# ELK Engineering Associates Inc.

*Specializing In Corrosion & Cathodic Protection Services*

# Establishing
# a Corrosion Control Program
# for a
# Large Diameter Concrete Cylinder Water Line

Presented to

**NACE International North Texas Section**

by

**Earl Kirkpatrick, P.E.**

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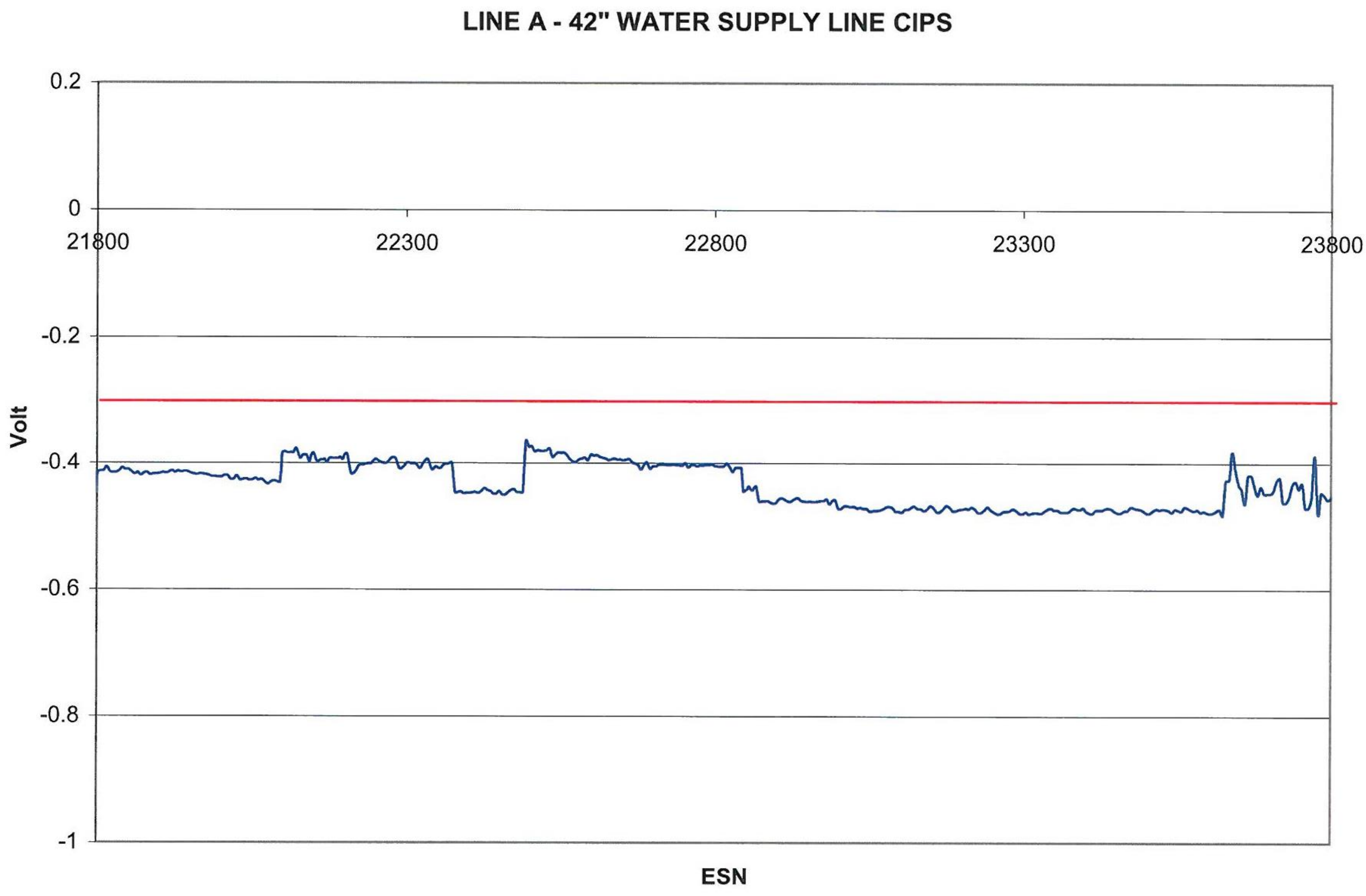
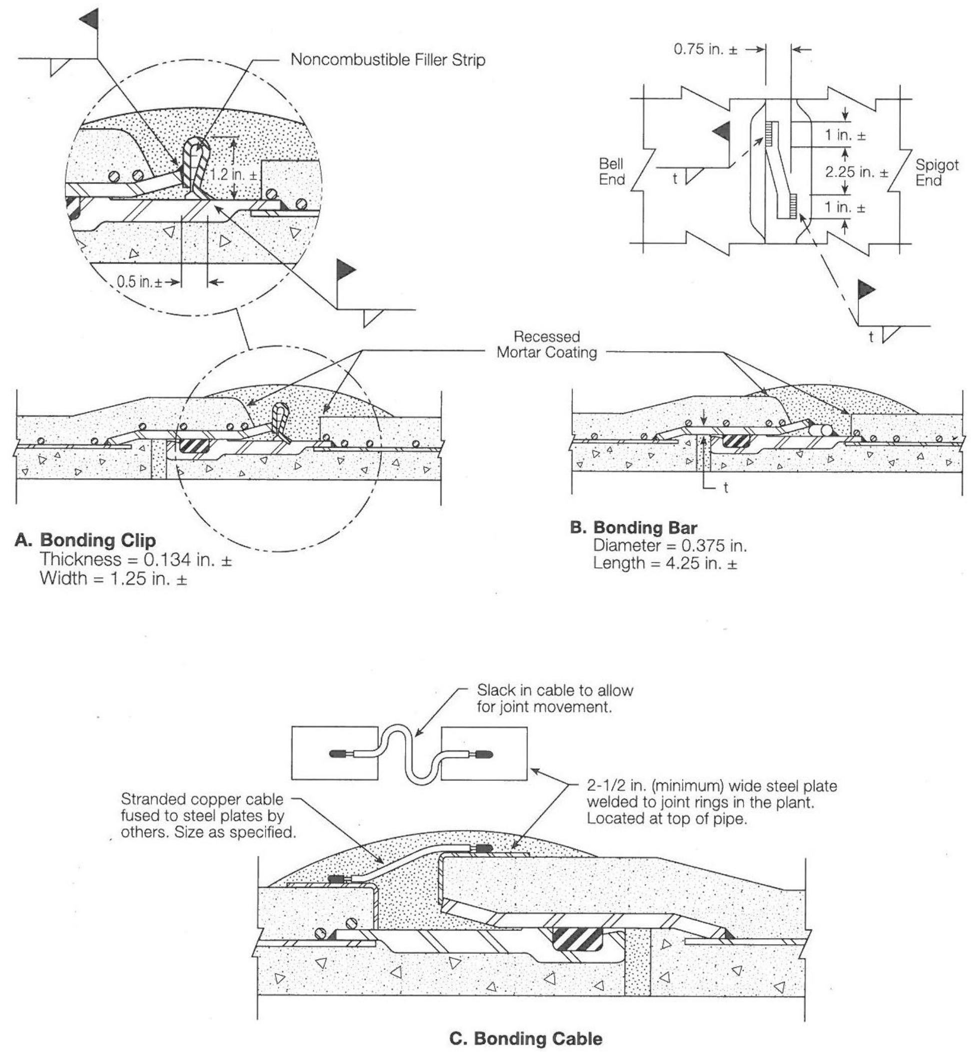
- **Task 1** – Initial Corrosion Assessment

  Close Interval Survey to define areas of active corrosion.

  Active corrosion activity was seen over most reaches of the pipelines.


LINE A - 42" WATER SUPPLY LINE CIPS
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
21800
22300
22800
23300
23800
Volt
ESN




The bonding methods shown provide electrical conductivity across the joint and accommodate relative movement due to pipeline settlement. To provide access for welding the bonds, as shown in diagrams A and B, recesses are chipped in the mortar coating as required after field assembly. Separate bonding is not required when joints are field welded.

Figure 12-2 Typical joint bonding details for AWWA C303-type pipe or lined cylinder AWWA C301-type pipe

# Description of Lines Under Investigation for Schertz Seguin Local Government Corporation

- **Line A** – 42” diameter, Class 200, RCCP water line from the Nixon Pump Station to the Schertz Booster Pump Station.

  This line is 109,040 feet in length with 10 original plus 84 new installed test stations.

- **Line B** – 36” diameter, Class 150 – 250, RCCP water line from the Schertz Booster Pump Station to the Live Oak storage tank facility in Schertz, Texas.

  This line is 97,544 feet in length with 9 original plus 75 new installed test stations.

- **Line C** – 30” diameter, Class 150, RCCP water line from Line A station number 973+00 to the Sequin Water Plant.

  This line is 19,325 feet in length with 4 original plus 11 new installed test stations.

- **Task 2** – Install 174 additional test stations at locations recommended and described in the previous report.  A schedule of recommended test station locations was provided.

**Typical test wire cad weld connections at pipe joint.**

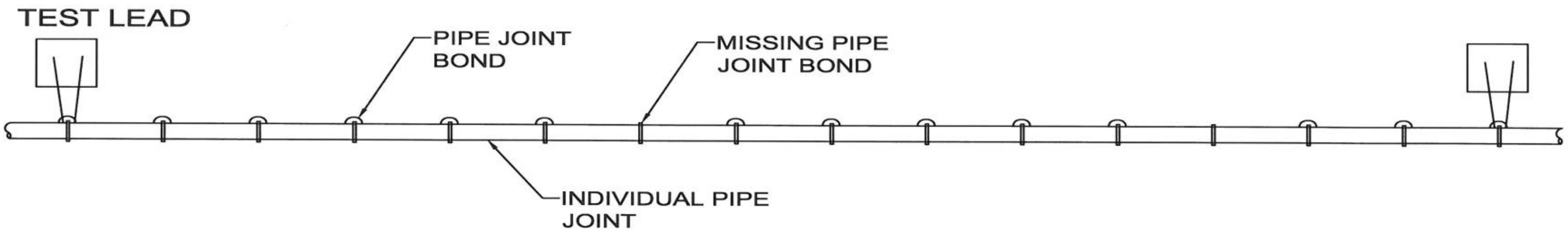

**Test wire connections at test station.**

**Typical test wire connections at casing.**

**Typical test station installation.**

- **Task 3** - Perform test wire effectiveness tests and pipe continuity tests across the entire length of the pipeline. Should any of the pipe continuity tests reveal a discontinuity between two test points, additional work would be required to locate and repair the ineffective pipe joint bonds.

# Typical Concrete Pipe Joint Bonds



# Weld Clips

# Calculation Example for Theoretical Resistance

**42" DIA 10 GA(Class 150)**

**Rc = Cylinder Resistance**
**ρs = Resistivity of Cylinder Steel, in ohm-cm**
**Lc = length of cylinder in a pipe section, in feet**
**Tc = Thickness of cylinder, in inch**
**D = Outside diameter of steel Cylinder, in inch**
**Rb = Bond Resistance**
**Rf = Fringing Resistance**
**ρc = Bond material Resistivity, in ohm-cm**
**Lb = Length of bonding copper cable**
**Ab = cross section area of bonding copper cable, steel bar or clip, in square inch**
**N = number of copper cables, bar or clip**

| | | | | |
|---|---|---|---|---|
| Tc | 0.1345 | inch | #10 = 0.1345 | |
| Lc | 1 | Feet | | |
| D | 43.875 | in inch | | |
| ρs | 0.00003 | ohm-cm | | |
| | | | | |
| Rc | 7.66E-06 | ohm per ft | | |
| | | | | |
| Lb | 2.5625 | inch | | |
| Ab | 0.159719 | sq inch | Thickness | 0.1345 |
| N | 3 | | Width | 1.1875 |
| ρc | 0.00003 | ohm-cm | | |

ELK ENGINEERING ASSOCIATES, INC.
8950 Forum Way
Fort Worth, TX 76140
Phone: 817.568.8585 Fax: 817.568.8590
WEB: WWW.elkeng.com

DATE: 2/29/2012
ELK JOB NO.: 2697
SURVEYED BY: ARB

WEATHER: Cool
Line Designation Line A
STA. NO.: 16750.00
STA. NO.: 15375.00
TOTAL DISTANCE TESTED 1375.00 FT.

PROJECT: Continuity Testing

OWNER: SSLGC

SKETCH

PIPE CONTINUITY TEST

ACTUAL RESISTANCE:

LOCATION:

| TEST # | $I_{ON}$ (MA) | $I_{OFF}$ (MA) | $\Delta I$ | $E_{ON}$ (MV) | $E_{OFF}$ (MV) | $\Delta E$ |
|---|---|---|---|---|---|---|
| 1 | 18.0 | | 18.0 | 154.0 | 19.0 | 135.0 |
| 2 | | | | | | |
| 3 | | | | | | |
| Ave | **18.0** | | **18.0** | **154.0** | **19.0** | **135.0** |

$R_{TEST}$ (Based Upon $\Delta E/\Delta I = R$) **7.50**

**THEORETICAL RESISTANCE OF TESTED SEGMENT:**

INSERT Pipe Type FROM PULL DOWN LIST **INPUT**
INSERT PIPE SIZE **42-Inch** $\phi$
**RESISTANCE OF PIPE DETERMINED BY:** **MFG**

RESISTANCE OF PIPE/FT **0.00000766 Ohms**

**RESISTANCE OF JOINT BONDS CALCULATED FROM**

BOND WIRE SIZE / TYPE 1 CLIP 2
RESISTANCE OF BOND 0.0001896 Ohms
LENGTH OF BOND WIRE NA
NUMBER OF BONDS / JOINT 3 Ea.

$(R_{wire} \times L_{wire}) \times N_{bonds/joint}$ = Calculated Bond Resistance
Calculated Bond Resistance **0.0001896 Ohms**

$\mathbf{R_{THEOR.} = (L_{PIPE} \times R_{PIPE}) + (N_{JOINTS} \times R_{JOINTS})}$

$\therefore$ $R_{THEOR.}$ =

( **1375.00 FT.** x **0.0000077 OHMS/FT.** ) + ( **45** X **0.0001896 Ohms** ) = **0.0190645 Ohms**

**ACCEPTANCE:**

IF $\mathbf{R_{TEST}}$ IS LESS THAN OR EQUAL TO 1.15 TIMES $\mathbf{R_{THEOR.}}$ THE PIPELINE SEGMENT IS ELECTRICALLY CONTINUOUS

$\mathbf{R_{TEST}} \leq 115\% \times \mathbf{R_{THEOR.}}$ 115% x 0.0190645 Ohms = **0.0219242 Ohms**

$\mathbf{R_{TEST}}$ = 7.50000 Ohms & **115%** $\mathbf{R_{THEOR.}}$ = 0.0219242 Ohms

**CONCLUSION**

THIS PIPELINE SEGMENT IS NOT ELECTRICALLY CONTINUOUS

# Results of Continuity Testing

- **Line A** – <u>83 pipe spans</u> only <u>50</u> could be tested
  48 failed 96% failed
  2 passed 4% passed

- **Line B** – <u>71 pipe spans</u> only <u>62</u> could be tested
  61 failed 98.39% failed
  1 passed 1.61% passed

- **Line C** – <u>10 pipe spans</u> only <u>8</u> could be tested
  7 failed 87.5% failed
  1 passed 12.5% passed


# Cathodic Protection (CP) Can Mitigate Future Corrosion Failures

| Galvanic Anode CP | Impressed Current CP |
|---|---|
| Pro: Simple Systems<br>Minimum routine monitoring<br>Con: Digging every other joint<br>ROW damage/land owner issues | Pro: Less costly than GACP for continuous pipe<br>Fewer excavations<br>Con: Will require extensive digs<br>Time and labor required to locate digs<br>ROW Damage/land owner issues |

Both Approaches: Multi year construction program

# The Way Forward

- SSLGC should designate the Highest Consequence Area (HCA) pipe section for further investigation
- Select a short segment within the HCA with no ROW issues for detailed evaluation by ELK
- ELK working with contractor to locate and bond discontinuities and gather data for CP design
- ELK to conduct design survey over all of pipelines A,B, and C
- Design report to provide:
  - **Determination of CP type: GACP or ICCP**
  - **Further assessment of all 3 pipelines**
  - **Design details**
  - **Costs**
  - **Suggested/recommended construction schedule**
- Construction and commissioning of recommended system

# QUESTIONS

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