

APPENDIX 15 SAMPLE STATION 15
SUBSURFACE MONITORING ZONE - 90' FT.

BIG BERTHA ARTESIAN WELL

PA STATE GAME LANDS #95 PROJECT SL-110-7-101.5

MONITORING POINT 15

The discussion of this monitoring point will be divided into four (4) phases as outlined below:

1. General Conditions
2. Pre Closure Analysis
3. Post Closure Analysis
4. Summary of Analysis

1. General Conditions

The data and associated graphical materials relevant to and utilized in describing the relationships at this monitoring location are outlined below:

- Sheet 7 - Relationship of Geophysical Parameters
 - Sheet 8 - Geologic Cross Sections
 - Sheet 24 - Relationship of Hydrologic Parameters
 - Appendix 15 - Subsurface Monitoring Zone
- Narrative exhibits contained on the following pages.

This monitoring point is 90 ' below the surface of the artesian well (Big Bertha), as shown on Sheets 7 and 8.

The flow relationships of the artesian well at this monitoring zone are given below:

- a. Velocity - the average velocity of water at this monitoring zone was 4.08 ft/min upward.
- b. Cumulative Quantity - the cumulative quantity of water contributed by this flow system was 10.6 gal/min
- c. Flow System Quantity - the average quantity of water contributed by this flow system was 3.4 gal/min. (.01 c.f.s.)

This monitoring point is representative of conditions in flow system B4. This sample zone is the top sample for this flow system representing fully mixed conditions.

2. Pre Closure Analysis (Monitoring Point 15)

The reviewer is directed to refer to the following materials during the discussion of the chemical analyses and trends at this monitoring point:

- a. Sheet 24 - which shows the sample data plotted using a time reference basis.
- b. The corresponding graphs (on the 6 pages immediately following the pre closure analysis) which show the data, the regression mean line, and the field of variance.
- c. Appendix 15 - which contains the raw sample data during pre closure which was utilized to develop the means, ranges, and regression analysis results.

1. pH Relationship

The pH at this monitoring point varied from 6.20 - 6.37. the mean value being 6.30. A moderate relationship exists.

2. Specific Conductance Relationship

The specific conductance at this monitoring point varied from 1200 - 1300. the mean value calculated as 1285.

3. Acidity/Alkalinity Balance (mg/l)

The alkalinity varied from 73 - 132 ; the mean value was 105 Regression analysis of the alkalinity values showed: A moderate relationship exists where alkalinity concentration decreases as conductance increases. The acidity varied from 00 - 5 ; the mean value was .71. Regression analysis of the sulphate values showed: No relationship was calculated as only 1 value of acidity was recorded.

4. Sulphate Relationship. (mg/l)

The sulphates varied from 315- 629 ; the mean value was 458. Regression analysis of the sulphate values showed: An extremely weak relationship existed where sulphate concentrations increased as conductance increased.

5. Total Iron Relationship (mg/l)

The total iron varied from 31 - 96; the mean value was 64. Regression analyses of the ferrous iron values showed: A moderate relationship exists where total iron concentrations increased as conductance increased. .

6. Ferrous Iron Relationship (mg/l)

The ferrous iron varied from 30 - 94; the mean value was 61. Regression analysis of the ferrous iron values showed: A moderate relationship exists where ferrous iron concentration increased as conductance increased.

7. Ferric Iron Relationship (mg/l)

The ferric iron varied from 0.2 - 8.0 ; the mean value was 3. Regression analysis of the ferric iron values showed: A moderate relationship exists where ferric iron concentration increased as conductance increased.

3. Post Closure Analysis

The reviewer is referred to sheet 24 which shows the post-closure data plotted using a time reference basis with pre-closure data for comparative purposes.

Closure dramatically increased the specific conductance, however, the values rapidly returned to near pre closure levels.

pH became slightly depressed as a result of closure, returning to pre closure levels after several months.

This zone experienced a significant and prolonged decrease in alkalinity concentrations and a significant and prolonged increase in acidity concentrations (where no acidity was observed prior to closure) as a result of closure activities. The author believes this due to charging of this zone with acidic waters from overlying zones and subsequent storage of acidic water during closure.

A significant increase in sulphate concentration occurred as a result of closure, but quickly returned to pre closure levels after the well was opened.

A dramatic increase in total iron concentration occurred due to closure, however, this returned to levels slightly elevated above pre closure after the well was opened.

A dramatic increase in ferrous iron concentration occurred due to closure, with levels returning to values similar to those observed during pre closure.

Ferric Iron concentrations increased slightly due to closure but quickly returned to pre closure levels.

4. Summary of Monitoring Point 15 Analysis

Closure allowed a free mixing of the flow systems between the lower zones and the upper zones (with higher permeabilities, higher recharge capacities and poorer quality). The upper zones dominated the lower zones and caused a depression in the water quality of the lower zones.

This zone appears to have been more significantly impacted by closure than lower zones. This is due to the close proximity of this zone to the poorer quality zones which immediately overlie this zone.

SAMPLE 15

PROJECT SL110-7-101.5:R16 BERTHA

DATE	SPEC COND UNITS/CM	DISCHARGE C.F.S.	PH SU	ALKALINITY MG/L	ACIDITY MG/L	SULPHATES MG/L	TOTAL IRON MG/L	FEROUS IRON MG/L	FERRIC IRON MG/L	REC #
021783	1200	.02	6.37	132	00	438	31.0	30.5	.2	1
022883	1300	.02	6.35	124	00	518	40.0	39.8	.2	2
031083	1300	.02	6.20	89	00	629	76.0	70.0	6.0	3
040783	1300	.02	6.29	115	00	409	84.0	76.0	8.0	4
041383	1300	.02	6.40	124	00	372	37.0	30.0	7.0	5
042083	1300	.02	6.27	77	00	315	84.0	83.5	.5	6
042683	1300	.02	6.22	73	05	528	96.0	94.5	1.5	7

SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. PH

COEFFICIENT MATRIX AND AUGMENTED MATRIX

	900	900	44.1000
		1158000	56693.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION	7.350000000000		
	0.000816666667		

ORIGINAL X - Y PAIRS	PREDICTED VALUES	DEVIATION
1200.0000 6.3700	6.3700	0.0000
1300.0000 6.3500	6.2883	0.0617
1300.0000 6.2000	6.2883	0.0883
1300.0000 6.2900	6.2883	0.0017
1300.0000 6.4000	6.2883	0.1117
1300.0000 6.2700	6.2883	0.0183
1300.0000 6.2200	6.2883	0.0683

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1
 NUMBER OF X - Y PAIRS= 7
 TOTAL SUMS OF SQUARE= .0348
 SUMS OF SQUARES DUE TO REGRESSION= 5.716667E-3
 SUMS OF SQUARES DUE TO DEVIATION= .029083
 GOODNESS OF FIT= .164272
 MULTIPLE CORRELATION COEFFICIENT 0.40530
 STANDARD DEVIATION .069622

ANALYSIS OF VARIANCE			
SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	.01	1	.01
DEVIATION	.03	5	.01
TOTAL VARIATION	.03	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE
 F TEST - SIGNIFICANCE OF REGRESSION = 0.98
 LEVEL .05% - CRITICAL VALUE = 6.61

SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. ALKALINITY

COEFFICIENT MATRIX AND AUGMENTED MATRIX

		900	734.0000
	900	1158000	941000.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION			
	511.999999999970		
-	0.316666666667		

ORIGINAL X - Y PAIRS	PREDICTED VALUES	DEVIATION
1200.0000 132.0000	132.0000	0.0000
1300.0000 124.0000	100.3333	23.6667
1300.0000 89.0000	100.3333	11.3333
1300.0000 115.0000	100.3333	14.6667
1300.0000 124.0000	100.3333	23.6667
1300.0000 77.0000	100.3333	23.3333
1300.0000 73.0000	100.3333	27.3333

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1

NUMBER OF X - Y PAIRS= 7

TOTAL SUMS OF SQUARE= 3614.857143

SUMS OF SQUARES DUE TO REGRESSION= 859.52381

SUMS OF SQUARES DUE TO DEVIATION= 2755.333333

GOODNESS OF FIT= .237775

MULTIPLE CORRELATION COEFFICIENT 0.48762

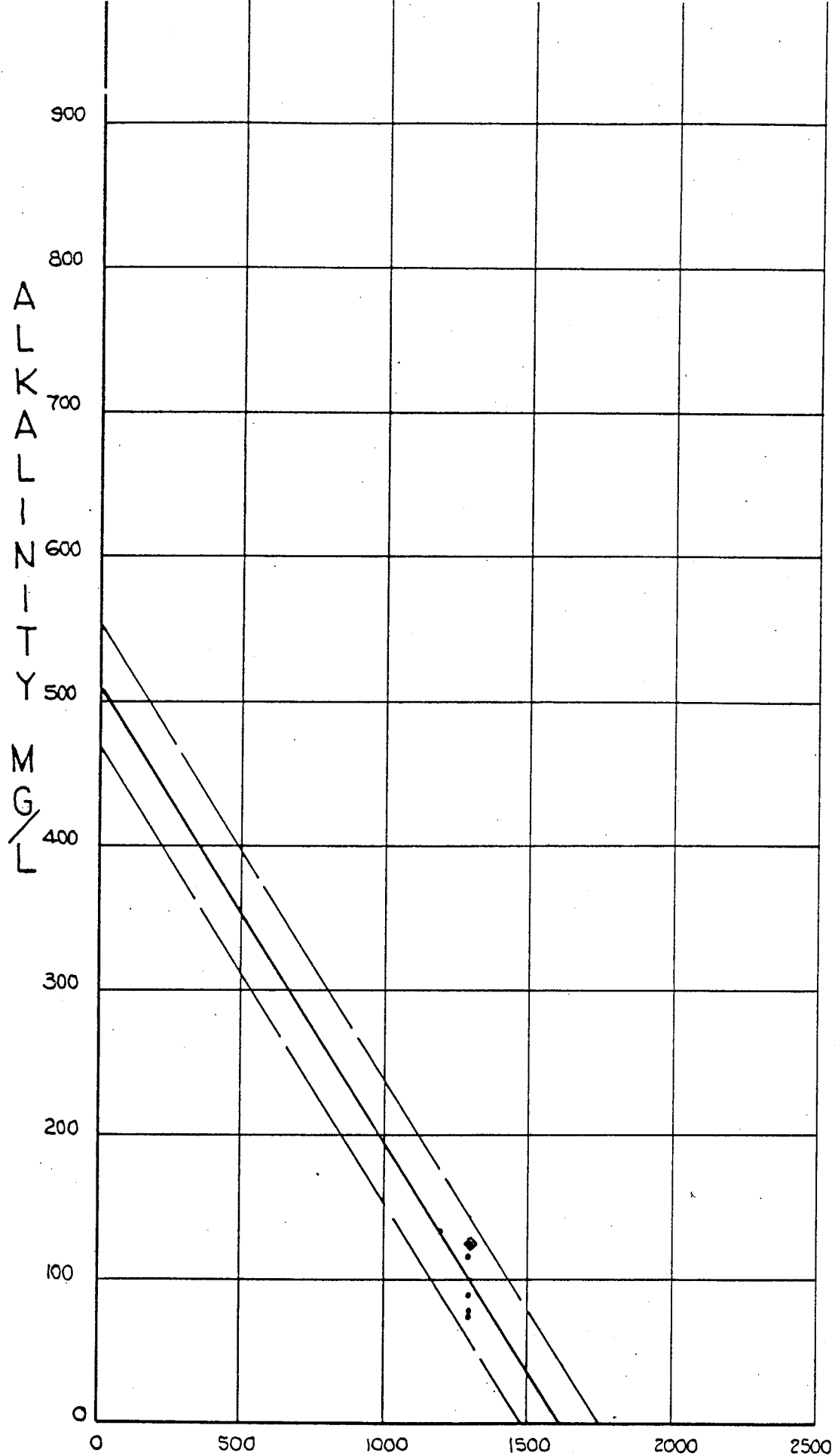
STANDARD DEVIATION 21.429471

ANALYSIS OF VARIANCE			
SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	859.52	1	859.52
DEVIATION	2755.33	5	551.07
TOTAL VARIATION	3614.86	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE

F TEST - SIGNIFICANCE OF REGRESSION = 1.56

LEVEL .05% - CRITICAL VALUE = 6.61



SPECIFIC CONDUCTANCE (umhos/cm)
 BIG BERTHA - SAMPLE ZONE 15

SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. ACIDITY

COEFFICIENT MATRIX AND AUGMENTED MATRIX

	900	900	5.0000
	900	1158000	6500.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION			
-	9.99999999999999		
	0.00833333333333		

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
1200.0000	0.0000	0.0000	0.0000
1300.0000	0.0000	0.8333	0.8333
1300.0000	0.0000	0.8333	0.8333
1300.0000	0.0000	0.8333	0.8333
1300.0000	0.0000	0.8333	0.8333
1300.0000	0.0000	0.8333	0.8333
1300.0000	5.0000	0.8333	4.1667

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1

NUMBER OF X - Y PAIRS= 7

TOTAL SUMS OF SQUARE= 21.428571

SUMS OF SQUARES DUE TO REGRESSION= .595238

SUMS OF SQUARES DUE TO DEVIATION= 20.833333

GOODNESS OF FIT= .027778

MULTIPLE CORRELATION COEFFICIENT 0.16667

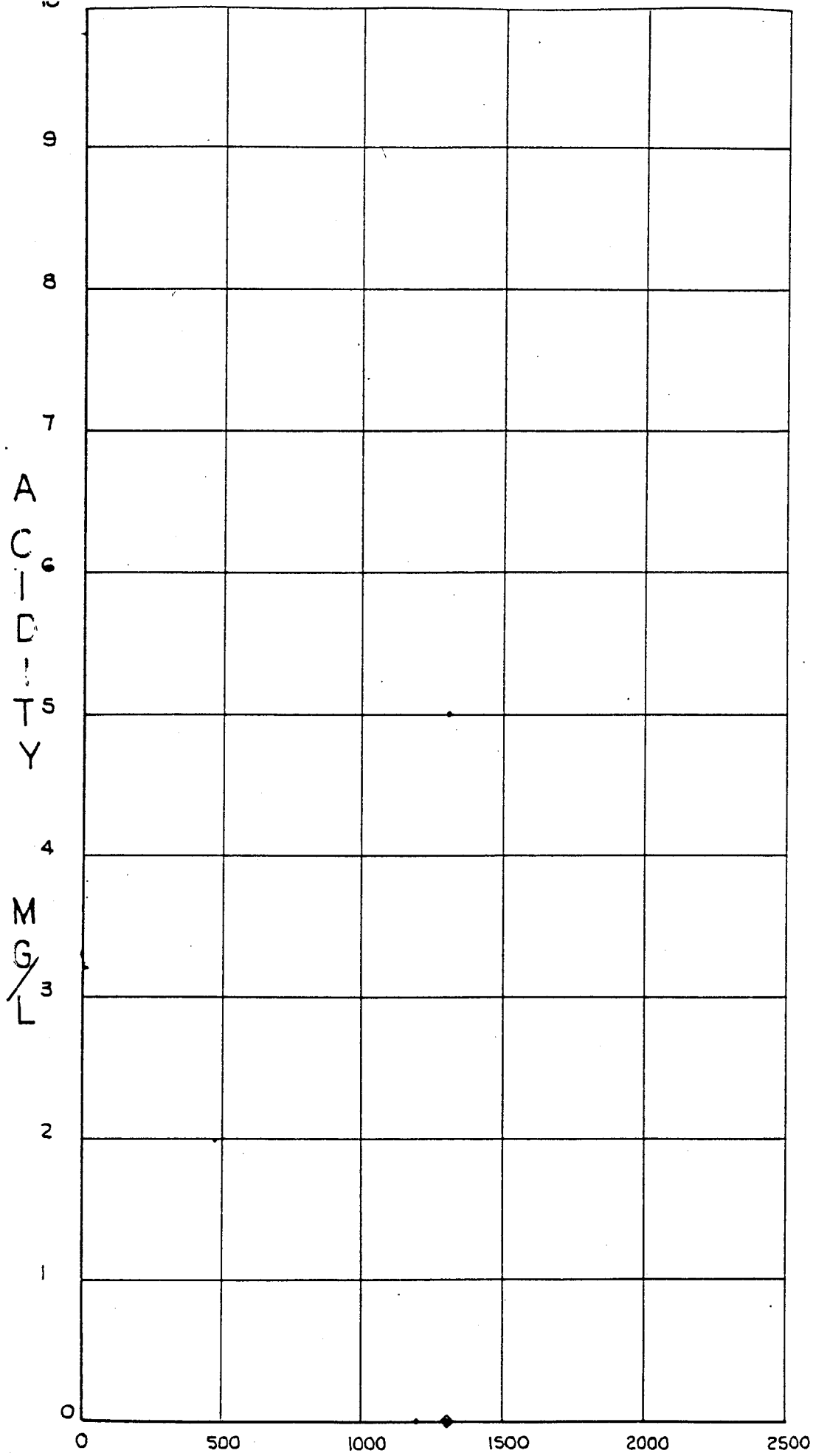
STANDARD DEVIATION 1.86339

SOURCE OF VARIATION	ANALYSIS OF VARIANCE		MEAN SQUARE
	SUM OF SQUARES	DEGREES OF FREEDOM	
LIN. REGRESSION	.60	1	.60
DEVIATION	20.83	5	4.17
TOTAL VARIATION	21.43	6	

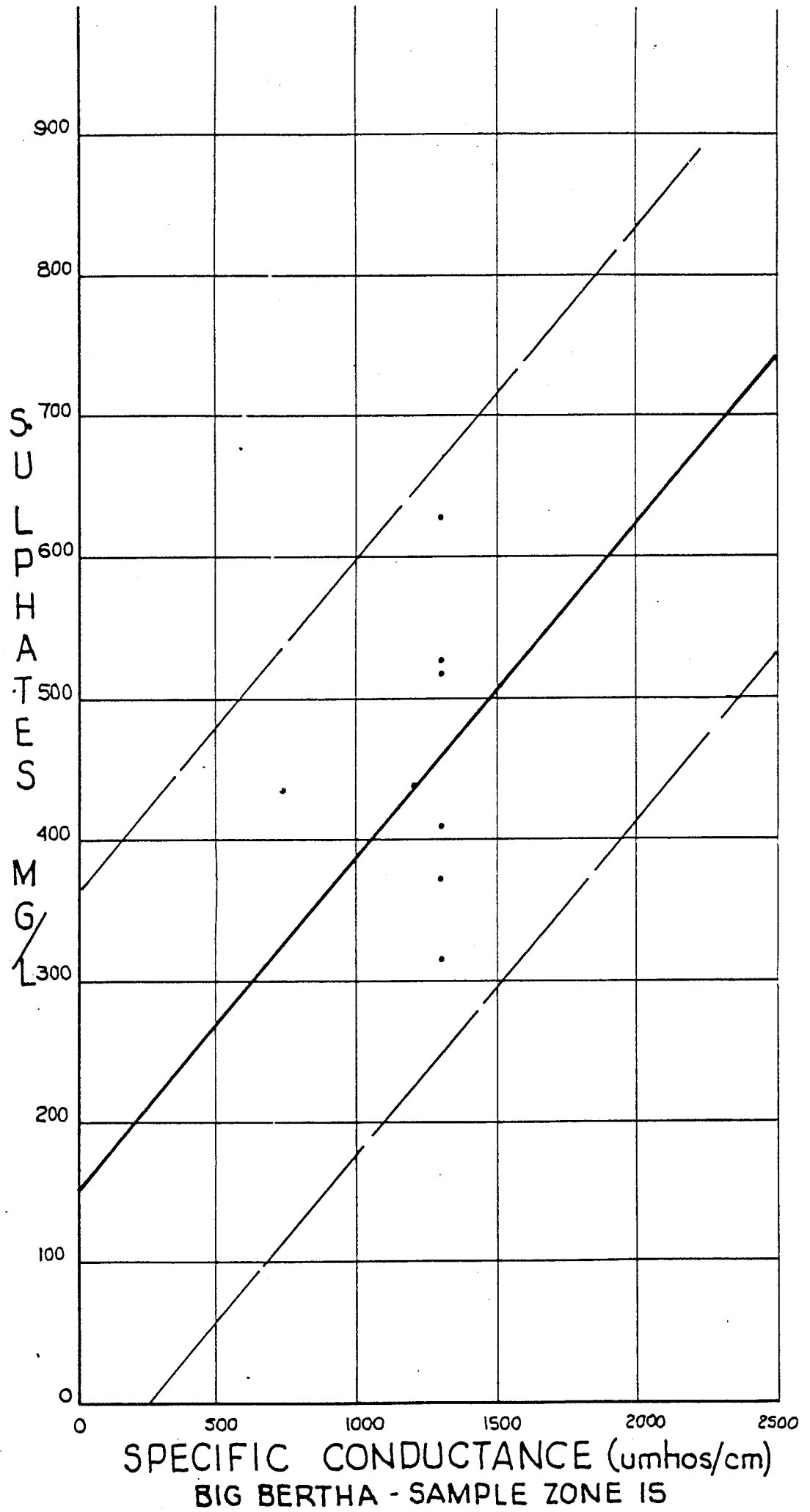
F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE

F TEST - SIGNIFICANCE OF REGRESSION = 0.14

LEVEL .05% - CRITICAL VALUE = 6.61



SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 15



SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. TOTAL IRON

COEFFICIENT MATRIX AND AUGMENTED MATRIX

900 448.0000
1158000 579300.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION
- 430.999999999969
0.385000000000

ORIGINAL X - Y PAIRS	PREDICTED VALUES	DEVIATION
1200.0000 31.0000	31.0000	0.0000
1300.0000 40.0000	69.5000	29.5000
1300.0000 76.0000	69.5000	6.5000
1300.0000 84.0000	69.5000	14.5000
1300.0000 37.0000	69.5000	32.5000
1300.0000 84.0000	69.5000	14.5000
1300.0000 76.0000	69.5000	26.5000

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1

NUMBER OF X - Y PAIRS= 7

TOTAL SUMS OF SQUARE= 4362

SUMS OF SQUARES DUE TO REGRESSION= 1270.5

SUMS OF SQUARES DUE TO DEVIATION= 3091.5

GOODNESS OF FIT= .291265

MULTIPLE CORRELATION COEFFICIENT 0.53969

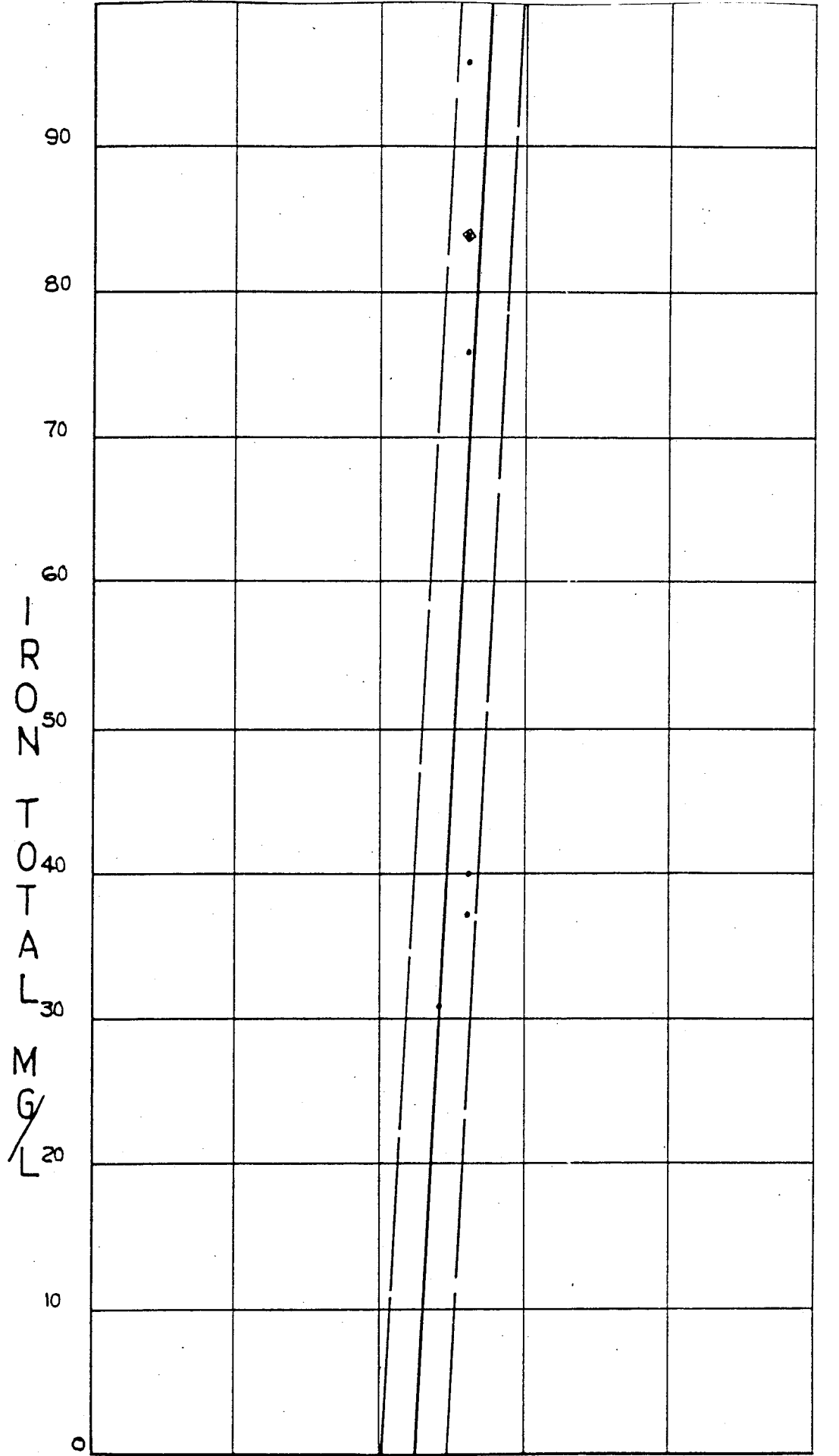
STANDARD DEVIATION 22.699119

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	1270.50	1	1270.50
DEVIATION	3091.50	5	618.30
TOTAL VARIATION	4362.00	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE

F TEST - SIGNIFICANCE OF REGRESSION = 2.05

LEVEL .05% - CRITICAL VALUE = 6.61



SPECIFIC CONDUCTANCE (umhos/cm)
 BIG BERTHA - SAMPLE ZONE 15

SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. FERROUS IRON

COEFFICIENT MATRIX AND AUGMENTED MATRIX

900 900 424.6000
1158000 548900.0000

REGRESSION COEFFICIENTS OF NORMAL EQUATION

- 387.199999999979
0.348333333333

ORIGINAL X - Y PAIRS	PREDICTED VALUES	DEVIATION
1200.0000 30.8000	30.8000	0.0000
1300.0000 39.8000	65.6333	25.8333
1300.0000 70.0000	65.6333	4.3667
1300.0000 76.0000	65.6333	10.3667
1300.0000 30.0000	65.6333	35.6333
1300.0000 83.5000	65.6333	17.8667
1300.0000 94.5000	65.6333	28.8667

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1

NUMBER OF X - Y PAIRS= 7

TOTAL SUMS OF SQUARE= 4256.157143

SUMS OF SQUARES DUE TO REGRESSION= 1040.02381

SUMS OF SQUARES DUE TO DEVIATION= 3216.133333

GOODNESS OF FIT= .244357

MULTIPLE CORRELATION COEFFICIENT 0.49433

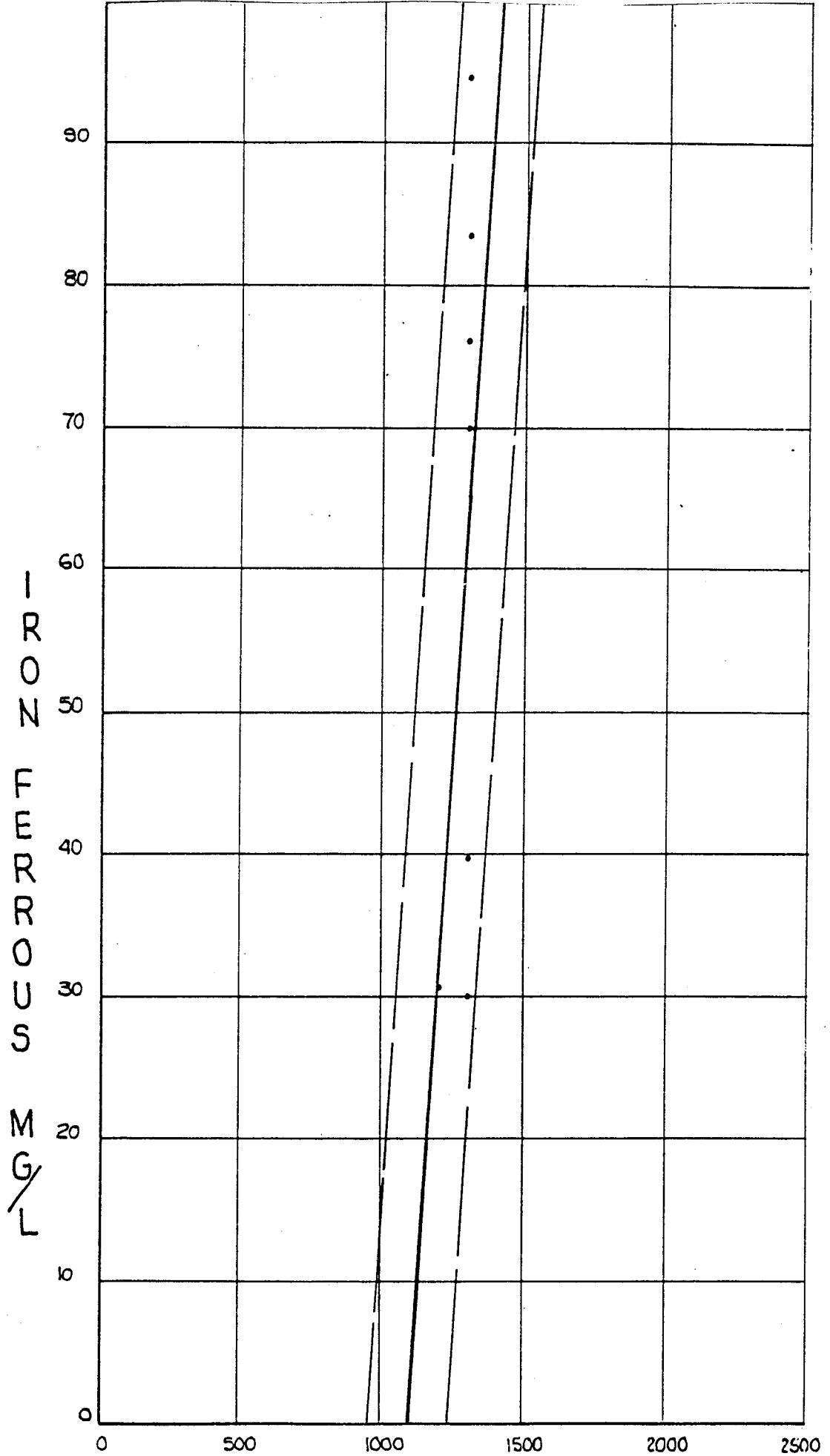
STANDARD DEVIATION 23.152154

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	1040.02	1	1040.02
DEVIATION	3216.13	5	643.23
TOTAL VARIATION	4256.16	6	

F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE

F TEST - SIGNIFICANCE OF REGRESSION = 1.62

LEVEL .05% - CRITICAL VALUE = 6.61



SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 15

SAMPLE.FIFTEEN

SPECIFIC CONDUCTANCE VS. FERRIC IRON

COEFFICIENT MATRIX AND AUGMENTED MATRIX

	900	900	23.4000
		1158000	30400.0000
REGRESSION COEFFICIENTS OF NORMAL EQUATION			
	43.7999999999997		
	0.0366666666667		

ORIGINAL X - Y PAIRS		PREDICTED VALUES	DEVIATION
1200.0000	0.2000	0.2000	0.0000
1300.0000	0.2000	3.8667	3.6667
1300.0000	6.0000	3.8667	2.1333
1300.0000	8.0000	3.8667	4.1333
1300.0000	7.0000	3.8667	3.1333
1300.0000	0.5000	3.8667	3.3667
1200.0000	1.5000	3.8667	2.3667

STATISTICAL ANALYSIS WITH ORDER OF EQUATION= 1

NUMBER OF X - Y PAIRS= 7

TOTAL SUMS OF SQUARE= 73.357143

SUMS OF SQUARES DUE TO REGRESSION= 11.52381

SUMS OF SQUARES DUE TO DEVIATION= 61.833333

GOODNESS OF FIT= .157092

MULTIPLE CORRELATION COEFFICIENT 0.39635

STANDARD DEVIATION 3.210227

ANALYSIS OF VARIANCE			
SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
LIN. REGRESSION	11.52	1	11.52
DEVIATION	61.83	5	12.37
TOTAL VARIATION	73.36	6	

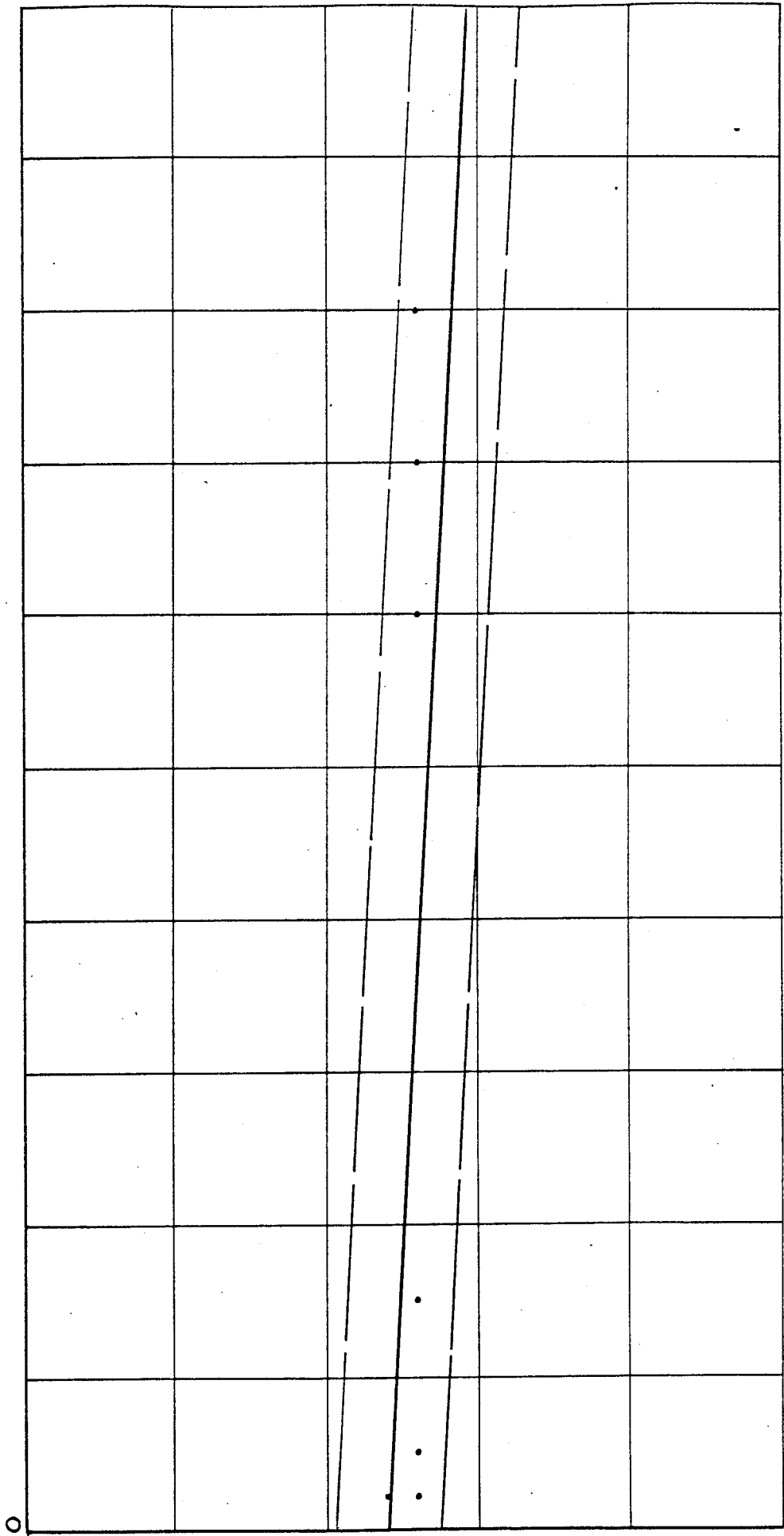
F-TEST FOR EQUALITY OF SAMPLE/REGRESSION VARIANCE

F TEST - SIGNIFICANCE OF REGRESSION = 0.93

LEVEL .05% - CRITICAL VALUE = 6.61

1
2
3
4
5
6
7
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9
10

IRON
FERRIC
C
M
L



0 500 1000 1500 2000 2500

SPECIFIC CONDUCTANCE (umhos/cm)
BIG BERTHA - SAMPLE ZONE 15

POST CLOSURE DATA LISTING *

SAMPLE FIFTEEN

DATE	SPEC. COND.	DISCHARGE	pH	ALKALINITY	ACIDITY	SULPHATES	TOTAL IRON	FERROUS IRON	FERRIC IRON
6/12	1900	.023	5.56	21	309	1340	182	174	8
6/16	1600	.023	5.34	14	280	1099	125	103	22
6/21	1500	.023	5.70	22	178	971	89.8	87	2.8
6/29	1500	.023	5.50	8	190	652	105	96.5	8.5
7/10	1400	.023	5.68	23	208	497	144	143	1
7/26	1400	.023	5.31	10	230	549	138	135	3
8/6	1600	.023	5.39	11	253	1125	160	156	4
8/21	1300	.023	5.70	17	282	911	176	164	12

* Units are as follows:

- specific conductance - umhos/cm
- discharge - c.f.s.
- pi - standard units
- all others - mg/L