

This presentation premiered at WaterSmart Innovations

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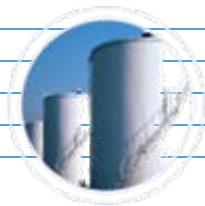
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Water Loss Prevention Through Corrosion Control Advancements

www.corrpro.com

October 8, 2008



Corrosion is the leading contributor to cast and ductile iron water system breaks!



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Corrosion



Structures

- ***Piping (Distribution/Transmission)***
- ***Metallic Fittings***
- ***Water Storage Tanks***
- ***Clarifier Units***
- ***Lift Stations***

Corrosion Can be Defined as Either:

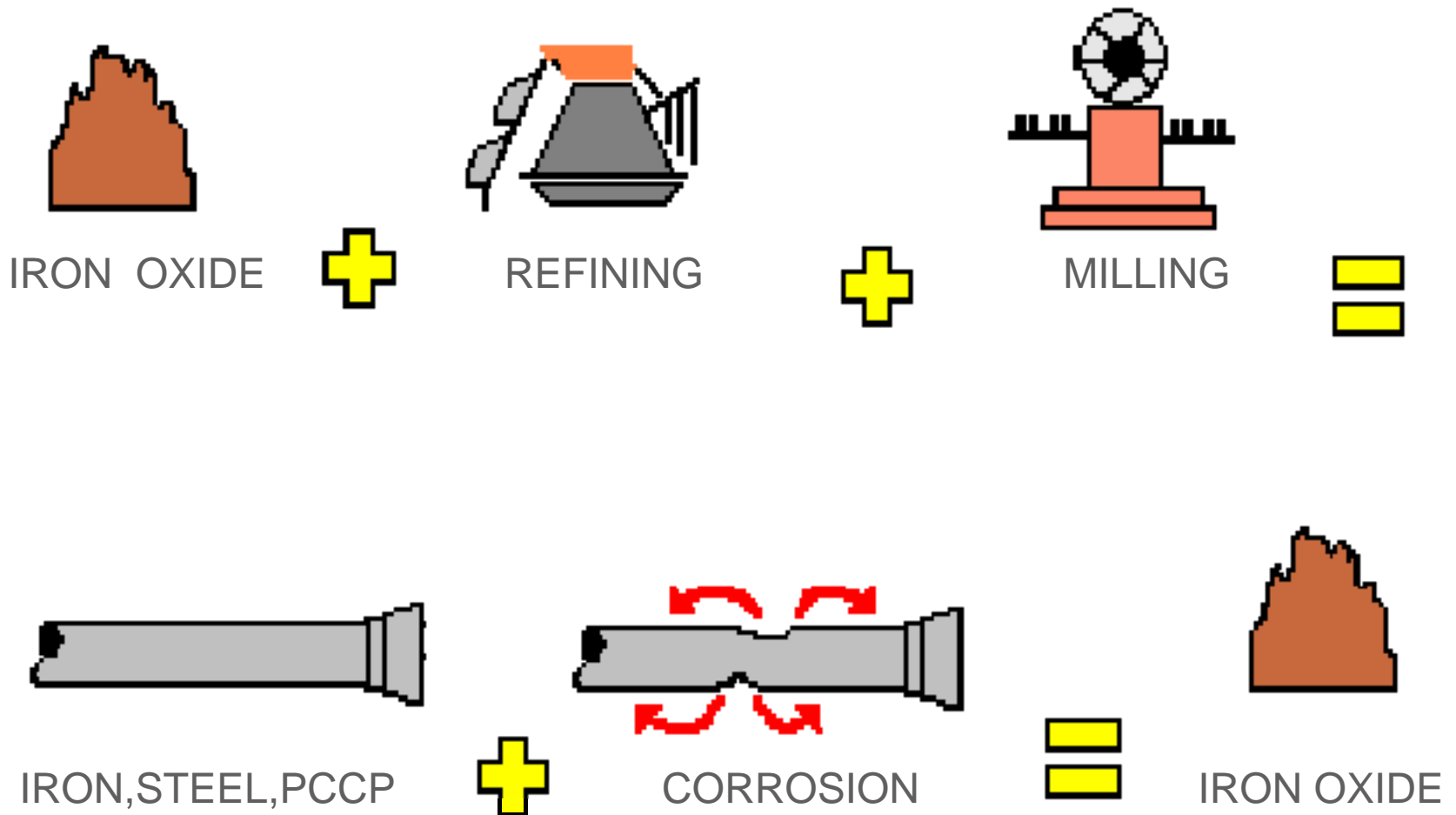
- ▶ **Practical**

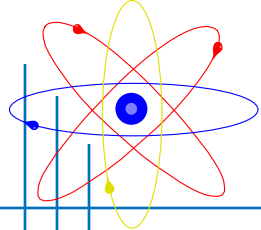
Tendency of a Metal to Revert
to its Native State

- ▶ **Scientific**

Electrochemical Degradation
of Metal as a Result of a Reaction
with its Environment

Corrosion - A Natural Process





PRACTICAL GALVANIC SERIES

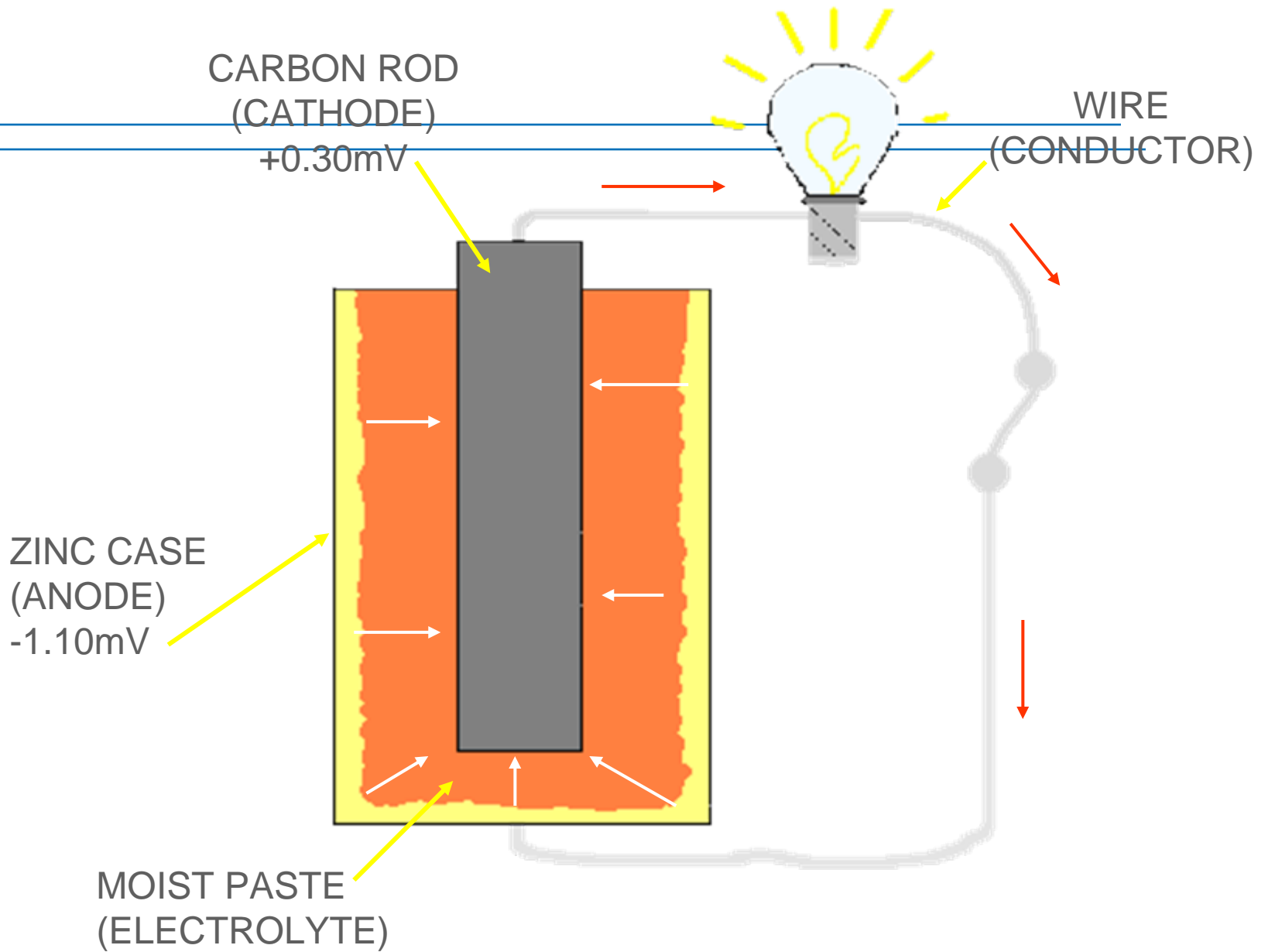
Material

Potential*

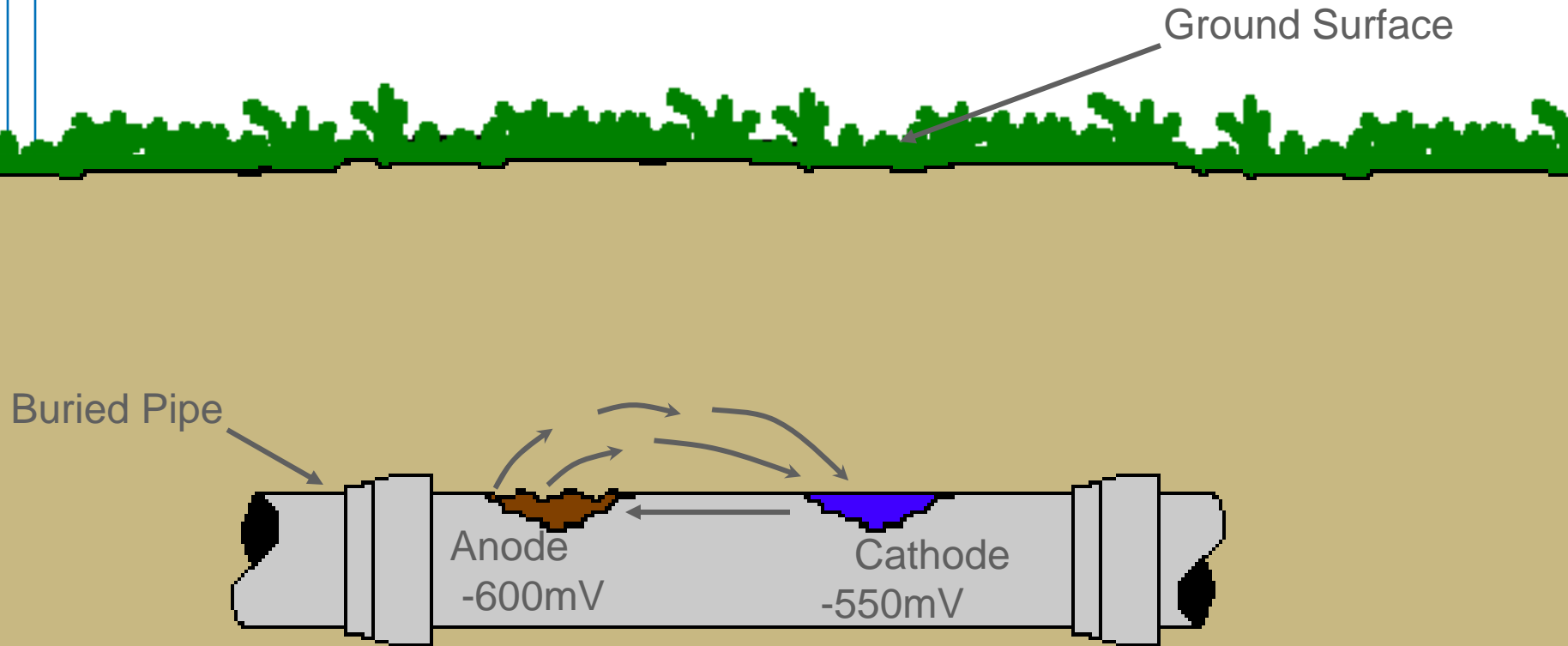
Pure Magnesium	-1.75
Magnesium Alloy	-1.60
Zinc	-1.10
Aluminum Alloy	-1.00
Cadmium	-0.80
Mild Steel (New)	-0.70
Mild Steel (Old)	-0.50
Cast/Ductile Iron	-0.50
Stainless Steel	-0.50 to + 0.10
Copper, Brass, Bronze	-0.20
Titanium	-0.20
Gold	+0.20
Carbon, Graphite, Coke	+0.30

* Potentials With Respect to Saturated Cu-CuSO₄ Electrode

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Basic Corrosion Cell



- 1) Anode
- 2) Cathode
- 3) Electrolyte
- 4) Electrical Connection

Corrosion Pitting



Coating Flaws (Holidays)



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Corrosion of Pre-stressed Concrete Cylinder Pipe (P.C.C.P.).



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History of Iron Pipe

Cast Iron

- Introduced to North America during the 1800's and installed till the 1970's.
- Early on, statically cast process produced a thick walled, heavy pipe.
- No longer produced in North America.

Ductile Iron

- Introduced in 1955 as an improvement to cast iron.
- Centrifugal casting process produces a thinner walled, lighter pipe which is stronger and more ductile than cast iron.

Cast (Grey) Iron





Pitting (concentrated)
corrosion attack on ductile iron
pipe.

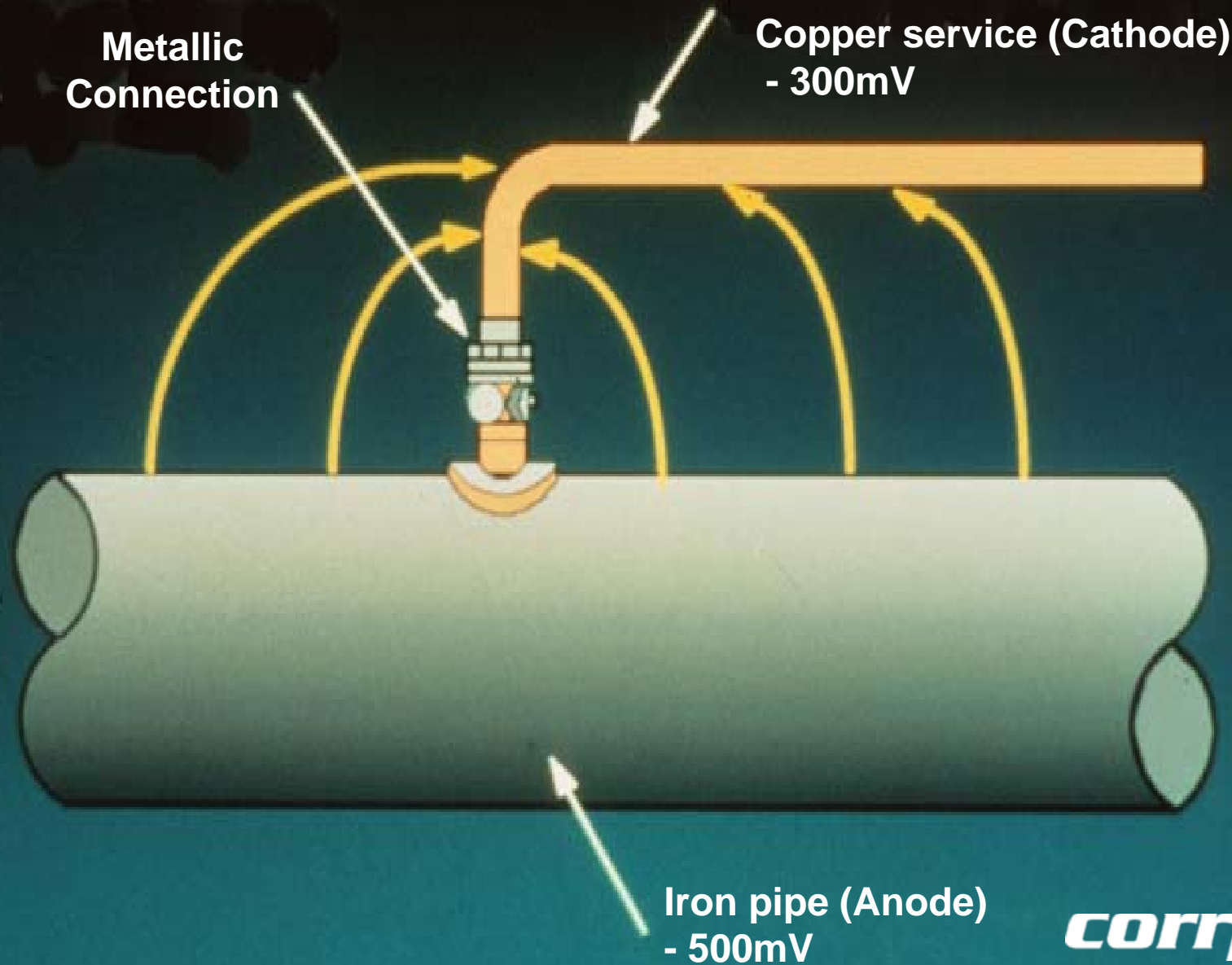
Adverse Conditions for Metallic Pipe

- ***High Chlorides***
- ***Low Soil/Water Resistivity***
- ***High Sulfates***
- ***Acidic Soils***
- ***Wet/Dry Fluctuations***
- ***Bimetallic Couplings***
- ***Stray Current Interference***

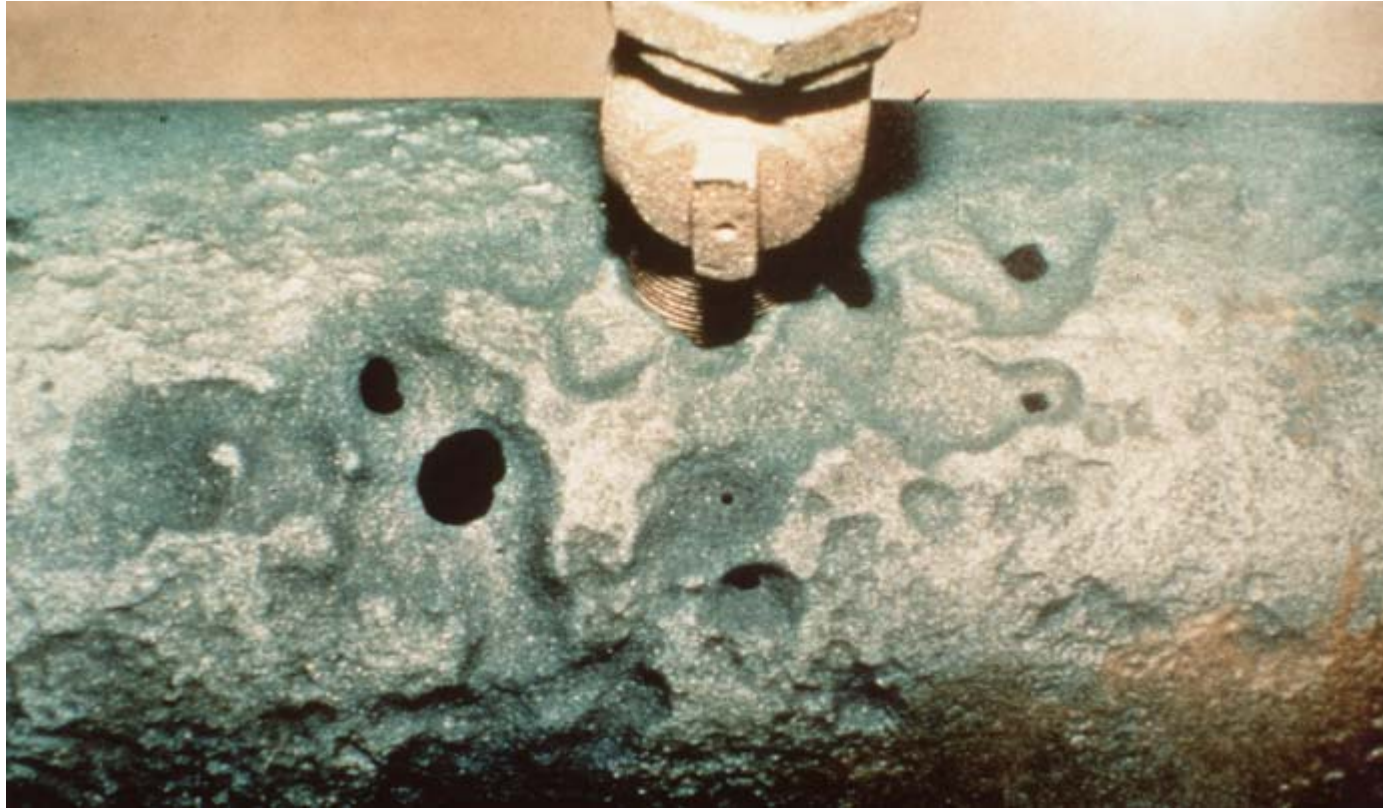


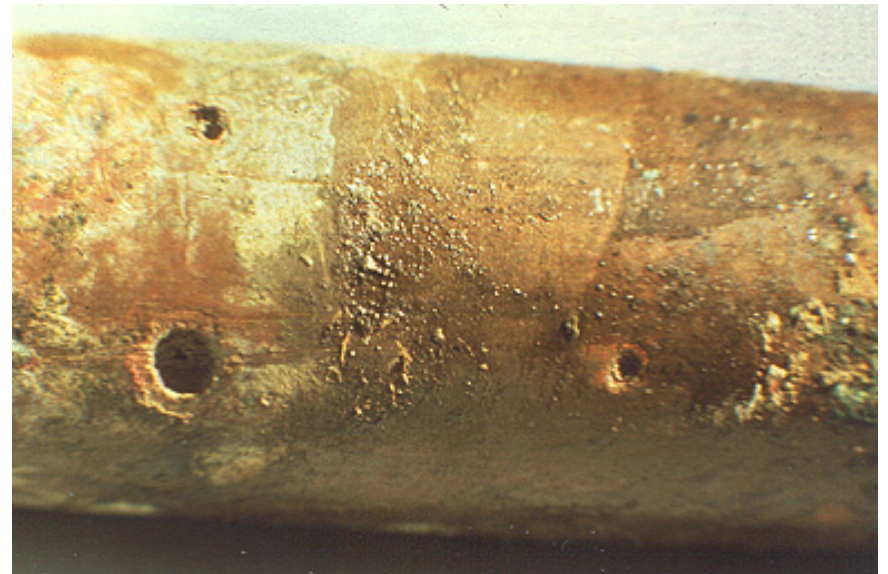
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Coupling to Dissimilar Metals



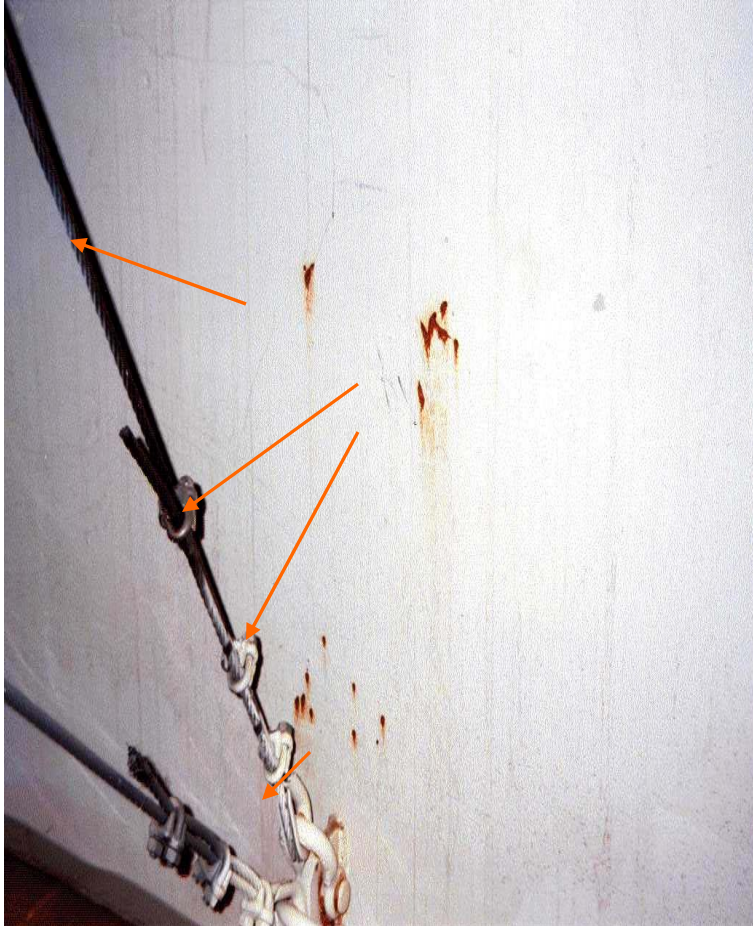
Corrosion of Iron When Coupled to Copper Service Line





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Dissimilar Metal Corrosion (Inside Water Tank)



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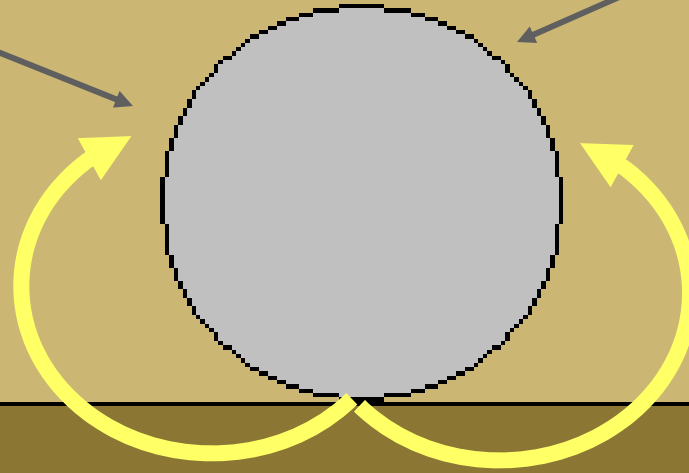
Corrosion Caused by Differential Aeration

Aerated Soil

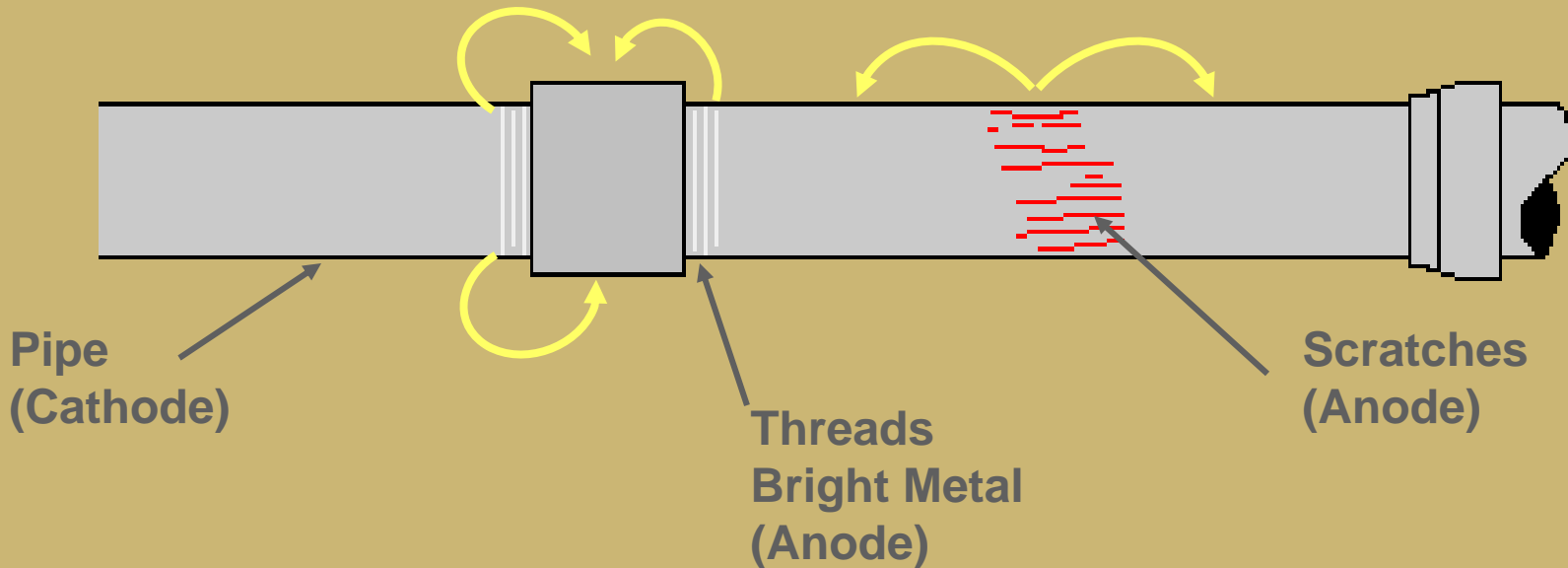
Oxygen Available
(Cathode)

Pipe

Low
Oxygen
(Anode)

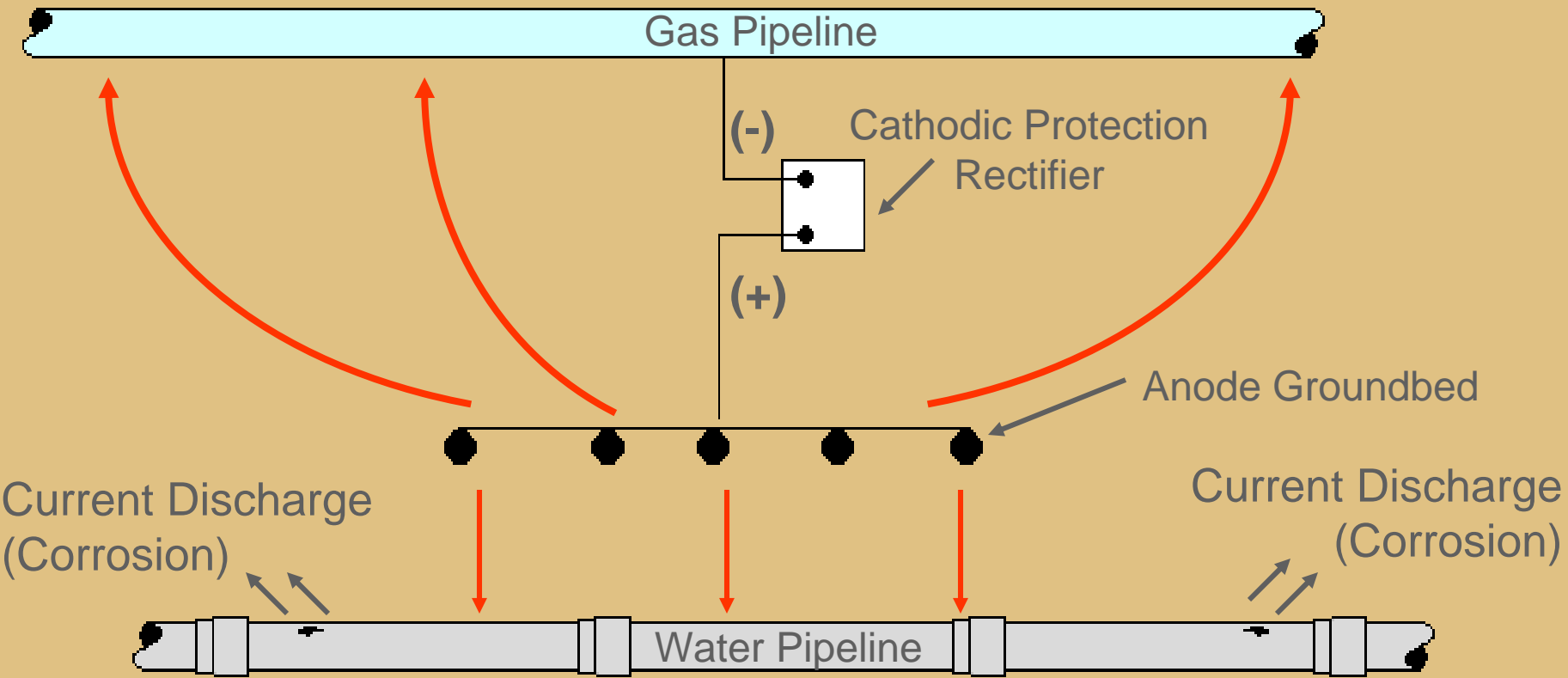


Dissimilar Surface Conditions



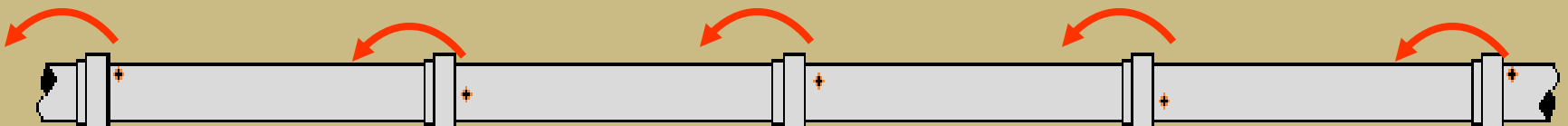
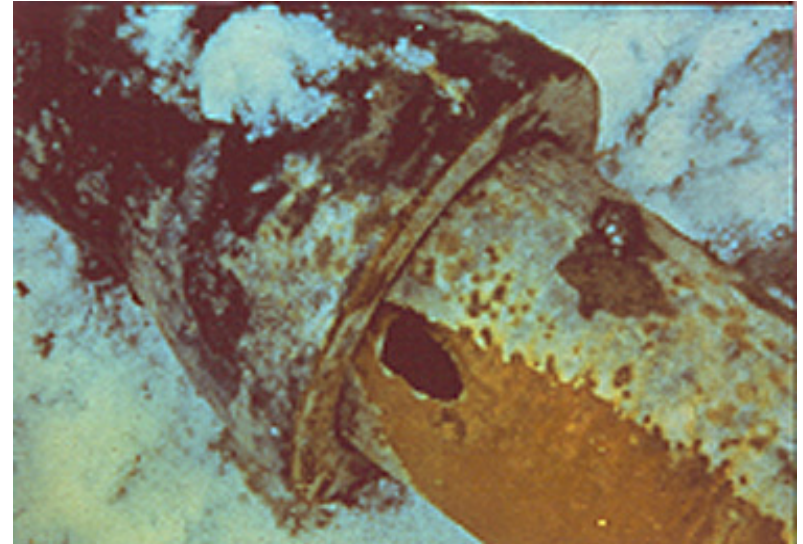
Impressed Current CP System on Oil/Gas Lines can Create Stray Current Problem on Water Lines





Stray Current Due to Impressed Current Cathodic Protection System

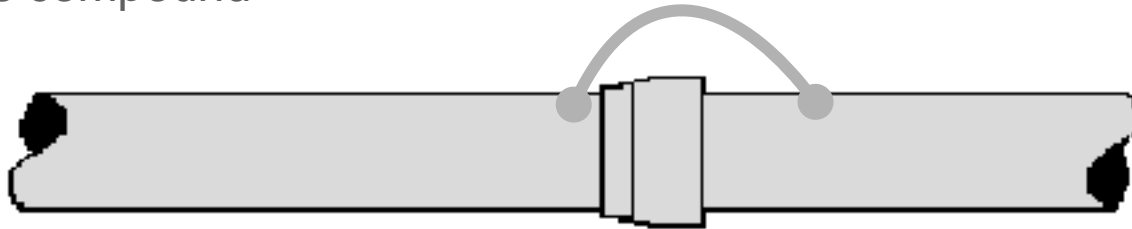
Stray Current

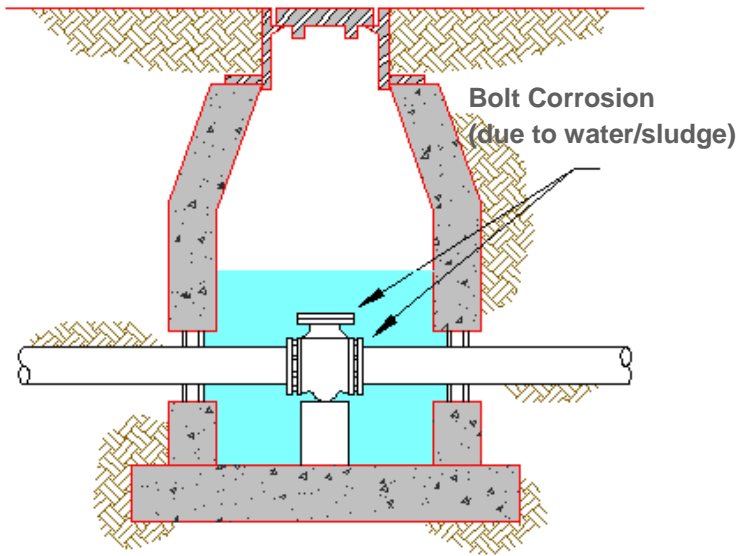


Bonding Across a Bell and Spigot or Slip-joint

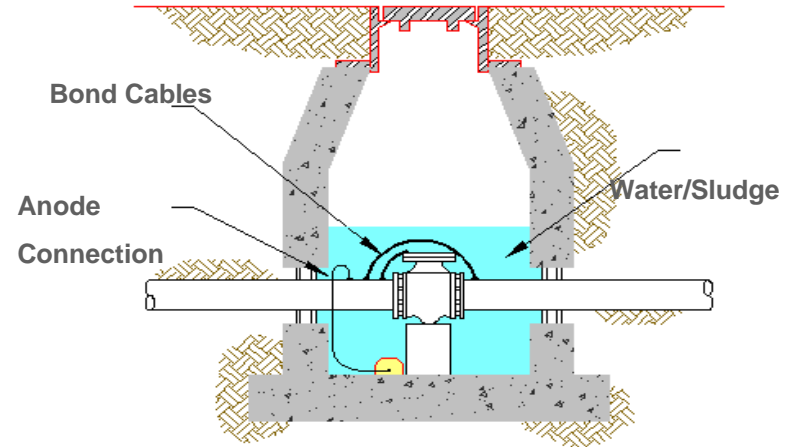
Thermite brazed connection coated with bitumous compound

Copper wire with direct burial insulation





Meter Vault Corrosion



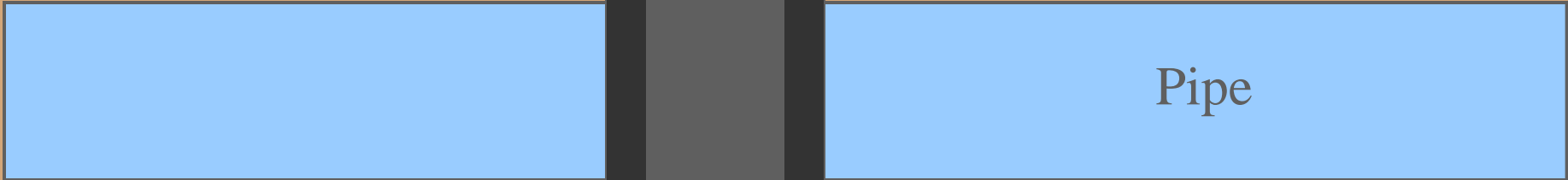
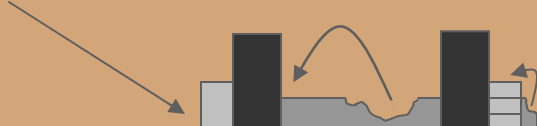
Meter Vault with Galvanic Anode

Bolt & Nut Corrosion





Lower Stress Area
(Cathode)



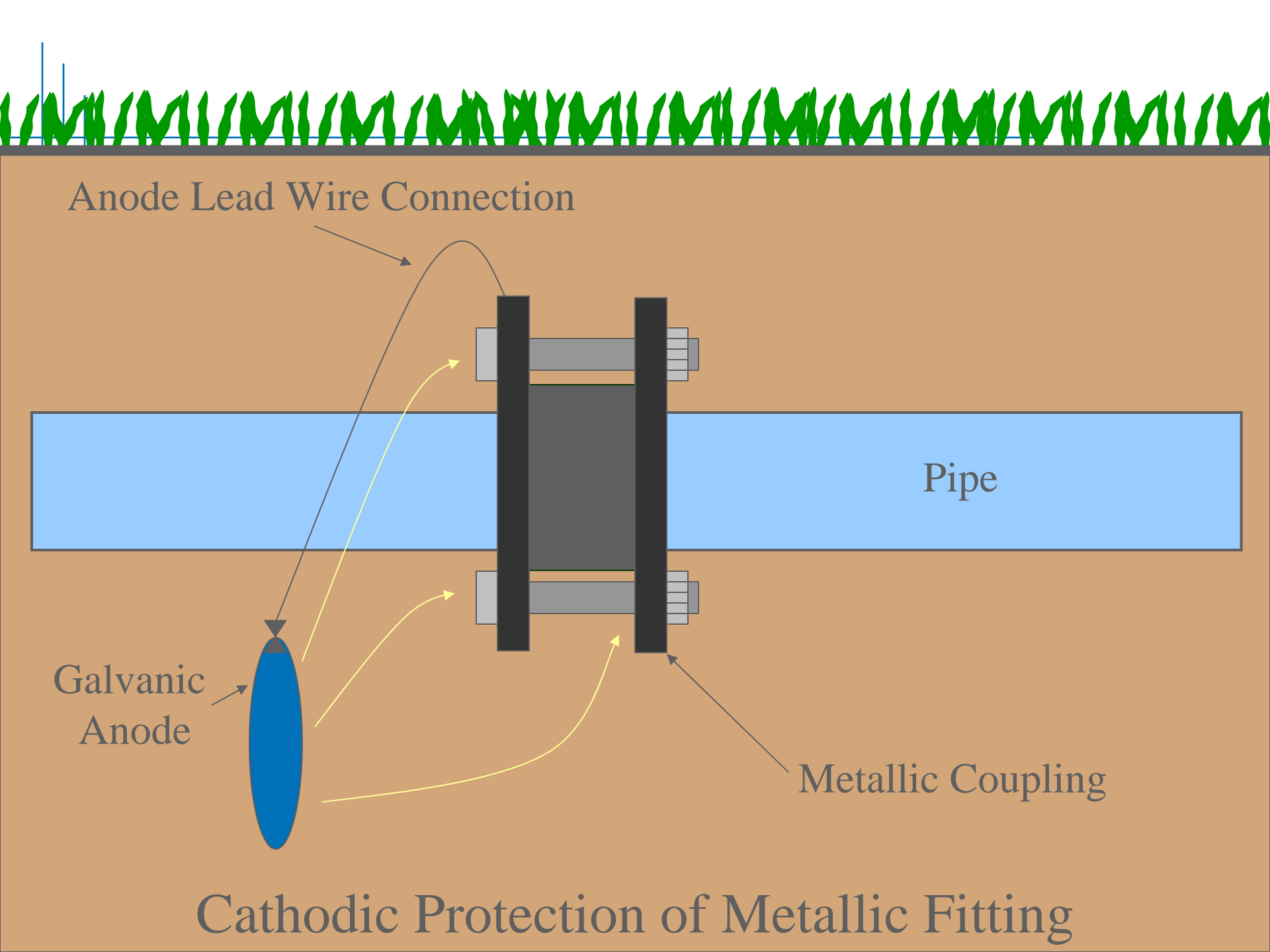
Pipe

Threaded Bolt
Higher Stress Area
(Anode)



Metallic Coupling

Stress Corrosion



Anode Lead Wire Connection

Pipe

Galvanic Anode

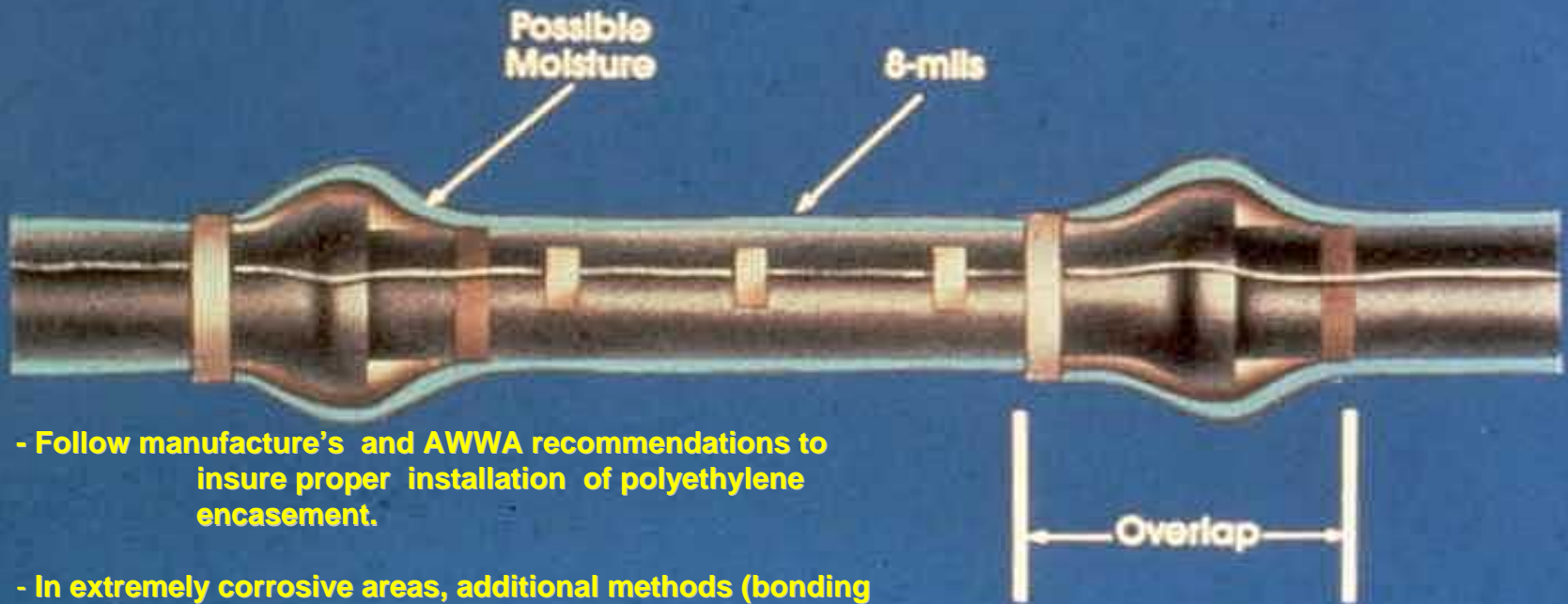
Metallic Coupling

Cathodic Protection of Metallic Fitting

How Do We Prevent Corrosion Attack?

- ▶ Corrosion occurs where current discharges from metal to electrolyte
- ▶ To prevent corrosion we must make the pipe a cathode by forcing current to flow on to it

Polyethylene Encasement



- Follow manufacture's and AWWA recommendations to insure proper installation of polyethylene encasement.

- In extremely corrosive areas, additional methods (bonding of joints, cathodic protection, may be required).

Proper Handling & Installation of Polyethylene Ductile Iron Pipe



Galvanic Anode on Polyethylene Encased Ductile Iron Pipe



Service Connection



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Repair of Break Should Include Anode Installation



Incomplete

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Complete

Water Leak Repair Kit



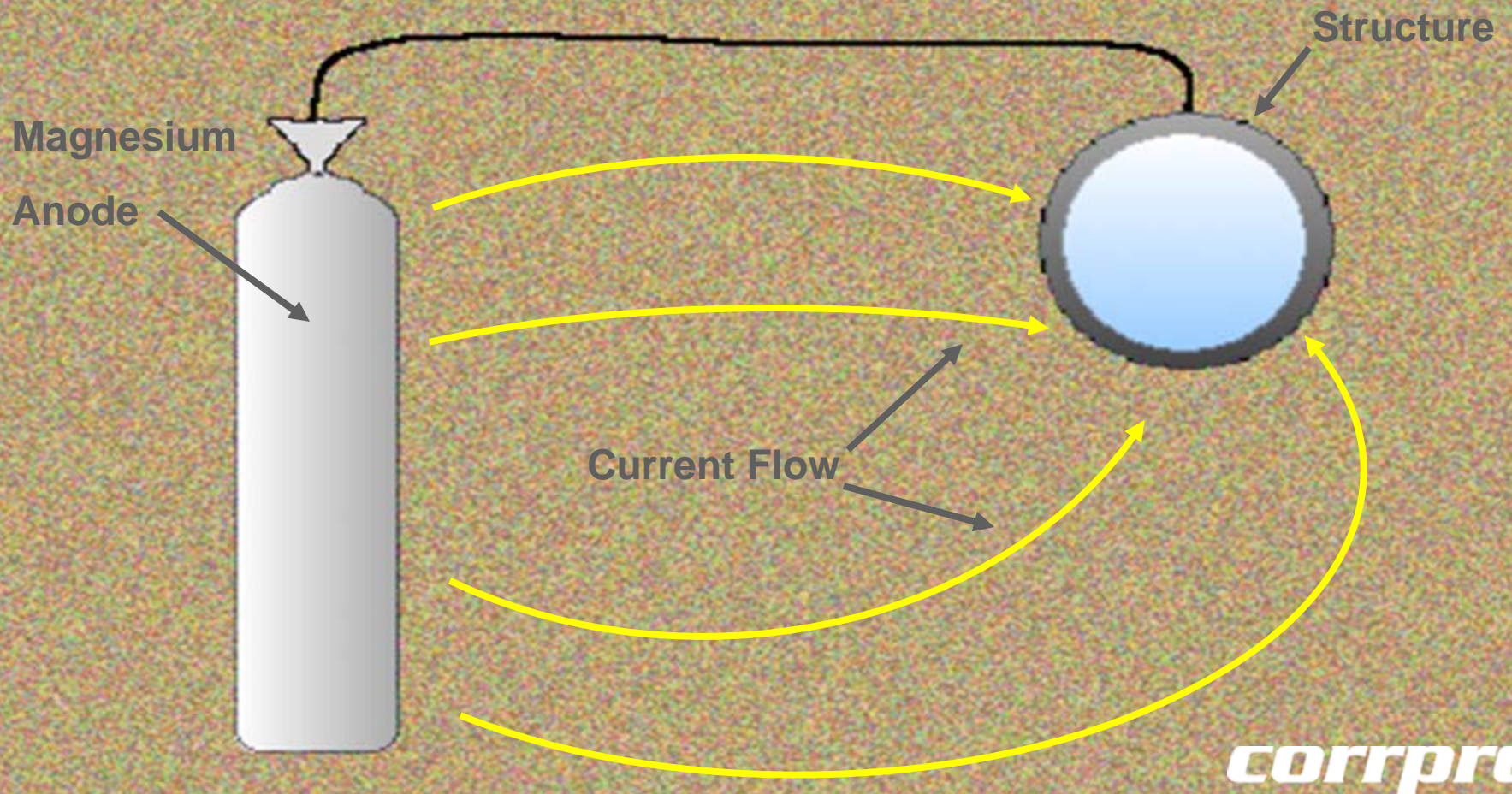
Includes:

Installation instructions.

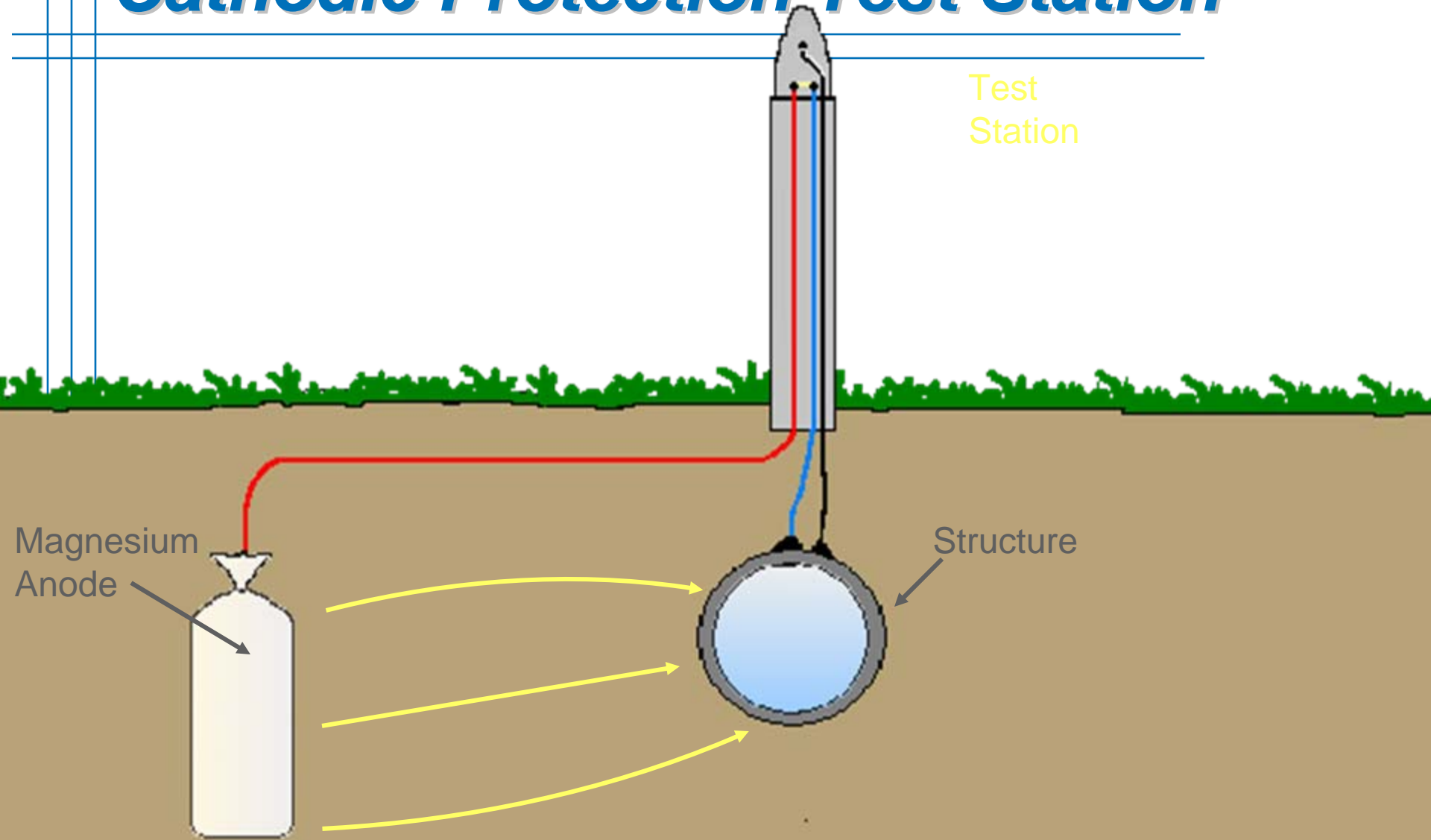
One day onsite technical assistance.

Cathodic protection components/connection materials suitable for 10 repairs.

Galvanic Cathodic Protection



Cathodic Protection Test Station



Rehabilitation Options?

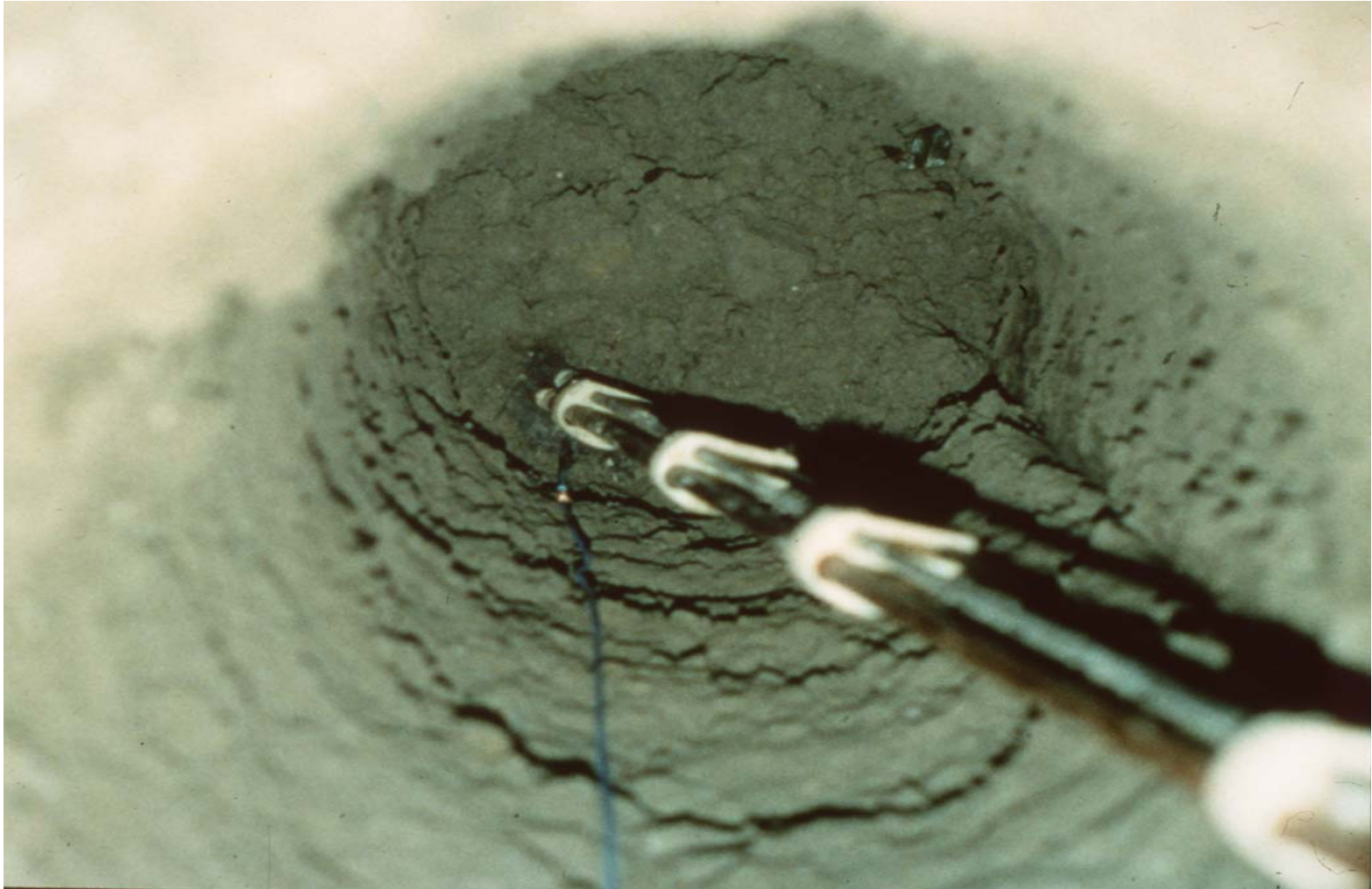
- **Replace Piping**
 - Costly
 - Disruptive
- **Repair Breaks**
 - Reactive approach
 - Disruptive
 - Does not address corrosion problem
 - Leaks will continue to occur
- **Implement BRLESM**
 - Addresses Corrosion Problem
 - Reduces breaks and extends life
 - Virtually non-disruptive
 - Economical

Access to Pipe



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Anode Lead Wire Connection to Pipe Using Spot Welder



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***Hot Spot Galvanic Anode Program on
Water Mains***

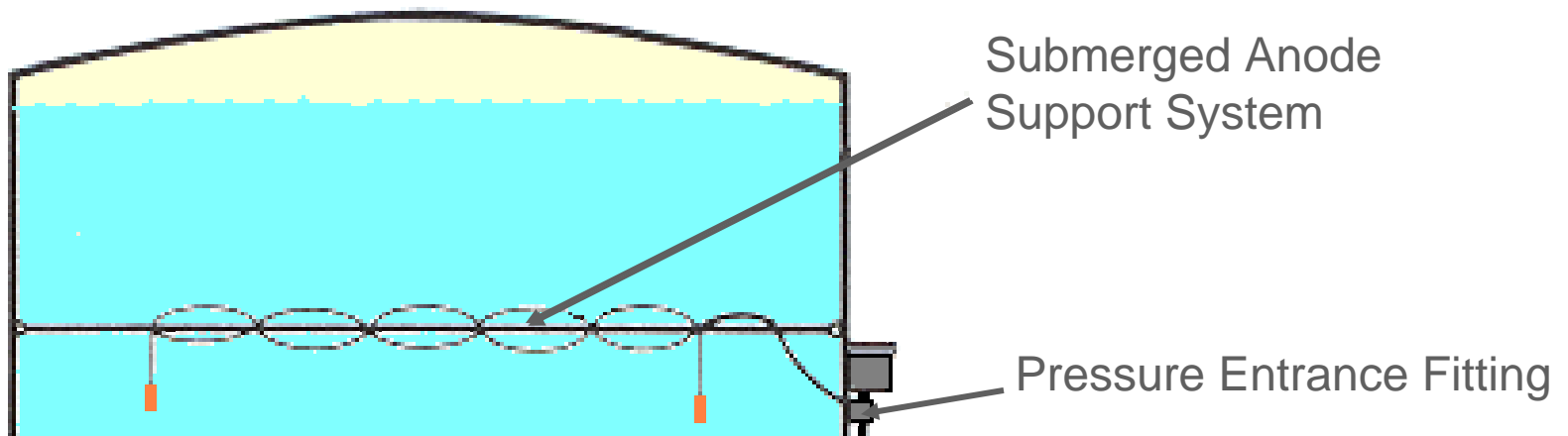
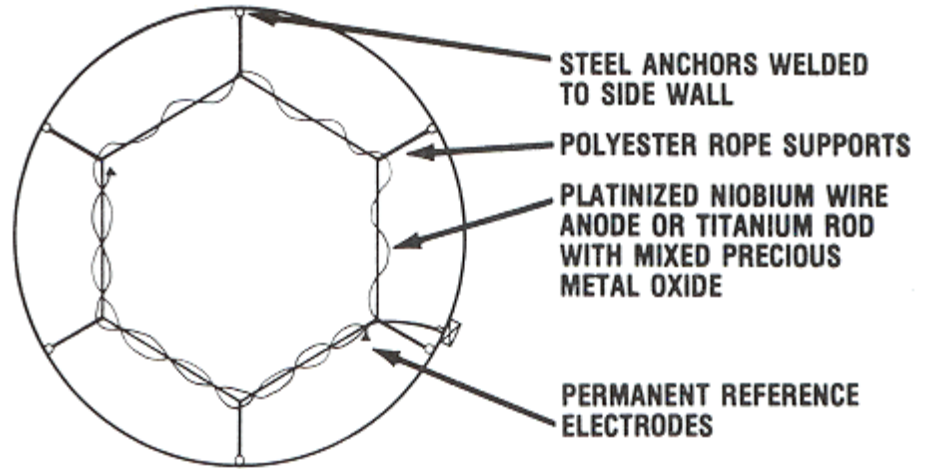
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Other Applications for Cathodic Protection Include

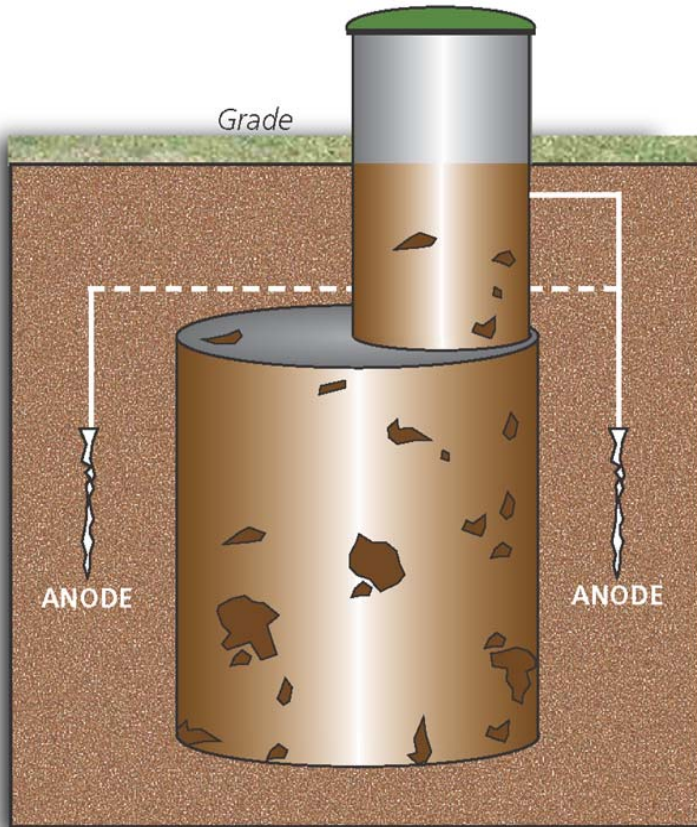
- ◆ Lift Stations
- ◆ Water storage tanks
- ◆ Water and Wastewater treatment clarifiers and processing tanks

Suspended Horizontal Anode System

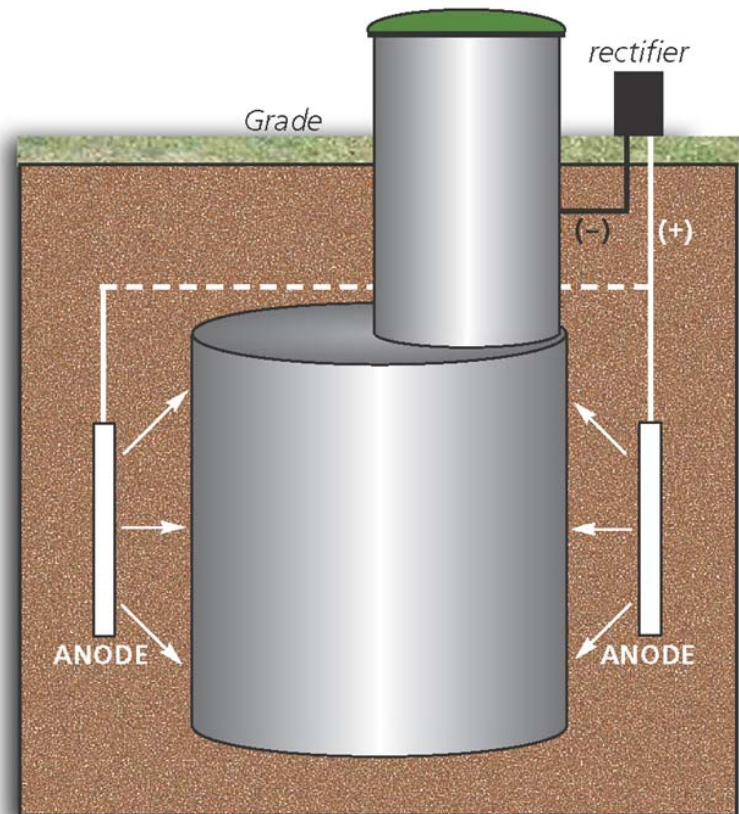
Top View Diagram



Depleted & Refurbished Cathodic Protection for Lift Stations



Depleted cathodic protection system allows corrosion to occur.



Effective cathodic protection system prevents corrosion and extends life of lift station.



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New Piping

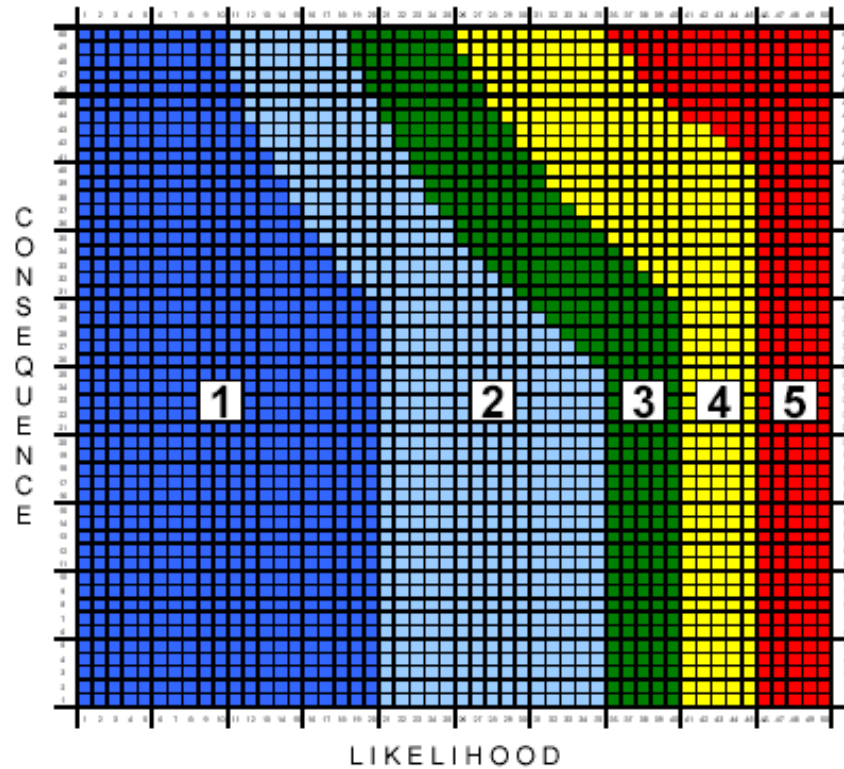
PHASE I

- Obtain drawings of proposed route
- Conduct independent field investigation:
 - a) Soil resistivity study
 - b) Identify foreign pipeline crossing
 - d) Identify AC potential influence
 - e) Collect soil samples (moisture content, chlorides, pH, sulfate ions concentration, conductivity)
- Stray current investigation





Design Decision Model



For Ductile Iron Pipe

Corrosion Protection Design - Phase II

Prepare Bid Quality Specifications for:

- **Coatings or Polyethylene Encasement**
- **Test Stations (Monitor Corrosion Rates)**
- **Bonded Joints**
- **Stray DC/AC Mitigation**
- **Cathodic Protection**
- **Combination of Multiple Items**

- **Review Submittals/Onsite Periodic Inspection**

Investigative Structure (Existing)

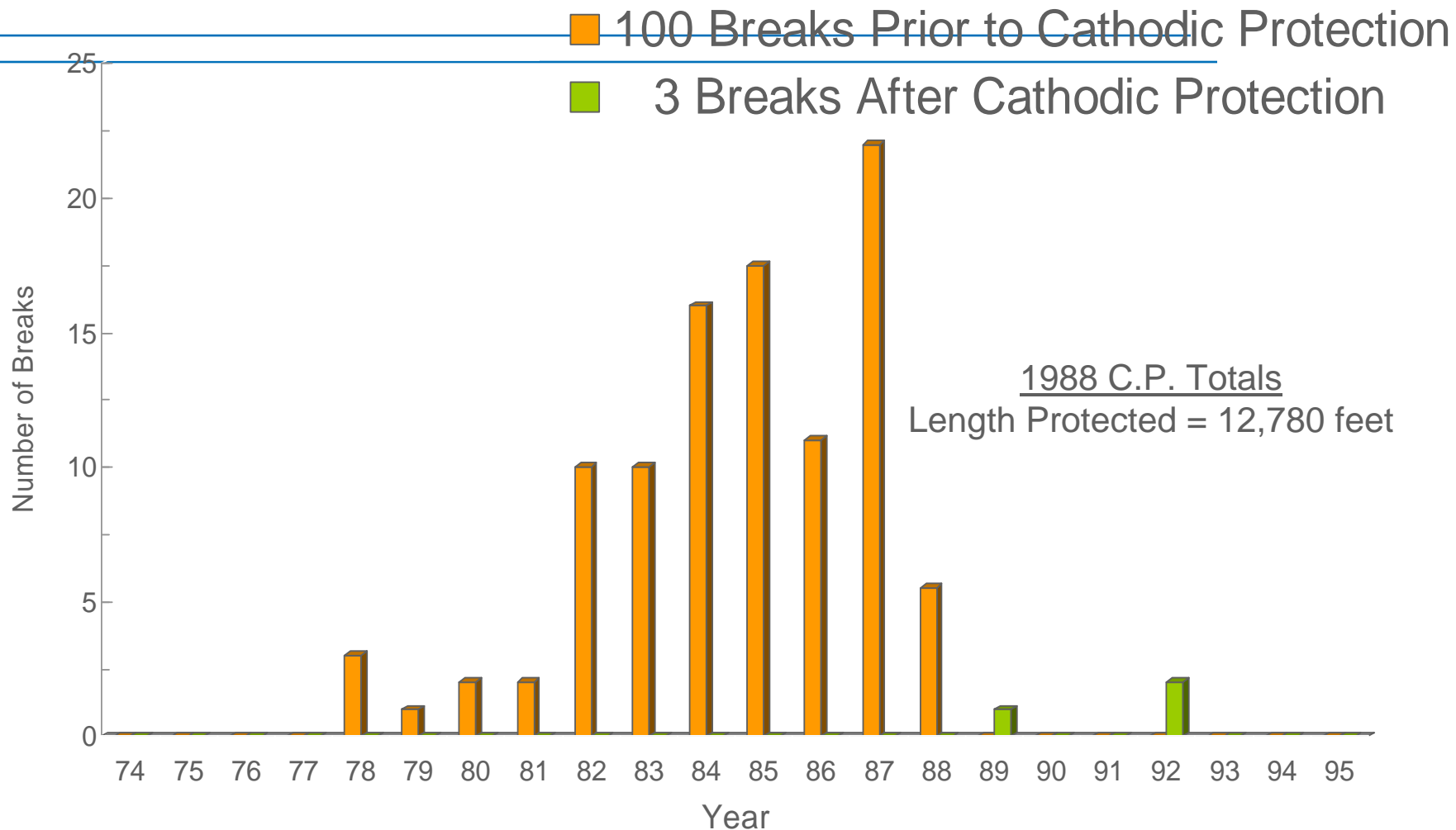
Corrosion Assessment

- **Review of General Characteristics of Water System**
 - Age
 - Material Type
 - Wall Thickness
 - Construction Practices
- **Review Break / Leak History**
- **Field Survey**
 - Soil Conditions (Resistivity, Moisture Content, Chemical Analysis)
 - Electrical Test
- **Data Analysis & Risk Management**
- **Priority Index (Identification of Opportunities to Reduce Replacement / Repair Costs)**

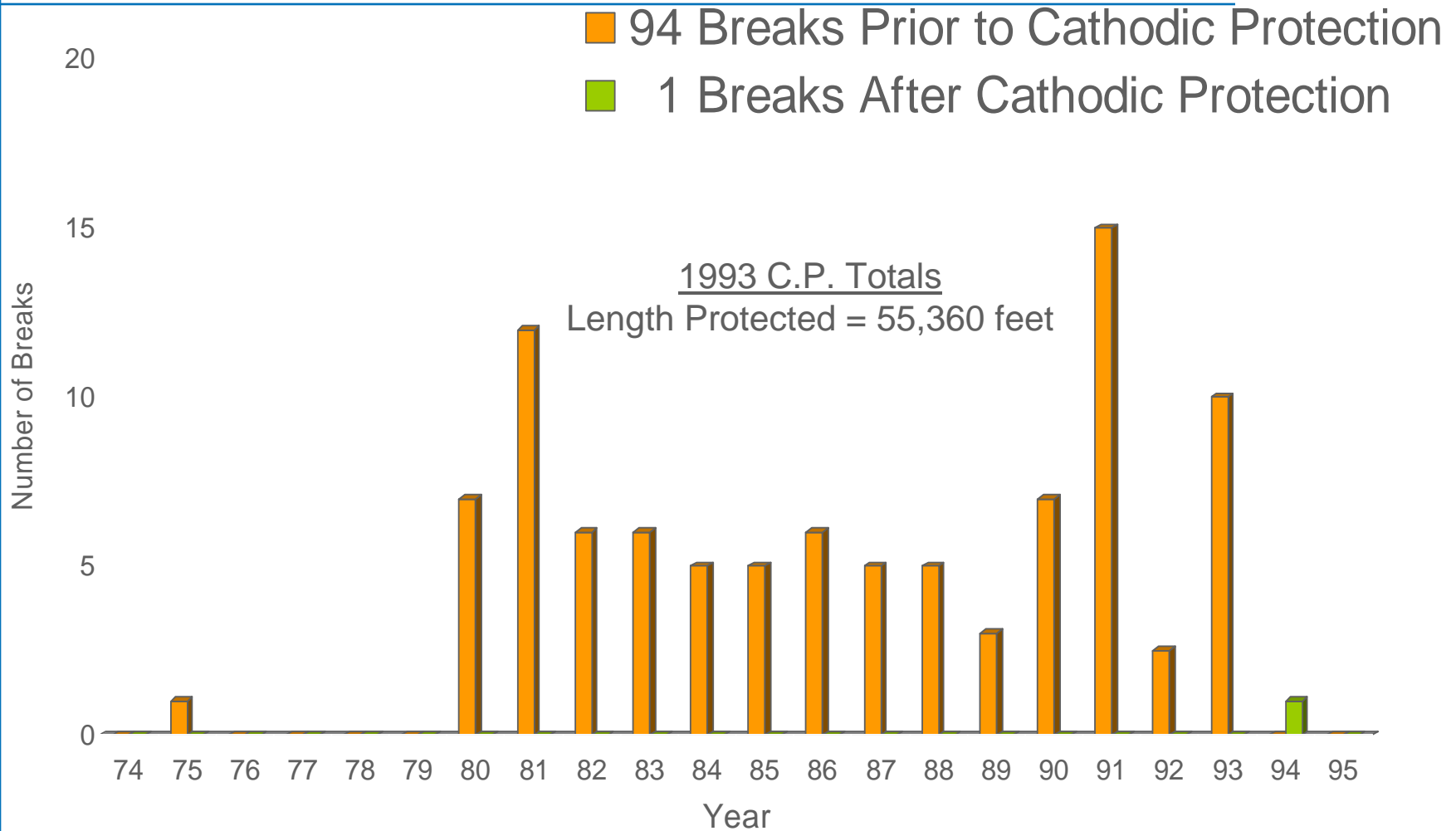


Summary

- ◆ Reducing corrosion rates on existing water distribution piping will result in a reduction of the number of breaks and also extend the operational life.
- ◆ Corrosion control measures should be considered during the design stage for any new metallic piping and storage tank installations.



Break Records for Water Mains Cathodically Protected in 1988



Break Records for Water Mains Cathodically Protected in 1993



QUESTIONS ?

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