Results of Corrosivity Testing for Reworking of Underground Utilities at Alvarado Intermediate School, 1901 Desire Avenue, Rowland Heights, Ca

Prepared For:

Mr. Fred Diamond
Director Building Services
ROWLAND UNIFIED SCHOOL DISTRICT
1018 South Otterbein Street
Rowland Heights, CA 91748
626/912-0665

October 30, 2008
HGEI Project No. 08-09-2863

Harrington Geotechnical Engineering, Inc.

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October 30, 2008

Mr. Fred Diamond
Director Building Services
ROWLAND UNIFIED SCHOOL DISTRICT
1018 South Otterbein Street
Rowland Heights, CA 91748

Re: Results of Corrosivity Testing for Reworking of Underground Utilities at Alvarado Intermediate School, 1901 Desire Avenue, Rowland Heights, Ca
HGEI Project No. 08-09-2863

Dear Mr. Diamond:

On October 14, 2008, three 10.5-ft-deep soil borings were drilled at the above-referenced school site (See Vicinity Map, Figure 1) at the locations shown on the attached plan, Plate A, to collect samples for corrosivity testing. The borings were drilled with a 4.5-in.-diameter hand-auger and were backfilled with auger cuttings immediately upon completion of sampling.

Boring logs are attached as Plates B-1 thru B-3. All borings were drilled in grass areas.

The 3 ft and 10 ft samples from each boring were sent to Schiff Associates, Consulting Corrosion Engineers, for testing and evaluation of protection required for underground unities. A copy of their report is attached.

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This opportunity to be of service to the district again is sincerely appreciated. We trust this summary and the attached report meet your current needs. However, if we can be of further assistance in this matter, please call at your convenience.

Very truly yours,

HARRINGTON GEOTECHNICAL ENGINEERING, INC.

Don P. Harrington, Sr., P.E.
President

REGISTERED PROFESSIONAL ENGINEER
DON P. HARRINGTON
No. 383
Exp. 6/30/09
GEOTECHNICAL
STATE OF CALIFORNIA

DPH: mvp

Attachments: Vicinity Map, Figure 1; Boring Location Plan, Plate A; Boring Logs, Plates B-1 thru B-3; Corrosivity Report.

Distribution: Addressee- 2
Henry Woo Architects, Attn: Sean Paradine- 2

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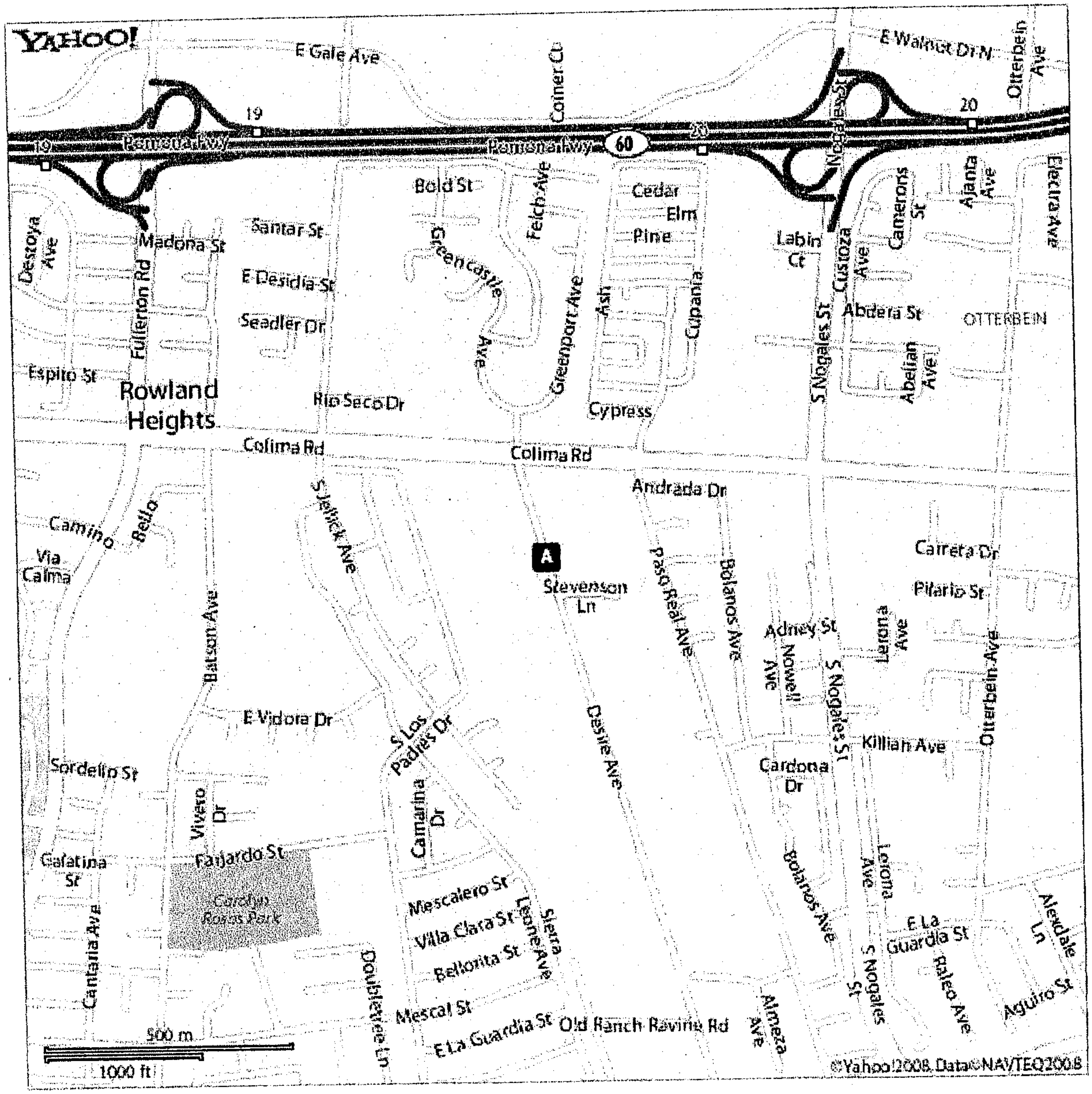

	ROWLAND UNIFIED SCHOOL DISTRICT **ALVARADO INTERMEDIATE SCHOOL**
	Vicinity Map **Figure 1** HGEI Project No. 08-09-2863

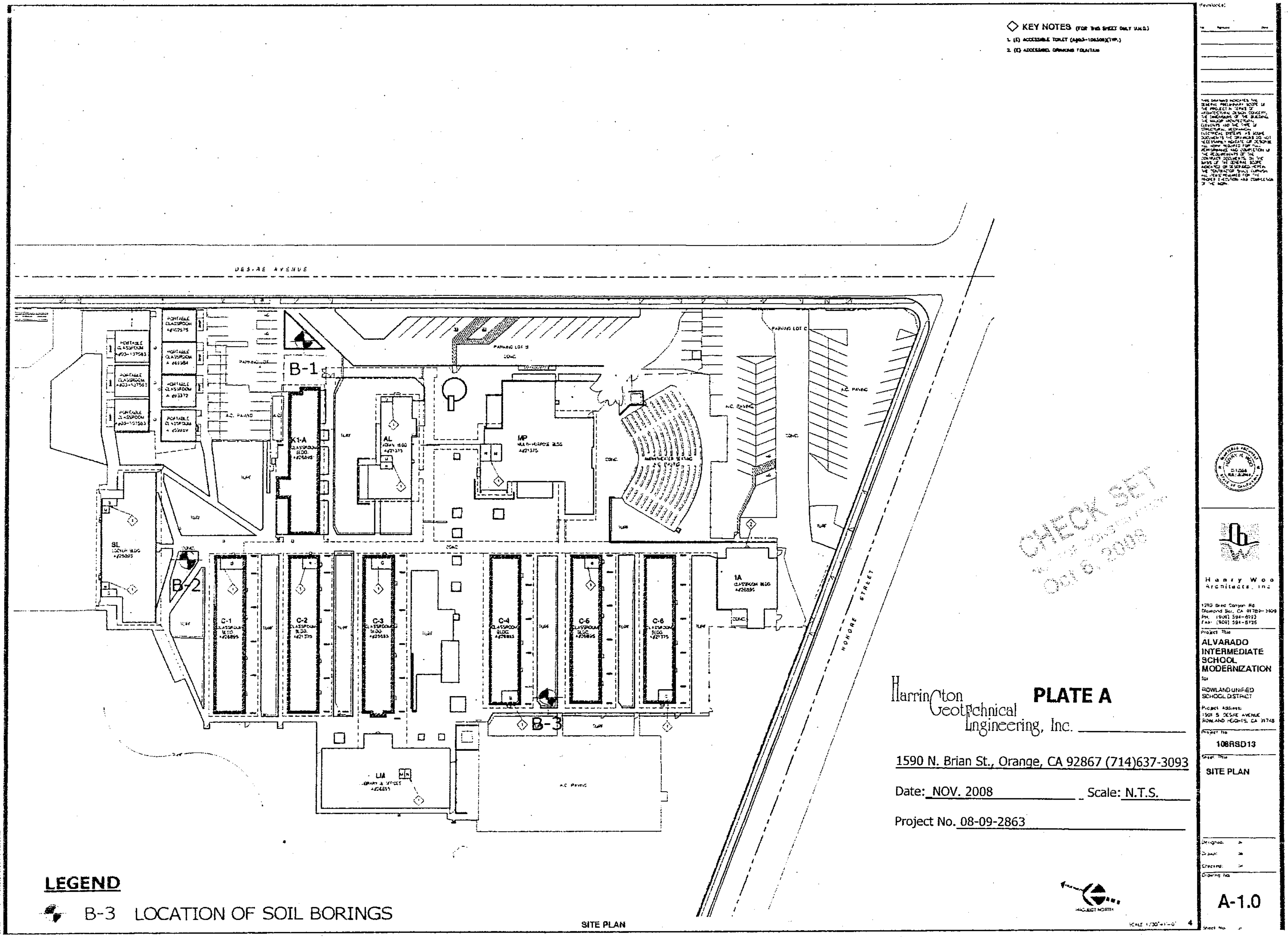

PLATE A

Harrington Geotechnical Engineering, Inc.

1590 N. Brian St., Orange, CA 92867 (714)637-3093

Date: NOV. 2008 Scale: N.T.S.

Project No. 08-09-2863

LEGEND

B-3 LOCATION OF SOIL BORINGS

LOG OF BORING B-1

Project:	Alvarado Intermediate School	Surface Elev.:	Existing Grade
Job No.:	08-09-2863	Top of Casing Elev.:	N.A.
Location:	1901 Desire Ave., Rowland Heights, CA	Drilling Method:	4.5" Hand-Auger
Coordinates:		Sampling Method:	Grab Sample

Elevation, feet	Depth, feet	Sample No.	Sampler Graphics	Symbol / USCS	Recovery %	MATERIAL DESCRIPTION	Blow Counts	Dry Unit Weight, lb/cu ft.	Water Content %
	0					LAWN **ALLUVIUM** - CLAYEY SAND (SC), with gravel, brown.			
			G						11
			G			SILTY SAND (SM), with gravel, brown.			9
	5		G						9
			G						10
	10		G						10

LEGEND:

G = Grab Sample

Completion Depth:	10.5
Date Boring Started:	10/14/08
Date Boring Completed:	10/14/08
Logged By:	JR
Drilling Contractor:	HGEI

Remarks:
Hole filled with auger cuttings. No groundwater at time of drilling. No caving.

The stratification lines represent approximate boundaries. The transition may be gradual.

Harrington Geotechnical Engineering, Inc.

PLATE B-1

LOG OF BORING B-2

Project:	Alvarado Intermediate School	Surface Elev.:	Existing Grade
Job No.:	08-09-2863	Top of Casing Elev.:	N.A.
Location:	1901 Desire Ave., Rowland Heights, CA	Drilling Method:	4.5" Hand-Auger
Coordinates:		Sampling Method:	Grab Sample

Elevation, feet	Depth, feet	Sample No.	Sampler Graphics	Symbol / USCS	Recovery %	MATERIAL DESCRIPTION	Blow Counts	Dry Unit Weight, lb/cu ft.	Water Content %
	0					LAWN **<u>FILL</u>** - SILTY SAND (SM) with concrete and asphalt fragments.			
			G						4
						ALLUVIUM			
			G			SILTY SAND (SM)			8
	5		G						12
			G						13
	10		G						10

Completion Depth: 10.5
Date Boring Started: 10/14/08
Date Boring Completed: 10/14/08
Logged By: JR
Drilling Contractor: HGEI

Remarks:
Hole filled with auger cuttings. No groundwater at time of drilling. No caving.

The stratification lines represent approximate boundaries. The transition may be gradual.

Harrington Geotechnical Engineering, Inc.

PLATE B-2

LOG OF BORING B-3

Project:	Alvarado Intermediate School	Surface Elev.:	Existing Grade
Job No.:	08-09-2863	Top of Casing Elev.:	N.A.
Location:	1901 Desire Ave., Rowland Heights, CA	Drilling Method:	4.5" Hand-Auger
Coordinates:		Sampling Method:	Grab Sample

Elevation, feet	Depth, feet	Sample No.	Sampler Graphics	Symbol / USCS	Recovery %	MATERIAL DESCRIPTION	Blow Counts	Dry Unit Weight, lb/cu ft.	Water Content %
	0					LAWN **ALLUVIUM** - CLAYEY SAND (SC), dark brown.			
			G						12
						SILTY SAND (SM), brown.			
			G						11
	5		G						14
			G						18
	10		G			CLAYEY SILT (ML)			16

Completion Depth:	10.5	Remarks:
Date Boring Started:	10/14/08	Hole filled with auger cuttings. No groundwater at time of drilling. No caving.
Date Boring Completed:	10/14/08	
Logged By:	JR	
Drilling Contractor:	HGEI	

The stratification lines represent approximate boundaries. The transition may be gradual.

Harrington Geotechnical Engineering, Inc.

PLATE B-3

October 29, 2008 via email: Dphsrhgei@sbcglobal.net

HARRINGTON GEOTECHNICAL ENGINEERING, INC.
1590 North Brian Street
Orange, CA 92867

Attention: Mr. Joe Welch, P.E.

Re: Soil Corrosivity Study
Alvarado Intermediate School
Rowland Heights, California
HGEI #08-09-2863, SA #08-1051SCSP

INTRODUCTION

Laboratory tests have been completed on eight soil samples provided for the Alvarado Intermediate School project. The purpose of these tests was to determine if the soils might have deleterious effects on underground utility piping and concrete structures. Schiff Associates assumes that the samples provided are representative of the most corrosive soils at the site.

The proposed construction consists of upgrading existing utility piping in an elementary school. The site is located at 1901 East Desire Avenue in Rowland Heights, California. The water table depth was not provided; therefore, its effect on site corrosivity could not be accounted for in this analysis and report.

The scope of this study is limited to a determination of soil corrosivity and general corrosion control recommendations for materials likely to be used for construction. Our recommendations do not constitute, and are not meant as a substitute for, design documents for the purpose of construction. If the architects and/or engineers desire more specific information, designs, specifications, or review of design, Schiff Associates will be happy to work with them as a separate phase of this project.

LABORATORY SOIL CORROSIVITY TESTS

The electrical resistivity of each sample was measured in a soil box per ASTM G187 in its as-received condition and again after saturation with distilled water. Resistivities are at about their lowest value when the soil is saturated. The pH of the saturated samples was measured per CTM 643. A 5:1 water:soil extract from each sample was chemically analyzed for the major soluble salts commonly found in soil per ASTM D4327 and D513. Test results are shown in Table 1.

SOIL CORROSIVITY

A major factor in determining soil corrosivity is electrical resistivity. The electrical resistivity of a soil is a measure of its resistance to the flow of electrical current. Corrosion of buried metal is an electrochemical process in which the amount of metal loss due to corrosion is directly proportional to the flow of electrical current (DC) from the metal into the soil. Corrosion currents, following Ohm's Law, are inversely proportional to soil resistivity. Lower electrical resistivities result from higher moisture and soluble salt contents and indicate corrosive soil.

A correlation between electrical resistivity and corrosivity toward ferrous metals is:[1]

Soil Resistivity in ohm-centimeters			Corrosivity Category
over		10,000	mildly corrosive
2,000	to	10,000	moderately corrosive
1,000	to	2,000	corrosive
below		1,000	severely corrosive

Other soil characteristics that may influence corrosivity towards metals are pH, soluble salt content, soil types, aeration, anaerobic conditions, and site drainage.

Electrical resistivities were in the mildly to moderately corrosive categories with as-received moisture. When saturated, the resistivities were in the moderately to severely corrosive categories. The resistivities dropped considerably with added moisture because the samples were dry as-received.

Soil pH values varied from 6.9 to 7.7. This range is neutral to mildly alkaline.[2] These values do not particularly increase soil corrosivity.

The soluble salt content of the samples ranged from low to moderate.

Ammonium and nitrate were detected in low concentrations.

Tests were not made for sulfide and negative oxidation-reduction (redox) potential because these samples did not exhibit characteristics typically associated with anaerobic conditions.

This soil is classified as severely corrosive to ferrous metals.

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[1] Romanoff, Melvin. *Underground Corrosion, NBS Circular 579*. Reprinted by NACE. Houston, TX, 1989, pp. 166–167.
[2] Romanoff, Melvin. *Underground Corrosion, NBS Circular 579*. Reprinted by NACE. Houston, TX, 1989, p. 8.

CORROSION CONTROL RECOMMENDATIONS

The life of buried materials depends on thickness, strength, loads, construction details, soil moisture, etc., in addition to soil corrosivity, and is, therefore, difficult to predict. Of more practical value are corrosion control methods that will increase the life of materials that would be subject to significant corrosion.

The following recommendations are based on the soil conditions discussed in the Soil Corrosivity section above. Unless otherwise indicated, these recommendations apply to the entire site or alignment.

Steel Pipe

Implement *all* the following measures:

1. Underground steel pipe with rubber gasketed, mechanical, grooved end, or other nonconductive type joints should be bonded for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.
2. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:
   a. At each end of the pipeline.
   b. At each end of all casings.
   c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.
3. To prevent dissimilar metal corrosion cells and to facilitate the application of cathodic protection, electrically isolate each buried steel pipeline per NACE Standard SP0286 from:
   a. Dissimilar metals.
   b. Dissimilarly coated piping (cement-mortar vs. dielectric).
   c. Above ground steel pipe.
   d. All existing piping.
4. Choose one of the following corrosion control options:

   OPTION 1

   a. Apply a suitable dielectric coating intended for underground use such as:
      i. Polyurethane per AWWA C222 *or*
      ii. Extruded polyethylene per AWWA C215 *or*
      iii. A tape coating system per AWWA C214 *or*
      iv. Hot applied coal tar enamel per AWWA C203 *or*
      v. Fusion bonded epoxy per AWWA C213.
   b. Apply cathodic protection to steel piping as per NACE Standard SP0169.

   OPTION 2

   As an alternative to dielectric coating and cathodic protection, apply a ¾-inch cement mortar coating per AWWA C205 or encase in concrete 3 inches thick, using any type of cement. Joint bonds, test stations, and insulated joints are still required for these alternatives.

NOTE: Some steel piping systems, such as for oil, gas, and high-pressure piping systems, have special corrosion and cathodic protection requirements that must be evaluated for each specific application.

Iron Pipe

Implement *all* the following measures:

1. Electrically insulate underground iron pipe from dissimilar metals and from above ground iron pipe with insulating joints per NACE Standard SP0286.
2. Bond all nonconductive type joints for electrical continuity. Electrical continuity is necessary for corrosion monitoring and cathodic protection.
3. Install corrosion monitoring test stations to facilitate corrosion monitoring and the application of cathodic protection:
    a. At each end of the pipeline.
    b. At each end of any casings.
    c. Other locations as necessary so the interval between test stations does not exceed 1,200 feet.
4. Choose one of the following corrosion control options:

    OPTION 1

    a. Apply a suitable coating intended for underground use such as:
        i. Polyethylene encasement per AWWA C105; *or*
        ii. Epoxy coating; *or*
        iii. Polyurethane; *or*
        iv. Wax tape.

       NOTE: The thin factory-applied asphaltic coating applied to ductile iron pipe for transportation and aesthetic purposes does not constitute a corrosion control coating.
    b. Apply cathodic protection to cast and ductile iron piping as per NACE Standard SP0169.

    OPTION 2

    As an alternative to dielectric coating and cathodic protection, concrete encase all buried portions of metallic piping so that there is a minimum of 3 inches of concrete cover provided over and around surfaces of pipe, fittings, and valves using any type of cement.

Copper Tubing

Implement *all* the following measures:

1. Place cold water copper tubing in an 8-mil polyethylene sleeve or encase in double 4-mil thick polyethylene sleeves and bed and backfill with clean sand at least 2 inches thick surrounding the tubing. Clean sand should have a minimum resistivity of no less than 3000 ohm-cm, and a pH of 6.0–8.0. Copper tubing for cold water can also be treated the same as for hot water.
2. Hot water tubing may be subject to a higher corrosion rate. Protect hot copper tubing by one of the following measures:
    a. Preventing soil contact. Soil contact may be prevented by placing the tubing above ground or encasing the tubing with PVC pipe with solvent-welded joints. *or*

b. Applying cathodic protection per NACE Standard SP0169. The amount of cathodic protection current needed can be minimized by coating the tubing.

Plastic and Vitrified Clay Pipe

1. No special precautions are required for plastic and vitrified clay piping placed underground from a corrosion viewpoint.
2. Protect all metallic fittings and valves with wax tape per AWWA C217 or epoxy.

All Pipe

1. On all pipes, appurtenances, and fittings not protected by cathodic protection, coat bare metal such as valves, bolts, flange joints, joint harnesses, and flexible couplings with wax tape per AWWA C217 after assembly.
2. Where metallic pipelines penetrate concrete structures such as building floors, vault walls, and thrust blocks use plastic sleeves, rubber seals, or other dielectric material to prevent pipe contact with the concrete and reinforcing steel.

Concrete

1. From a corrosion standpoint, any type of cement may be used for concrete structures and pipe because the sulfate concentration is negligible, 0 to 0.1 percent.[3,4,5,6]
2. Standard concrete cover over reinforcing steel may be used for concrete structures and pipe in contact with these soils due to the low chloride concentration[7] found onsite.

CLOSURE

Our services have been performed with the usual thoroughness and competence of the engineering profession. No other warranty or representation, either expressed or implied, is included or intended.

Please call if you have any questions.

Respectfully Submitted,
SCHIFF ASSOCIATES

Leobardo Solis

REGISTERED PROFESSIONAL ENGINEER STEVEN R FOX No. CR 1137 Exp. 3-31-09 CORROSION STATE OF CALIFORNIA

Steven R. Fox, P.E.

Enc: Table 1

[3] 1997 Uniform Building Code (UBC) Table 19-A-4
[4] 2006 International Building Code (IBC) which refers to American Concrete Institute (ACI-318) Table 4.3.1
[5] 2006 International Residential Code (IRC) which refers to American Concrete Institute (ACI-318) Table 4.3.1
[6] 2007 California Building Code (CBC) which refers to American Concrete Institute (ACI-318) Table 4.3.1
[7] *Design Manual 303: Concrete Cylinder Pipe*. Ameron. p.65

Table 1 - Laboratory Tests on Soil Samples

Harrington Geotechincal
Alvarado Intermediate School, Rowland Heights, CA
Your #08-09-2863, SA #08-1051SCSP
15-Oct-08

Sample ID			B-1 @ 3' SI SP (SM)	B-1 @ 10' SI SP (SM)	B-2 @ 3' SI SP (SM)	B-2 @ 10' SI SP (SM)	B-3 @ 3' SI SP (SM)
Resistivity		**Units**					
as-received		ohm-cm	8,400	7,600	10,800	5,600	6,800
saturated		ohm-cm	2,280	1,400	2,280	2,240	1,320
pH			7.1	7.5	7.5	7.7	7.3
Electrical Conductivity		mS/cm	0.20	0.26	0.19	0.19	0.30
Chemical Analyses							
Cations							
calcium	Ca^{2+}	mg/kg	97	119	91	76	101
magnesium	Mg^{2+}	mg/kg	20	17	14	8.4	20
sodium	Na^{1+}	mg/kg	99	174	110	135	201
potassium	K^{1+}	mg/kg	28	22	23	13	29
Anions							
carbonate	CO_3^{2-}	mg/kg	ND	ND	ND	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	406	665	412	497	397
flouride	F^{1-}	mg/kg	1.6	5.5	2.1	4.2	1.7
chloride	Cl^{1-}	mg/kg	3.8	7.6	5.5	6.1	57
sulfate	SO_4^{2-}	mg/kg	69	90	62	52	154
phosphate	PO_4^{3-}	mg/kg	2.2	ND	10	4.0	ND
Other Tests							
ammonium	NH_4^{1+}	mg/kg	4.1	ND	ND	ND	5.9
nitrate	NO_3^{1-}	mg/kg	2.9	ND	ND	ND	ND
sulfide	S^{2-}	qual	na	na	na	na	na
Redox		mV	na	na	na	na	na

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed

Table 1 - Laboratory Tests on Soil Samples

Harrington Geotechincal
Alvarado Intermediate School, Rowland Heights, CA
Your #08-09-2863, SA #08-1051SCSP
15-Oct-08

Sample ID			B-3 @ 10' SI SP (ML)	B-4 @ 3' SI SP (SM)	B-4 @ 10' Clayey Silt (ML)
Resistivity		**Units**			
as-received		ohm-cm	2,240	18,400	1,360
saturated		ohm-cm	960	1,880	920
pH			7.5	6.9	7.3
Electrical Conductivity		mS/cm	0.28	0.22	0.34
Chemical Analyses					
Cations					
calcium	Ca^{2+}	mg/kg	123	90	110
magnesium	Mg^{2+}	mg/kg	26	18	21
sodium	Na^{1+}	mg/kg	147	140	270
potassium	K^{1+}	mg/kg	20	21	15
Anions					
carbonate	CO_3^{2-}	mg/kg	ND	ND	ND
bicarbonate	HCO_3^{1-}	mg/kg	674	387	781
flouride	F^{1-}	mg/kg	6.7	ND	5.4
chloride	Cl^{1-}	mg/kg	25	7.4	18
sulfate	SO_4^{2-}	mg/kg	102	109	177
phosphate	PO_4^{3-}	mg/kg	ND	3.2	ND
Other Tests					
ammonium	NH_4^{1+}	mg/kg	ND	0.6	ND
nitrate	NO_3^{1-}	mg/kg	ND	1.0	ND
sulfide	S^{2-}	qual	na	na	na
Redox		mV	na	na	na

Electrical conductivity in millisiemens/cm and chemical analysis were made on a 1:5 soil-to-water extract.
mg/kg = milligrams per kilogram (parts per million) of dry soil.
Redox = oxidation-reduction potential in millivolts
ND = not detected
na = not analyzed