes (+/-5% of depth under normal conditions)	N/A	Does not work well in congested environments. Signal may jump to nearby services
	Connection	Up to 10m depending on signal strength	Yes (+/-5% of depth under normal conditions)	N/A	Signal may jump to nearby services
	Sewer Sonde	Up to 15m depending on Sonde type	Yes (+/-5% of depth under normal conditions)	Depends on Sonde type. Smallest Sonde diameter 15mm	Generally ducts and gravity pipes only. Other applications possible
GPR (100MHz to 1GHz)		Up to 3-4m depending on ground	Yes (+/-10%) Sometimes better in good ground conditions	25mm (see note in Section 1.6.3)	See resolution chart (attached). It is possible to detect a pipe with a diameter 10% or larger than the cover depth.

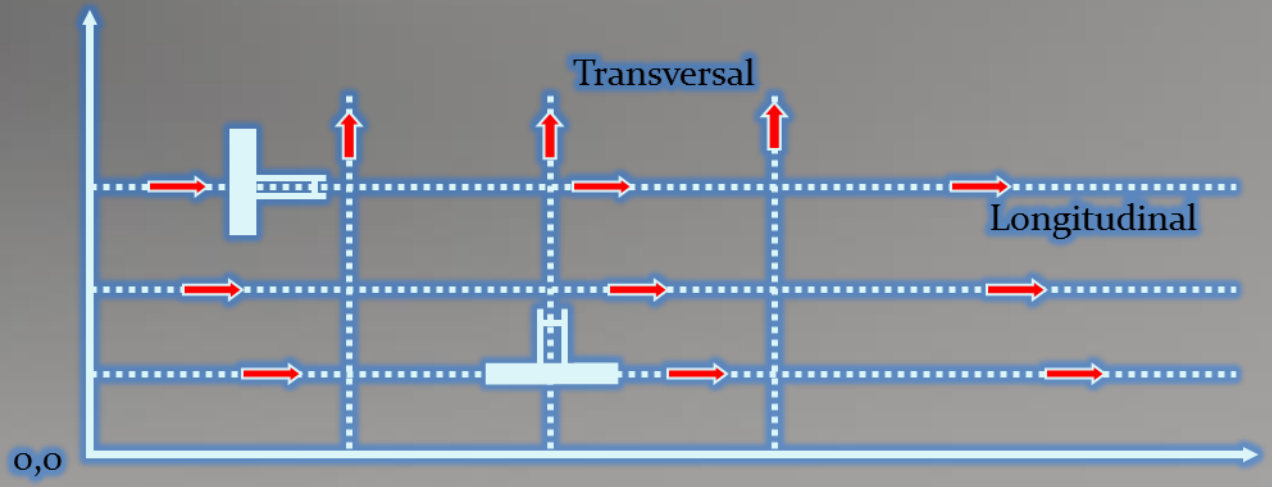
DETECTION USING GPR



	Line of scanning. The first and last point of each line is surveyed.
	Line of scanning. The first and last point is surveyed.
	Direction of scanning
	Underground Utility

GPR DATA ACQUISITION

- Data compilation
- Surface surveying
- Survey Grid design and layout
- Longitudinal and Transversal lines acquisition
- 0.5 - 2m with automated referencing system
- Systematic continuos acquisition
- NO in field target marking or with target marking



Investigation Scale and Equipments use

DETECTION

Small Scale

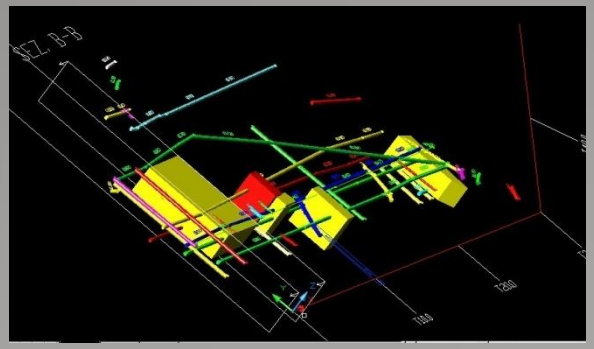
Small and Medium Scale

MAPPING

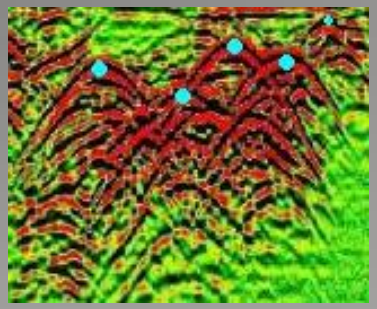
Large Scale

Single/Multi Channel GPR
Detection / Relative location
Digital data record & output

Multi Channel GPR
Referenced Detailed
Mapping CAD 3D



ElectromagneticLocator
Acoustic signal,
empiric, subjective
evaluation.
NO
physical data output



Control Survey

- Executed simultaneously with underground utility detection

- Conventional survey equipment

- GPS

Survey of Surface Features

- Surface utilities
  - - street light, overhead cables, pylon …
  - - phone booth, antenna tower, satellite station …
  - - reservoir, water tank, water meter, fire hydrant…
  - - sewerage pond…
- Topographic features
  - –built environment
  - - hydrography
  - - relief
  - - transportation

Survey of Exposed Utilities

- Verify location of underground utilities by test holes
- Survey of Utilities During Installation

Teknik yang digunapakai semasa melaksanakan penggalian lubang ujian (test holes)

- Ekskavasi hampagas

Survey of Utilities During Installation

- Least expensive
- Depth or z value can be obtained with high accuracy
- Survey done with high accuracy
- Properties of pipes/cable can be determined
- Requires less field workers
- Minimise risk and danger associated with working in a confined space
- Most recommended for new installation

Survey Reference

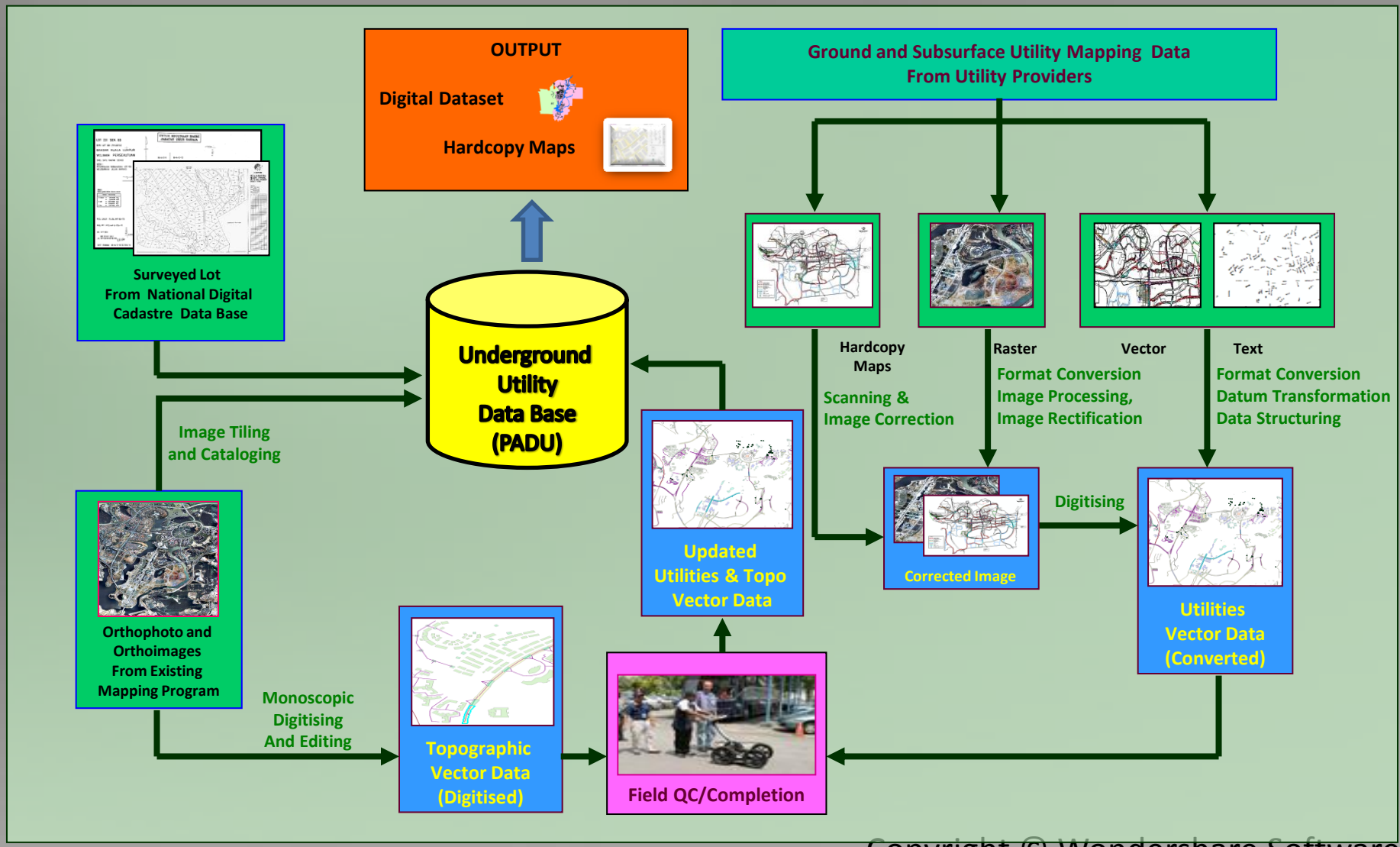
- Planimetry:
  GDM2000 and RSO

- Vertical:
  z value and depth

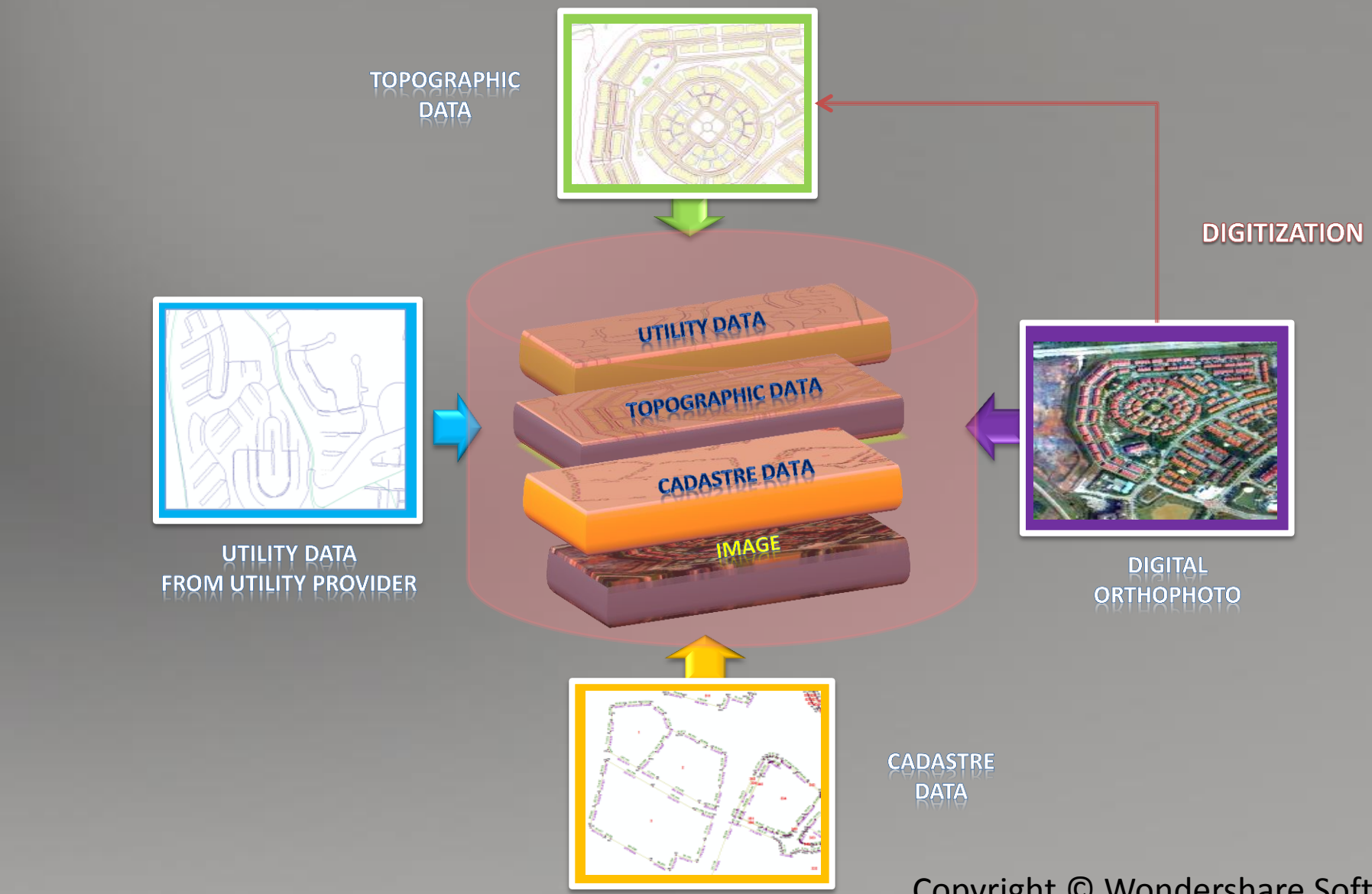
Deliverables

- Digital survey plan in GIS format
- Plan verified by land surveyor
- Equipment calibration certificate

Data Flow for Utility Mapping



NATIONAL UNDERGROUND UTILITY DATABASE (PADU)



Guidelines for Underground Utility Mapping

- 3 guidelines produced by the Technical Committee for Utility Mapping

- KPUP Circular KPUP 1/2006 – Standard Guideline for Underground Utility Mapping
  - roles of stakeholders
  - classification of quality levels
  - specifications of underground utility maps
  - creation and maintenance of underground utility database by JUPEM

- KPUP Circular 1/2007 – Guideline for Underground Utility Survey
  - guideline for surveyors in undertaking utility survey

- KPUP Circular 1/2013 – Guideline for As- Built Survey for New Utility Installation
  - guideline for surveyors in undertaking as - built survey for new installation

Role of utility owners

- enables surveyors to access existing underground utility records
- furnish existing underground utility information with its metadata for inclusion into the underground utility database
- furnish information on utility relocation for maintenance of underground utility database
- ensure all new underground utility installation attain quality level A

Role of Surveyors

- provide consultation to utility owners
- conduct utility survey and prepare underground utility maps
- indicate quality level of each utility surveyed
- certify utility maps

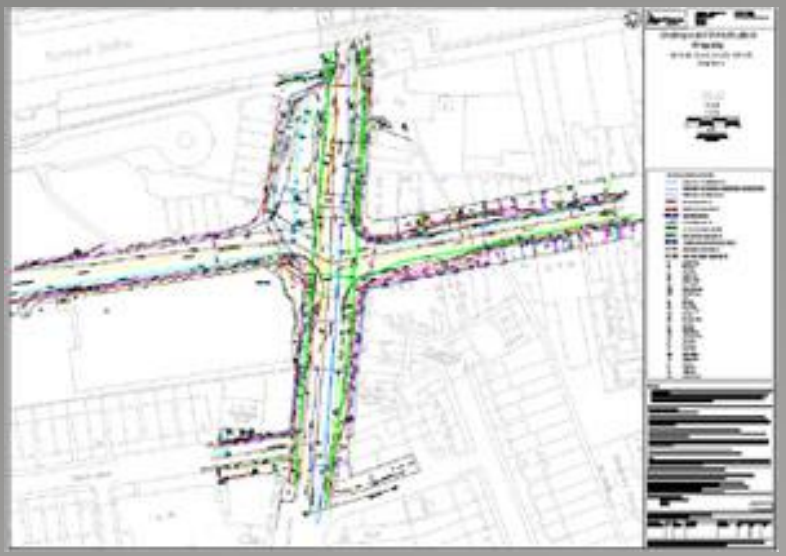
Role of JUPEM

- create, populate and maintain underground utility database with:

  - utility data provided by utility owners
  - utility data collected by JUPEM
  - digital cadastral data and topographic data to form large scale base map

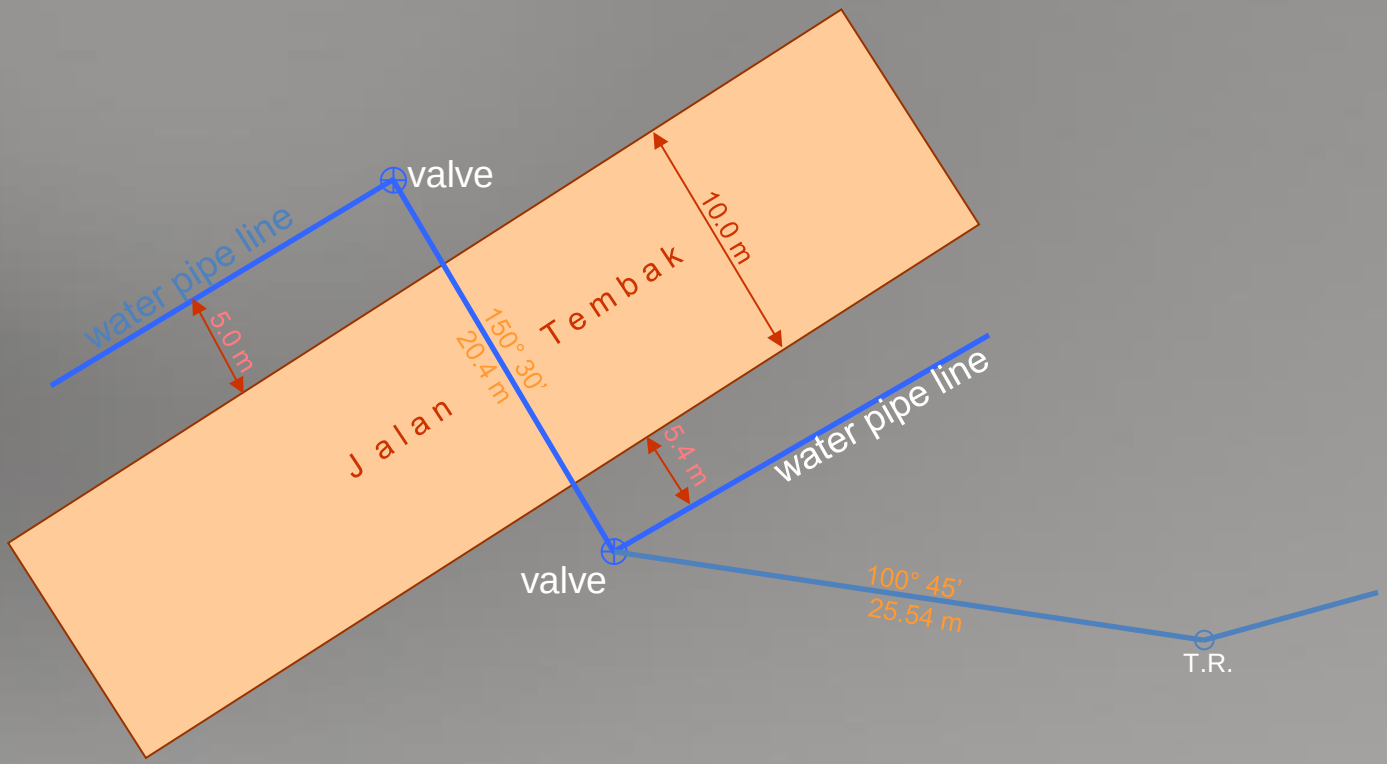
Quality Level D

- The position of buried utilities based on design plans or sketches
- For utilities where quality level is not known
- Lowest quality level



Quality Level C

- Better than quality level D
- The position or alignment of buried utilities is based on surface features



Quality Level B

- Better than quality level C
- The position of buried utilities is determined and marked on the surface by geophysical methods
- The position of the marks is surveyed to the accuracy of 10 cm

Quality Level A

- Better than quality level B
- The position of buried utilities is determined by exposing the utilities by intrusive excavation methods at specific locations

  The horizontal and vertical location is surveyed reference to the approved datum
- The position of utilities is surveyed during installation
- Survey done to the accuracies at 10 cm or better
- Highest quality level

Equipment Calibration

- All survey and geophysical detection equipment used to acquire quality level A and level B data shall be appropriately calibrated to enable it to achieve the required accuracy as specified in this guideline

National Underground Utility Database (PADU)

- Projections and coordinate systems
  - GDM2000 and RSO Geocentric
- Data Exchange Standards – use of MS1759
- Metadata – compliance with MyGDI metadata standard

Deliverables

- Basic Deliverables – hardcopy or mapping file
- Quality levels information (Line Code and Style, Labeling, Symbol Embedding, Colour, Line weight, Layer, Annotation)
- Parcel Boundaries
- Lot Numbers
- Names of Buildings, Street, Road or River
- North Arrow
- Scale Representation
- Map date
- Marginal information
- Disclaimer

KPUP Circular 1/2007
Garis Panduan Ukuran Pepasangan Utiliti

Panduan dan rujukan kepada JTB menjalankan kerja ukur berkaitan pemetaan utiliti yang meliputi;

- Pengesanan dan ukuran secara non-invasive

- Ukuran pengesanan yang terdedah (Exposed)

Pengesanan dan ukuran secara non-invasive

- Menghasilkan tahap kualiti B
- Menggunakan peralatan EML dan GPR
  - Ketepatan EML = ±5%
  - Ketepatan GPR = ±10% (bergantung kpd keadaan tanah dan frequensi sensor)
- Sela pengesanan = 20m

Ukuran pengesanan yang terdedah (exposed)

- Menghasilkan tahap kualiti A
- Melalui penggalian lubang ujian (test holes) dan ukuran as-built menggunakan;
  - Ekskavasi hampagas (potholing)
  - GNSS dan Total Station
- Ketepatan= ±10sm

KPUP Circular 1/2013
Garis Pengukuran Jajaran Laluan Utiliti Baru

Panduan dan rujukan kepada JTB menjalankan ukuran as built bagi jajaran utiliti baru

- Hanya melibatkan pembangunan baru dan pembangunan semula

- Disesuaikan dgn Garis Panduan Perancangan Laluan Kemudahan Utiliti oleh JPBD bagi menempatkan utiliti secara common trenching atau common utility tunnel

Skop kerja- kerja ukur JTB

- Meliputi ukuran ke atas pepasangan utiliti bagi keadaan berikut
  - Penempatan laluan utiliti bawah tanah tanpa saluran terowong tetapi berkongsi laluan bersama (common trenching)
  - Penempatan laluan utiliti bawah tanah di dlm binaan terowong utiliti bersepadu (common utility tunnel)
  - Penempatan laluan utiliti bawah tanah yang di pasang secara berasingan di bwh permukaan jln atau dlm kawasan rezab
  - Utiliti yang dipasang melalui pengerudian berarah (HDD)

Peralatan yg digunapakai

- Total Station
- GNSS
- Gyro HDD

Thank you for your attention ....