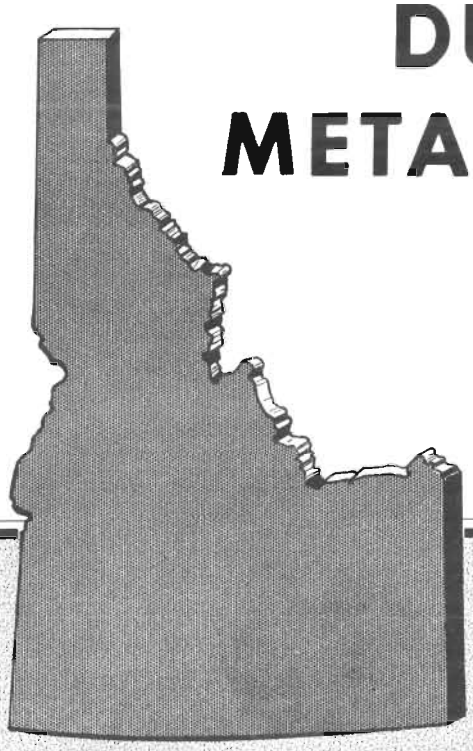
Lab

DURABILITY OF METAL PIPE CULVERTS

APRIL 1965

RESEARCH PROJECT NO. 16



STATE OF IDAHO DEPARTMENT OF HIGHWAYS

A STUDY OF THE DURABILITY OF METAL PIPE CULVERTS

April, 1965

Materials Section
Surveys and Plans Division

State of Idaho
DEPARTMENT OF HIGHWAYS
Boise, Idaho

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SYNOPSIS

A field and laboratory investigation of the performance of galvanized metal pipe with particular emphasis on service life, indicates a life expectancy in excess of 40 years except in a few areas. Soil in timbered areas and in pasture lands with excess soil moisture reduced the life expectancy to less than 30 years, and in a few installations to 20 years.

The test devised by the California Highway Department using soil pH and electrical resistivity appears to give a satisfactory estimate of service life, although few installations are of an age to verify the predicted life.

It is recommended that this test be used for predicting service life, and that when the life predicted is less than 40 years, the pipe be bituminous coated.

Installations of aluminum pipe and fiber glass coated concrete box culverts were reported, but no conclusions can be drawn as their service life is insufficient to warrant any such attempt.

A STUDY OF THE DURABILITY OF METAL PIPE CULVERTS

INTRODUCTION

The Idaho Department of Highways, together with the Armco Metal Products Company, made an inspection of metal culverts during November, 1957. This inspection reviewed installations throughout southern Idaho, but winter weather and lack of manpower prevented completing the investigation to the north of Boise. The purpose of these inspections was to determine the life of pipe installations with the intent of improving selection of type of pipe, coatings and providing appropriate specifications.

The present investigation was established as a sequel to the 1957 Study. This current study checked those metal pipe installations surveyed in 1957 and extended the survey to include installations into North Idaho. Concrete pipe was not included in the current study except for concrete boxes coated with fiber glass.

The purpose of the present investigation was to supplement the 1957 report and to determine the life of metal pipe installation, determination of spelter and condition of the base metal as well as gauge. Each installation was checked for the following information:

Description of drainage area served by the pipe installation, i.e., mountainous, hilly, flat,

cultivated land, timbered, range grass land, pasture land, barnyards or stock feed areas, mine waste, etc.

The flow of water in the pipe was noted whether continuous, frequent, intermittent, etc., and if the pipe was filling with sediment, other pertinent information was noted.

Samples of soil were taken for pH and resistivity tests in the Central Laboratory.

In addition to the field information obtained, the District or Laboratory endeavored to determine the age of the pipe from records verifying these age determinations with people familiar with the maintenance of these roadways. The Laboratory tested the soil for pH value and electrical resistivity and using the California charts estimated the service life (See Appendix A). In addition, the coupons were washed carefully and checked for appearance describing the coupon as follows:

1. Like new
2. Dull - age weathered to point all zinc luster gone
3. Pin Point Rust - evidence of rust in very small areas
4. Scaly Rust - large areas of rust wherein scale can be seen
5. Pitting - rusted to the extent base metal is pitted

RESULTS OF INVESTIGATION

The results of this investigation substantiate the conclusions drawn from the 1957 study, i.e., that galvanized corrugated metal pipe, can be expected to give adequate service in the environment of southern and eastern Idaho.

The test method developed by the California Division of Highways and their service life charts appear to be satisfactory. It appears the test method estimates the service life conservatively in all but a few installations.

Several installations are reported to have had the pipe removed or the location of the pipe was not found. In some instances, the pipe was removed due to construction or relocation of the highway. Others were evidently removed and we can only speculate removal was because of necessity, whether from deterioration or other causes.

In some instances scaly rust is evident on the pipe where the resistivity test indicates a service life twice or more its present age. These installations may have been overly optimistic in predicting service life. Only five installations have a predicted service life near to or less than the actual age. In two of these installations, the actual age exceeds the expected service life by nearly 10 years.

Pipe, in the southern part of the State, in the so-called desert area, is indicated to have service lives of greater than 40 years with a majority in excess of 50 years. Cultivated regions are indicated to have service lives in excess

of 30 years with about 2/3 greater than 50 years. Timbered lands vary from less than 20 years to more than 50 years. The average would be about 30-40 years. Pasture lands also indicate a service life in excess of 30 years. Only a very few installations have service lives approaching these predictions. The vast majority are still in fair to excellent condition considering their actual service life.

The performance of aluminum pipe and the special installation of fiber glass coated concrete are too recently installed to draw any conclusions. The tables in the Appendix B give the results of this investigation.

CONCLUSIONS

The following conclusions are made from a review of the investigation:

1. The performance of galvanized metal pipe in service indicates a life as follows:

   a. Desert Lands - 40 to 60+ years
   b. Cultivated Land - 30 to 60+ years
   c. Timbered - 25 to 60+ years
   d. Pasture - 30 to 50 years

2. Actual age of pipe (except for five installations) is less than predicted by 10-25 years and they are reported to be in fair to excellent condition.

3. The only installations indicating a service life less than 40 years are timbered areas, pasture lands, and some cultivated soils.

4. It appears that the service life of corrugated metal pipe with galvanized coating is giving good to excellent service with many installations having served in excess of 30 years and no evidence of serious distress during this investigation.

RECOMMENDATIONS

It is recommended that the California test and criteria be used as a guide to the service life of pipe.

Asphalt coating is recommended to extend the service life wherein the service life predicted is less than 40 years.

It is recommended that the service life of pipe removed due to deterioration be reported and soil samples furnished for test to further the information available for correlation. Cooperation of the District Maintenance and Materials personnel is necessary to obtain this record. These reports should be furnished to the Materials Engineer and the Research Engineer for correlation.

APPENDIX A

STATE OF IDAHO
DEPARTMENT OF HIGHWAYS
BOISE, IDAHO

IDAHO T-55-64

STANDARD METHOD OF TESTS FOR SOIL pH AND RESISTIVITY IN ESTIMATING LIFE OF METAL CULVERT

SCOPE

1. TWO ENVIRONMENTAL FACTORS DETERMINE METAL PIPE SERVICE. THE HYDROGEN-ION CONCENTRATION (pH) OF THE SOILS AND WATERS INDICATES THE DEGREE OF ACIDITY OR ALKALINITY, WHILE THE RESISTIVITY MEASUREMENTS INDICATE THE RELATIVE QUANTITY OF SOLUBLE SALTS. USING THESE VALUES THE PROBABLE SERVICE LIFE OF A METAL CULVERT CAN BE ESTIMATED ON THE ATTACHED CHART. THE TESTS ARE DIVIDED INTO TWO PARTS: pH DETERMINATION AND RESISTIVITY DETERMINATION.

pH DETERMINATION

2. (A) APPARATUS.

(1) 150 ML. GLASS BEAKER
(2) TEASPOON OR SMALL METAL SCOOP
(3) WASH BOTTLE CONTAINING DISTILLED WATER
(4) pH METER
(5) pH STANDARD SOLUTION OF pH 7

(B) PROCEDURE.

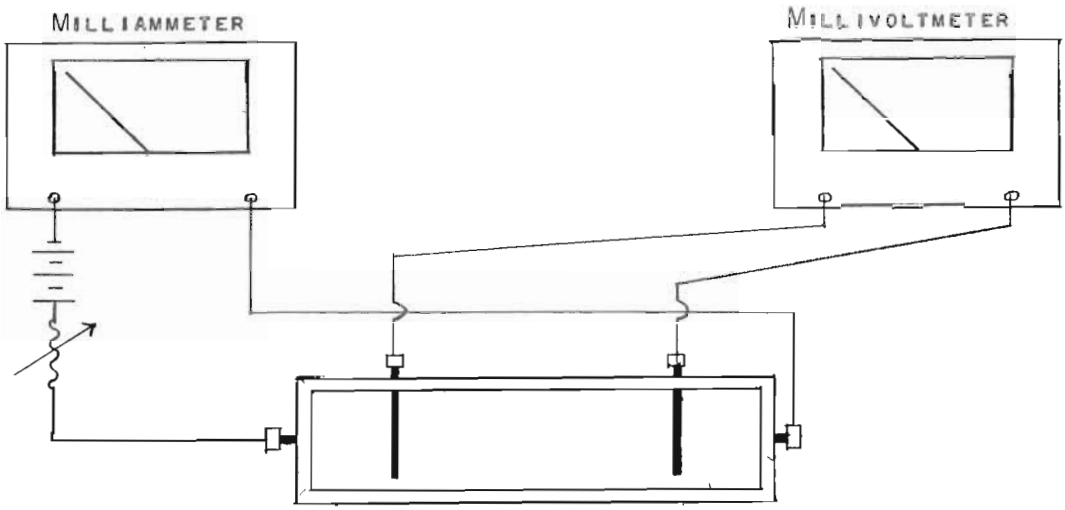
(1) CALIBRATE THE pH METER TO 7 BY USING THE STANDARD SOLUTION OF BUFFER IN A GLASS CONTAINER. ONCE STANDARDIZED THE INSTRUMENT SHOULD BE RESTANDARDIZED PERIODICALLY FOR ACCURATE TESTING.

(2) PLACE 4 ROUNDED TEASPOONS OF SOIL AND 4 TEASPOONS OF DISTILLED WATER IN A 150 ML. BEAKER AND MIX TOGETHER TO A SLURRY. PLACE THE pH METER ELECTRODE IN THE BEAKER OF SLURRY AND ALLOW THE METER NEEDLE TO STABILIZE. RECORD THIS READING AS THE pH OF THE SAMPLE.

RESISTIVITY DETERMINATION

3. (A) APPARATUS.

(1) MILLIAMMETER
(2) VACUUM TUBE VOLTMETER
(3) CALIBRATED SOIL BOX
(4) NO. 8 SIEVE
(5) ROUND ENAMELED PAN, 8-IN. DIAMETER AND 3 INCHES DEEP
(6) STAINLESS STEEL SPOON, 13 IN. LONG
(7) BALANCE, 2000 G. CAPACITY, ACCURATE TO 5 G.
(8) WIRING DIAGRAM



SOIL BOX

(B) PROCEDURE.

(1) PASS WELL-MIXED REASONABLY DRY SOIL THROUGH A NO. 8 SIEVE. WEIGH OUT 650 G. OF THE SOIL SAMPLE AND PUT INTO AN 8-IN. ROUND PAN. ADD 75 ML. DISTILLED WATER TO THE SOIL AND MIX. PLACE THE MIXTURE INTO THE SOIL BOX, COMPACT IT, (MODERATE COMPACTION WITH THE FINGERS IS SUFFICIENT) AND MEASURE RESISTIVITY. REMOVE THE MIXTURE FROM THE SOIL BOX AND PUT BACK INTO THE PAN. ADD AN ADDITIONAL 50 ML. DISTILLED WATER; MIX THOROUGHLY. COMPACT SOIL IN BOX AND MEASURE RESISTIVITY. REPEAT PROCEDURE ONCE MORE. IF RESISTIVITY OF SOIL HAS NOT FOLLOWED A TREND OF HIGH RESISTIVITY, LOW RESISTIVITY, AND THEN AN INCREASE IN RESISTIVITY, CONTINUE TO ADD 50 ML. INCREMENTS OF WATER TO SOIL UNTIL THE MINIMUM RESISTIVITY IS OBTAINED.

(2) THE MINIMAL RESISTIVITY IS USUALLY OBTAINED AS THE SOIL AND WATER "PUDDLE" WHEN MIXED TOGETHER. GENERALLY THIS OCCURS DURING THE THIRD OR FOURTH INCREMENT ADDITION OF WATER. AFTER PERFORMING THE COMPLETE SEQUENCE OF TESTING NUMEROUS TIMES TO GET THE MINIMUM RESISTIVITY, A SKILLED OPERATOR CAN EXPEDITE MORE TESTS JUST BY ADDING INCREMENTS OF WATER (75 ML., 50 ML., 50 ML., ETC.) TO THE SOIL UNTIL IT STARTS TO "PUDDLE." AT THIS POINT TWO OR THREE TESTS SHOULD BE PERFORMED BY THE ADDITION OF WATER, MIXING, COMPACTING IN SOIL BOX, AND MEASURING RESISTIVITY WITH THE LOWEST READING BEING RECORDED.

(3) TO CALCULATE RESISTIVITY IN OHMS CM, USE FORMULA:

$$\frac{MV}{MA} = \text{OHMS CENTIMETERS}$$

(4) TO DETERMINE THE ESTIMATED SERVICE LIFE OF METAL CULVERT, TAKE THE MINIMUM RESISTIVITY AND pH VALUES AND LOCATE THE YEARS TO PERFORATION ON ATTACHED CHART. RECORD THIS FIGURE AS ESTIMATED TIME (YEARS) TO PERFORATION OF 16-GAGE PIPE DURING NORMAL EXPOSURE AND NO ABRASION.

REFERENCE: CALIFORNIA MATERIALS MANUAL - TEST METHOD N-643-B, JULY 1963.

CHART FOR ESTIMATING YEARS TO PERFORATION OF METAL CULVERTS

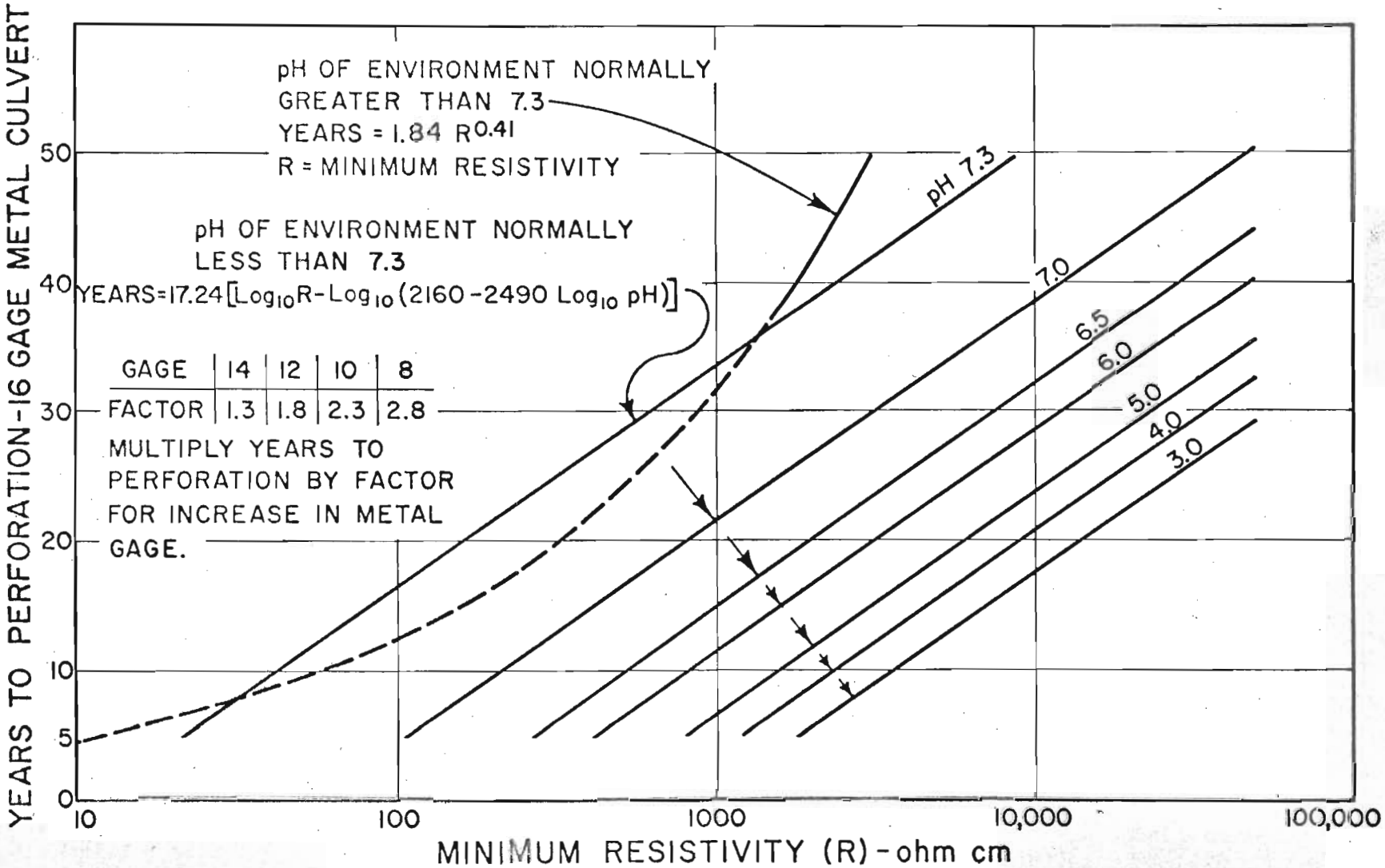


CHART FOR ESTIMATING METAL CULVERT SERVICE LIFE
CALIFORNIA DIVISION OF HIGHWAYS

APPENDIX B

TABLE I

CORRUGATED METAL PIPE
Field Inspection Condition and Test Results on Bedding Soil

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm3 - 1957	Resistivity Ohm/cm3 - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Visual Condition of Metal: Side & Top	Metal Thickness Inches: Invert	Metal Thickness Inches: Side Top
1	Bonn.	OLD US 91	130.2	18"	16	18"	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.5	8.1	2580	2900	28	36	59	45	Good	Dull, Spelter Present	Dull, Spelter Present	0.069	0.069
2	Bonn.	OLD US 91	-	24"	14	18"	Cultivated Land, Intermittent Flow of Water	8.1	8.0	3000	2400	28	36	60	53	No comment	Pin Point Rust	Dull, Spelter Present	0.079	0.083
3	Jeff.	OLD US 91	147.0	24"	14	18"	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	7.8	8.1	2410	2900	28	36	53	58	Good	Pin Point Rust	Dull, Spelter Present	0.083	0.082
4	Jeff.	OLD US 91	152.5	18"	16	2'	Desert Rangeland, Intermittent Flow of Water.	8.0	8.2	1260	3800	28	36	33	58	Good	Dull, spelter Present	Pin Point to Scaly Rust	0.063	0.067
5	Jeff.	OLD US 91	166.0	30"	14	4'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	6.8	8.4	2110	3600	31	33	42	60+	Fair	Scaly Rust or No Spelter	Pin Point Rust or No Spelter	0.077	0.076
6	Jeff.	OLD US 91	170.0	18"	16	5'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.0	7.6	1850	6500	31	33	45	56	Good, End is Buried under silt and rock	Pin Point Rust	Dull, Spelter Present	0.067	0.070
7	Clark	US 91	179.8	18"	16	3'	Desert Rangeland, Intermittent Flow of Water.	8.3	8.2	2390	2600	29	35	42	43	Good	Dull, Spelter Present	Dull, Spelter Present	0.062	-
8	Clark	US 91	184.4	18"	16	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.8	1950	5400	29	35	39	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.066	0.068
9	Clark	US 91	188.3	18"	16	2'	Desert Rangeland, Intermittent Flow of Water.	7.9	8.8	2490	3600	31	33	42	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.062	0.064
10	Clark	US 91	193.3	18"	16	2'	Hilly Land, Timbered Area, Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	7.3	7.5	3440	7000	31	33	46	58	Fair	Scaly Rust	Dull, Spelter Present	0.055	0.062
11	Clark	US 91	194.3	18"	16	2'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.	7.4	7.3	2190	4300	30	34	38	49	Good, Ends damaged by grader	Dull, Spelter Present	Dull, Spelter Present	0.065	0.066
12	Bing.	OLD US 91 191	-	18"	16	2'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.4	1950	3800	41	23	38	60+	Good	Pin Point to Scaly Rust	Dull, Spelter Present	0.065	0.064
13	Bing.	Co. Hwy New Sweden	-	18"	16	2'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.8	8.9	1425	4000	37	27	35	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.070	0.065
14	Bonn.	OLD US 91	130.0	18"	16	2'	Cultivated Land, Pasture, Intermittent Flow of Water, Sediment in Pipe.	8.5	8.3	2895	3800	28	36	46	60	Good	Dull, Spelter Present	Dull, Spelter Present	0.069	0.069
15	Bonn.	OLD US 91	133.1	18"	16	2'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.3	8.5	2890	4000	28	36	46	60+	Good	Pin Point Rust	Pin Point Rust Top Outside, dull Spelter Top Inside	0.068	0.069

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Visual Condition of Metal: Side & Top	Metal Thickness Inches: Invert	Metal Thickness Inches: Side Top
16	Bonn.	OLD US 91	138.8	18"	16	2'	Has Been Removed	9.3	-	2220	-	28	-	41	-	Pipe removed since 1957				
17	Jeff.	OLD US 91	153.2	18"	16	2'	Desert Rangeland, Intermittent Flow of Water.	9.1	8.5	1565	4600	28	36	36	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.069	0.069
18	Jeff.	OLD US 91	154.5	18"	16	3'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.5	8.6	1565	4900	25	39	37	60+	Good	Pin Point Rust	Dull, Spelter Present	0.068	0.065
19	Jeff.	OLD US 91	155.0	18"	16	3'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.5	8.8	2460	5000	25	39	43	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.067	0.067
20	Jeff.	OLD US 91	155.6	18"	16	3'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.6	8.7	3440	5400	25	39	57	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.069	0.070
21	Jeff.	OLD US 91	155.8	18"	16	2'	Desert Rangeland, Intermittent Flow of Water.	8.2	8.4	3125	6100	25	39	47	60+	Good	Dull, Spelter Present	Dull, Spelter Present	0.070	0.071
22	Bann.	US 91, 191 & 30N	64.2	18"	16	3'	Pasture, Frequent Flow of Water, Sediment in Pipe.	7.7	8.1	2890	3300	33	31	43	49	Good	No Sample	Dull, Spelter Present	-	0.060
23	Bann.	US 91, 191 & 30N	62.4	24"	14	-	Unable to Locate.	7.4		1955	-	35	29	48	-	Could Not Locate				
24	Bann.	US 91, 191 & 30N	61.4	36"	12	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.0	1690	2800	35	29	60+	60+	Good	Pin Point Rust	Dull, Spelter Present, Pin Point Rust	0.115	0.113
25	Bann.	US 91, 191 & 30N	59.4	18"	16	2'	Pasture, Continuous Flow of Water.	8.0	8.3	1090	2000	35	29	33	39	Fair to Good	Scaly Rust to No Spelter Present	Pin Point Rust	0.065	0.063
26	Bann.	US 91, 191 & 30N	57.8	24"	14	2'	Desert Rangeland, Frequent Flow of of Water, Sediment in Pipe.	8.2	8.1	2060	3300	35	29	52	60+	Good	Pin Point Rust	Dull, Spelter Present	0.078	0.077
27	Bann.	OLD US 91	422+51	36"	14	20"	Desert Rangeland, Intermittent Flow of Water.	8.4	8.6	1720	3800	29	35	48	60+	Good	Dull, Spelter Present, Scaly Rust Outside	Pin Point Rust to Scaly Rust	0.076	0.080
28	Bann.	OLD US 91	-	24"	14	2'	Desert Rangeland, Intermittent Flow of Water.	8.4	8.7	2060	2100	29	35	52	52	Good	Dull, Spelter Present	Dull, Spelter Present	0.086	0.083
29	Bann.	OLD US 91	480+03	36"	12	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.2	1720	2300	29	35	60+	55	Good	Pin Point Rust	Dull, Spelter Present	0.112	0.110
30	Bann.	OLD US 91	582+67	24"	14	2'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.4	8.5	1485	2600	29	35	47	57	Good	Scaly Rust	Dull, Spelter Present	0.075	0.079

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
31	Bann.	US 91, 191 & 30N	57.9	18"	16	2'	Desert Rangeland, Frequent Flow of Water, Sediment in Pipe.	8.0	8.3	2345	3000	35	29	41	46	Good	Dull, Spelter Present to Pin Point Rust	Dull, Spelter Present to Pin Point Rust	0.072	0.076
32	Power	OLD US 30N	278.2	18"	16	6"	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	8.5	8.2	2500	7000	25	39	43	60+	Good - Ends Torn	Dull, Spelter Present	Dull, Spelter Present	0.068	0.067
33	Power	OLD US 30N	277.8	18"	16	6"	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	7.8	8.6	3280	5000	25	39	48	60+	Good - Ends Bent	Dull, Spelter Present	Dull, Spelter Present	0.064	0.068
34	Power	OLD US 30N	276.9	18"	16	6"	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	7.8	8.2	3125	5500	25	39	46	60+	Good - Ends Torn	Dull, Spelter Present	Dull, Spelter Present	0.067	0.066
35	Power	US 30N	275.1	24"	14	2'	Has Been Removed.	7.7	-	2970	-	25	-	43	-	Pipe Removed				
36	Minid.	US 30N	-	36"	12	4'	Has Been Removed.	8.5	-	1220	-	36	-	34	-	Pipe Removed				
37	Cassia	US 30S	267.2	18"	16	1'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.	9.8	7.7	782	1550	33	31	29	35	Good	Scaly Rust to no Spelter	Spelter gone to Dull, Spelter Present	0.066	0.058
38	Cassia	US 30S	270.4	18"	16	1'	Desert Rangeland, Intermittent Flow of Water.	9.0	8.5	2190	2350	31	33	41	42	Excellent	Pin Point Rust	Dull, Spelter Present	-	0.062
39	Cassia	US 30S	-	24"	14	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	9.1	9.2	1095	2000	31	33	43	51	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.091	0.089
40	Twin Falls	OLD US 93	-	18"	16	3'	Unable to Locate	8.4	-	2735	-	27	30	44	-	Inaccessible				
41	Twin Falls	OLD US 93	-	18"	16	2'	Has Been Removed	7.7	-	2345	-	27	-	40	-	Pipe Removed				
42	Twin Falls	OLD US 93	-	30"	14	15'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	7.7	7.4	1880	2450	27	37	48	52	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.079	0.082
43	Twin Falls	US 30	174.5	24"	14	3'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe	8.2	7.7	1880	1200	20	44	49	42	Good	Pin Point Rust	Dull, Spelter Present	0.083	0.087
44	Twin Falls	US 30	165.4	18"	16	6"	Has Been Removed	8.3	-	3120	-	20	-	48	-	Pipe Removed				
45	Gooding	US 30	162.4	12"	16	1'	Has Been Removed	8.1	-	1875	-	28	-	38	-	Pipe Removed				

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm3 - 1957	Resistivity Ohm/cm3 - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
46	Gooding	US 30	161.0	18"	16	1'	Cultivated Land, Frequent Flow of Water, Sediment in Pipe.	8.5	7.9	2500	1700	28	36	43	37	Good	Scaly rust to Pin Point Rust	Pin Point Rust Dull, Spelter Present	0.066	0.070
47	Gooding	OLD SH 46	2.0	18"	16	2'	Pasture, Intermittent Flow of Water, Sediment in Pipe.	8.4	7.4	2660	1750	20	44	44	34	Excellent	No Spelter to Dull, Spelter Present	Pin Point Rust to Dull, Spelter Present	0.065	0.065
48	Gooding	OLD SH 46	2.8	18"	16	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.3	3160	6100	20	44	48	60+	Excellent	Pin Point Rust	Pin Point Rust	0.064	0.062
49	Gooding	OLD SH 46	2.6	24"	14	4'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.2	7.9	3360	4100	20	44	60+	60+	Good	Dull, Spelter Present	No Spelter to Dull, Spelter Present	0.074	0.072
50	Jerome	SH 79	4.2	30"	14	2'	Cultivated Land, Frequent Flow of Water.	8.0	7.7	2060	1850	26	36	52	47	Fair	Heavily Pitted	Scaly Rust	0.063	0.074
51	Jerome	SH 79	4.0	12"	16	2'	Unable to Locate	8.8	-	1640	-	28	36	36	-	Unable to Locate Pipe				
52	Elmore	US 30, 20-26	107.6	36"	12	4'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.6	8.3	1875	1300	37	27	60+	60+	Fair, Asphalt Dipped Pipe	Heavily Pitted to No Spelter	Scaly Rust to No Spelter	0.116	0.116
53	Elmore	OLD US 30	-	24"	14	8'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	7.8	7.8	4375	3600	30	34	60+	60+	Excellent	Pin Point Rust	Pin Point Rust	0.079	0.081
54	Ada	OLD US 30	-	18"	16	3'	Desert Rangeland, Intermittent Flow of Water.	8.0	7.9	1640	2200	30	34	36	40	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.063	0.067
55	Ada	OLD US 30	-	18"	16	8'	Desert Rangeland, Intermittent Flow of Water.	8.5	8.3	2140	2700	30	34	40	44	Excellent	Dull, Spelter Present	Pin Point Rust	0.064	0.063
56	Ada	OLD US 30	-	24"	14	-	Unable to Locate	8.1	-	2345	-	30	27	53	-	Inaccessible				
57	Ada	OLD US 30	74.5	18"	16	-	Unable to Locate	8.1	-	1250	-	30	27	34	-	Unable to Locate				
58	Ada	US 30, 20-26	69.0	18"	16	4'	Has Been Removed	7.5	-	2345	-	39	-	39	-	Pipe Removed				
59	Ada	US 30, 20-26	66.1	18"	16	4'	Desert Rangeland, Intermittent Flow of Water.	8.5	8.3	1875	2200	39	25	38	41	Good	Dull, Spelter Present	Dull, Spelter Present	0.067	0.064
60	Ada	OLD US 30	64.6	54"	10	6'	Desert Rangeland, Intermittent Flow of Water.	8.4	7.5	2140	2200	39	25	60+	60+	Excellent	Scaly Rust	Dull, Spelter Present	0.112	0.117

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm3 - 1957	Resistivity Ohm/cm3 - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
61	Ada	US 30	51.8	18"	16	1'	Cultivated Land, Frequent Flow of Water, Sediment in Pipe.	7.4	7.1	2815	2750	27	37	40	37	Fair	Pin Point Rust	Scaly Rust	0.061	0.064
62	Payette	US 30 SH 52	-	18"	16	1'	Cultivated Land, Pasture, Intermittent Flow of Water, Sediment in Pipe.	7.5	7.2	1565	3300	37	27	34	40	Fair	Scaly Rust To No Spelter	Pin Point Rust	0.050	0.063
63	Gem	OLD SH 52	-	12"	16	1'	Cultivated Land, Pasture, Frequent Flow of Water.	6.7	7.0	5320	5500	30	34	42	47	Fair Pipe, Outlet Buried	No Sample	Pin Point Rust	-	0.067
64	Gem	OLD SH 52	-	12"	16	6"	Has Been Removed.	6.8	-	4300	-	30	-	41	-	Pipe Removed				
65	Gem	SH 16	34.9	18"	16	2'	Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.	8.1	8.7	3120	2100	29	35	47	40	Good	Dull, Spelter Present	Dull, Spelter Present	0.072	0.072
66	Gem	SH 16	35.9	36"	12	3'	Has Been Removed	7.9	-	2190	-	29	-	60+	-	Pipe Removed				
67	Ada	SH 16	37.8	36"	12	2'	Has Been Removed	7.2	-	4220	-	29	-	60+	-	Pipe Removed				
68	Ada	SH 44	44.8	18"	16	1'	Has Been Removed	7.1	-	2810	-	20	-	37	-	Pipe Removed				
*****																				
101	Boise	SH 15	9.1	36"	12	3'	Cultivated Land, Frequent Flow of Water, Sediment in Pipe.		7.5		2800	38	26		60+	Good	Scaly Rust	Dull, Spelter Present	0.112	0.113
102	Boise	SH 15	18.6	18"	16	4'	Pasture, Intermittent Flow of Water.		7.8		2800	40	24		43	Good	Scaly to Pin Point Rust	Dull, Spelter Present	0.068	0.069
103	Boise	SH 15	24.6	24"	14	15'	Cultivated Land, Frequent Flow of Water.		6.8		21500	37	27		60+	Good	Scaly Rust	Dull, Spelter Present	0.080	0.083
104	Boise	SH 15	30.0	24"	14	5'	Hilly Land, Timbered Area, Frequent Flow of Water.		6.7		14000	34	30		42+	Excellent	No Comments	No Comments	0.086	0.084
105	Valley	SH 15	93.9	24"	14	2'	Timbered Area, Desert Rangeland, Intermittent Flow of Water, Sediment in Pipe.		6.0		46000	28	36		27+	Fair	Scaly Rust	Dull, Spelter Present	0.081	0.084
106	Valley	SH 15	96.6	18"	16	2'	Pasture, Intermittent Flow of Water, Sediment in Pipe.		6.4		6300	28	36		35	Good	Scaly to Pin Point Rust	Dull, Spelter Present	0.064	0.067
107	Wash.	US 95	110.4	18"	16	3'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.		7.4		1500	38	26		33	Excellent	Pin Point Rust	Dull, Spelter Present	0.071	0.070

***** Numbers 69 through 100 unused numbers

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
108	Wash.	US 95	136.3	18"	16	3'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		6.8		6000	27	37		44	Good	Scaly to Pin Point Rust	Dull, Spelter Present	0.067	0.066
109	Adams	US 95	159.1	18"	16	3'	Hilly Land, Timbered Area, Frequent Flow of Water, Sediment in Pipe.		6.4		5100	49	15		32	Good	Heavy Pitting	Dull, Spelter Present	0.061	0.065
110	Adams	SH 15	106.8	18"	16	5'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.5		9500	43	21		37	Good	Heavy Pitting to Pin Point Rust	Dull, Spelter Present	0.059	0.063
111	Valley	SH 15	102.3	18"	16	5'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.0		2500	37	27		19	Good	Heavily Pitted	Dull, Spelter Present	0.060	0.063
112	Idaho	US 95	198.2	18"	16	1'	Hilly Land, Continuous Flow of Water.		7.0		12000	33	31		50+	Good	Heavily Pitted to Dull, Spelter Present	Dull, Spelter Present	0.061	0.064
113	Idaho	US 95	219.5	18"	16	1'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		8.1		4150	23	41		60+	Good	Heavily Pitted to Dull, Spelter Present	Dull, Spelter Present	0.060	0.068
114	Idaho	US 95	228.8	18"	16	2'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		8.0		12000	32	32		60+	Excellent	Pin Point Rust	Dull, Spelter Present	0.069	0.068
115	Idaho	US 95	231.9	18"	16	2'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		7.6		5000	35	29		55	Good	Pin Point Rust	Dull, Spelter Present	0.067	0.067
116	Idaho	US 95	272.5	18"	16	3'5'	Cultivated Land, Intermittent Flow of Water.		7.0		11000	33	31		50+	Excellent	Pin Point Rust	Dull, Spelter Present	0.064	0.066
117	Idaho	US 95	277.6	24"	14	3'-4'	Cultivated Land, Intermittent Flow of Water.		7.0		9000	33	31		60+	Excellent	Pin Point Rust	Dull, Spelter Present	0.082	0.084
118	Nez Perce	US 95	311.9	24"	14	4'	Cultivated Land, Hilly Land, Frequent Flow of Water.		7.9		5800	39	25		60+	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.084	0.082
119	Nez Perce	US 95	309.7	18"	16	4'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		7.2		11000	39	25		50+	Excellent	Pin Point Rust	Dull, Spelter Present	0.069	0 069
120	Lewis	US 95	296.2	24"	14	6'	Hilly Land, Timbered Area, Intermittent Flow of Water.		7.2		6000	61	3		60+	Excellent, Asphalt Dipped Pipe	Like New to Dull, Spelter Present	Like New to Dull, Spelter Present	0.082	0.082
121	Lewis	US 95	293.0	60"	8	10'-12'	Hilly Land, Timbered Area, Frequent Flow of Water.		7.4		6000	61	3		60+	Excellent, Asphalt Dipped Pipe	Dull, Spelter Present	Like New to Dull, Spelter Present	0.164	-
122	Latah	US 95	367.3	18"	16	5'-20'	Cultivated Land, Intermittent Flow of Water.		6.6		9000	42	22		39	Good	Heavily Pitted to Pin Point Rust	Pin Point Rust to Dull, Spelter Present	0.063	0.063

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
123	Ben.	US 95	389.9	18"	16	5'-10'	Hilly Land, Timbered Area Frequent Flow of Water. Sediment in pipe.		7.2		40000	34	30		50+	Good to Fair, End Dented	Scaly Rust	Dull, Spelter Present	0.058	0.064
124	Ben.	US 95	401.4	24"	14	6'	Cultivated Land, Intermittent Flow of Water, Sediment in Pipe.		7.3		9000	40	24		60+	Good	Scaly Rust to Pin Point Rust	Dull, Spelter Present	0.079	0.082
125	Koot.	US 95	430.8	18"	16	1.5'	Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.8		1000	36	28		28	Fair	Scaly Rust	Dull, Spelter Present	0.049	0.061
126	Koot.	US 95	436.8	18"	16	2'	Pasture, Intermittent Flow of Water, Sediment in Pipe.		6.8		34000	36	28		50+	Good	Scaly Rust to Heavily Pitted	Dull, Spelter Present	0.060	0.066
127	Shos.	US 10	59.2	36"	12	10'	Hilly Land, Timbered Area, Continuous Flow of Water, Sediment in Pipe.		5.8		46000	45	19		54	Good, Water Covering Invert	No Sample	Dull, Spelter Present	-	0.110
128	Shos.	US 10	53.5	30"	14	20'	Hilly Land, Mine Area, Continuous Flow of Water, Sediment in Pipe.		6.1		15000	41	23		39	Fair, Rusty Perforated in Places	Perforated	Pin Point Rust to Perforated	-	0.070
129	Koot.	US 10	29.7	60"	10	2'	Hilly Land, Timbered Area, Continuous Flow of Water, Sediment in Pipe.		6.8		10000	56	8		60+	Excellent, Asphalt Dipped, Water Flowing Through	No Sample	Dull, Spelter Present	-	0.145
130	Koot.	US 10	28.7	24"	14	3'-20'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.6		16000	56	8		38+	Excellent, Asphalt Dipped	Like New to Dull, Spelter Present	Dull, Spelter Present	0.078	-
131	Bonner	US 95	473.2	18"	16	1'-4'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.8		41000	50	14		50+	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.069	0.070
132	Bonner	US 95	482.1	18"	16	20'	Hilly Land, Timbered Area, Intermittent Flow of Water.		6.8		25000	50	14		50+	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.067	0.068
133	Ben.	Alt. US 95	425.2	18"	16	4'	Hilly Land, Timbered Area, Frequent Flow of Water, Sediment in Pipe.		7.0		4700	39	25		44	Good	Heavy Pitting to Pin Point Rust	Dull, Spelter Present	0.065	0.067
134	Ben.	Alt. US 95	419.1	18"	16	4'	Hilly Land, Timbered Area, Intermittent Flow of Water, Sediment in Pipe.		6.6		19000	34	30		40+	Good	Heavy Pitting to Scaly Rust	Dull, Spelter Present	0.065	0.069
135	Latah	SH 7	343.8	18"	16	5'-10'	Hilly Land, Intermittent Flow of Water. Cultivated Land.		6.6		9500	40	24		39	Good	Heavily Pitted	Dull, Spelter Present	0.063	0.068
136	Latah	SH 7	340.0	24"	14	6'	Cultivated Land, Hilly Land, Intermittent Flow of Water.		6.8		6500	41	23		56	Excellent Asphalt Dipped	Like New to Dull, Spelter Present	Dull, Spelter Present	0.078	0.079
137	Lewis	US 12	52.7	36"	12	3'	Hilly Land, Timbered Area, Continuous Flow of Water		7.0		14000	37	27		60+	Fair	Scaly Rust	Dull, Spelter Present	0.097	0.113

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Visual Condition of Metal: Side & Top	Metal Thickness Inches: Invert	Metal Thickness Inches: Side Top
138	Idaho	US 12	69.9	18"	16	6'-10'	Cultivated Land, Hilly Land, Timber Area, Intermittent Flow of Water.		6.9		6400	37	27		45	Excellent	Dull, Spelter Present	Dull, Spelter Present	0.065	0.065
139	Lewis	US 95	296.1	6'	8 Mules Plate	2'-3'	Hilly Land, Timbered Area, Continuous Flow of Water, Sediment in Pipe.		7.2		3600	61	3		60+	Good, Some Water Flowing Below Pipe	Dull, Spelter Present	Like New	No Sample Taken	
140	Lewis	US 95	294.2	12'	8 Mules Plate	6'-8'	Hilly Land, Timbered Area, Continuous Flow of Water		7.0		3800	61	3		60+	Excellent, Some Abrasion at Inlet Concrete Floor	Like New	Like New	No Sample Taken	
141	Shos.	US 10	1351+00	-	Conc.	10'	Mine Area, Continuous Flow of Water.		6.3		1750	63	1		Conc.	CMP Replaced by Fiber Glass Coated Concrete Box	Replaced CMP due to high acid content of water.			
142	Shos.	US 10	1336+90	-	Conc.	2'	Mine Area, Continuous Flow of Water.		6.0		5900	63	1		Conc.	CMP Replaced by Fiber Glass Coated Concrete Box	Replaced CMP due to high acid content of water.			
143	Elmore	SH 68	135.0	18'	16	10'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		6.2		4200	63	1		28	Excellent	Dull, Spelter Present	Dull Spelter Present	No Sample Taken	
144	Elmore	SH 68	133.2	24'	14	5'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		7.0		13000	63	1		55+	Excellent	Dull, Spelter Present	Dull Spelter Present	No Sample Taken	
145	Elmore	SH 68	132.7	18'	16	5'	Hilly Land, Intermittent Flow of Water.		7.3		4700	63	1		50	Excellent	Like New to Dull, Spelter Present	Like New to Dull, Spelter Present	No Sample Taken	
146	Elmore	SH 68	132.2	30'	14	10'-15'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		6.6		5900	63	1		Alum.	Excellent, Aluminum Pipe	Like New	Like New	No Sample Taken	
147	Elmore	SH 68	131.7	36"	12	5'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		6.2		2800	63	1		Alum.	Excellent, Aluminum Pipe	Like New	Like New	No Sample Taken	
148	Elmore	SH 68	131.6	24"	14	6'	Hilly Land, Frequent Flow of Water, Sediment in Pipe.		6.9		12000	63	1		Alum.	Excellent, Aluminum Pipe	Like New	Like New	No Sample Taken	
149	Elmore	SH 68	130	24"	14	4'-6'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		6.7		4600	63	1		Alum.	Excellent, Aluminum Pipe	Dull, Spelter Present	Like New	No Sample Taken	
150	Elmore	SH 68	129.4	24"	14	4'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		6.3		3200	63	1		Alum.	Excellent, Aluminum Pipe	Dull, Spelter Present	Like New	No Sample Taken	
151	Elmore	SH 68	129.3	24"	14	5'	Hilly Land, Intermittent Flow of Water, Sediment in Pipe.		6.4		5300	63	1		Alum.	Excellent, Aluminum Pipe	Dull, Spelter Present	Like New	No Sample Taken	
152	Elmore	SH 68	128.9	5'	12	4'	Hilly Land, Timbered Area, Desert Rangeland, Continuous Flow of Water.		6.0		3900	63	1		41	Excellent, Asphalt Dipped Pipe	Dull, Spelter Present	Dull, Spelter Present	No Sample Taken	

TABLE I - Continued

Site No.	County	Route	Mile Post	Diameter	Gauge	Est. Cover Ft.	Characteristics of Area Drained	Tests on Soil: Ph - 1957	Ph - 1964	Resistivity Ohm/cm³ - 1957	Resistivity Ohm/cm³ - 1964	Year Installed	Age - 1964	Est. Life of Pipe in 1957	Est. Life of Pipe in 1964	Condition From Field Inspection	Visual Condition of Metal: Invert	Side & Top	Metal Thickness Inches: Invert	Side Top
153	Elmore	SH 68	128.7	24"	14	5'-6'	Hilly Land, Timbered Area, Swamp Area, Continuous Flow of Water.		7.3		4250	63	1		Alum.	Excellent, Aluminum Pipe	Dull, Spelter Present	Like New	No Sample Taken	
154	Elmore	SH 68	128.6	48"	12	4'	Hilly Land, Swamp Area, Intermittent Flow of Water, Sediment in Pipe.		6.3		4600	63	1		Alum.	Excellent, Aluminum Pipe	Dull, Spelter Present	Like New	No Sample Taken	