0006

WATER QUALITY MEMORANDUM

Utah Coal Regulatory Program

OK

January 10, 2008

TO: Internal File

THRU: Pamela Grubaugh-Littig, Permit Supervisor

FROM: Dana Dean, P.E., Senior Reclamation Hydrologist

RE: 2007 Second Quarter Water Monitoring, Genwal Resources, Inc., Crandall Canyon Mine, C/015/0032-WQ-07-2 Task #2731

The Crandall Canyon Mine was conducting continuous miner retreat mining in barrier pillars along the mains during the second quarter of 2007. Water monitoring requirements can be found in Section 7.31.21, and 7.31.22 of the MRP, especially Tables 7-4, 7-5, 7-8, 7-9, and 7-10.

1. Was data submitted for all of the MRP required sites? YES ☒ NO ☐

Springs

The MRP requires the Permittee to monitor 24 springs each quarter. Some require full laboratory analysis according to Table 7-4, while others simply require field measurements.

The Permittee submitted all required samples for the spring sites.

Streams

The MRP requires the Permittee to monitor12 streams each quarter. Some require full laboratory analysis according to Table 7-8, while others simply require field measurements.

The Permittee submitted all required samples for the stream sites.

Wells

The MRP requires the Permittee to monitor 7 wells during the second quarter. All require full laboratory analysis according to Table 7-4.

The Permittee submitted all required samples for the wells. Two were dry, and five were in-mine wells located in now inaccessible areas of the mine.

UPDES

The UPDES Permit/MRP require monthly monitoring of 2 outfalls: 001,sed. pond discharge, and 002, mine water discharge.

The Permittee submitted all required samples for the UPDES sites. Outfall 001 reported no flow.

2. Were all required parameters reported for each site? YES ☒ NO ☐

3. Were any irregularities found in the data? YES ☒ NO ☐

Several parameters fell outside of two standard deviations from the mean encountered at the respective sites. They were:

Site	Parameter	Value	Standard Deviations from Mean	Mean
BCF	Dissolved Sodium	7.48 mg/L	3.71	3.94 mg/L
BCF	Sulfate	52.1 mg/L	2.05	29.98 mg/L
LOF-1	Total Hardness	484.31 mg/L	2.67	310.51 mg/L
LOF-1	Dissolved Calcium	11.3 mg/L	2.19	73.58 mg/L
LOF-1	Sulfate	228 mg/L	2.84	75.78 mg/L
Section 4 Creek	Sulfate	92.9 mg/L	2.44	132.61 mg/L
UPF-1	Total Dissolved Solids	577 mg/L	2.53	320.04 mg/L
UPF-1	Total Hardness	489.15 mg/L	2.58	287.89 mg/L
UPF-1	Sulfate	249 mg/L	2.53	72.71 mg/L
UPF-1	Total Cations	10.12 meq/L	2.30	6.43 meq/L
LB-7A	Water Temperature	12.9 °C	2.39	10.02 °C
SP-22	Water Temperature	14.9 °C	2.75	7.84 °C
SP-58	Total Dissolved Solids	512 mg/L	2.35	335.68 mg/L
SP-58	Total Hardness	459.52 mg/L	2.48	311.72 mg/L
SP-58	Cation/Anion Balance	4.5 %	2.01	1.63 %
UT-0024368-002 – Apr 18	Specific Conductivity	960 µmhos/cm	2.57	755.46 µmhos/cm
UT-0024368-002 – June 13	Specific Conductivity	965 µmhos/cm	2.64	755.46 µmhos/cm

The cation/anion balance at SP-58 is not of concern, since it is within the expected range (<5%).

Dissolved calcium has a strong upward trend at LOF-1 (R^2= 0.7014). This is the highest reading ever at LOF-1. There are no criteria for dissolved calcium, but it does contribute to water hardness. The total hardness at LOF-1 also has a somewhat strong upward trend (R^2 = 06054). This is also the highest total hardness ever recorded at LOF-1. The hardness at this site has always fluctuated between the hard (150-300 mg/l) and very hard (>300 mg/L) classifications, and continues to be in that range.

Total hardness also has a strong upward trend at UPF-1 (R^2= 0.7768), and SP-58 (R^2= 0.6682). The hardness at this site has always fluctuated between the hard (150-300 mg/l) and very hard (>300 mg/L) classifications, and continues to be in that range.

There is no trend in dissolved sodium at BCF, but this is the highest value ever recorded. Most dissolved sodium readings at this site have been between 4 and 6 mg/L, and this reading of 8 mg/L is still extremely low.

There is a weak upward trend in the specific conductivity at Outfall 002 (R^2 = 0.321), with no real correlation to flow. There is no standard for specific conductivity, but it is closely related to total dissolved solids (TDS). The total dissolved solids concentration at Outfall 002 has no trend and is within the expected range.

There is a very strong upward trend in sulfate at LOF-1 (R^2 = 0.8134), a strong upward trend at UPF-1 (R^2 = 0.705), no trend at BCF (R^2 = 0.0015), and a weak downward trend at Section 4 Creek (R^2 = 0.2269). Sulfate is not toxic to plants or animals (even at very high concentration), but has a cathartic effect on humans in concentrations over 500 mg/L. For this reason, the EPA has set the secondary standard as 250 mg/L. The sulfate at these sites has been less than 250 mg/L, except once at UPF-1.

There is a fairly strong upward trend in total cations at UPF-1 (R^2 = 0.6514), with no correlation to flow. The cation/anion balance is within the 5% recommended limit at UPF-1. The number of cations also relates to the total dissolved solids in the water sample.

There is a fairly strong upward trend in TDS at UPF-01 (R^2= 0.6112), and SP-58 (R^2 = 0.6812), with no correlation to flow. Both of these sites are located above the minesite, in areas unaffected by mining.

The higher than normal water temperatures were due to high air temperatures.

Many routine reliability checks fell outside of standard values:

Site	Reliability Check	Value Should Be...	Value is...
BCF	Conductivity/Cations	>90 & < 110	74
BCF	K/(Na + K)	< 20%	43%
BCF	Mg/(Ca + Mg)	< 40 %	52%

BCF	Na/(Na + Cl)	> 50%	39%
Horse Canyon Creek	TDS/Conductivity	>0.55 & <0.75	0.52
Horse Canyon Creek	Conductivity/Cations	>90 & < 110	89
Horse Canyon Creek	K/(Na + K)	< 20%	59%
Horse Canyon Creek	Mg/(Ca + Mg)	< 40 %	51%
Horse Canyon Creek	Na/(Na + Cl)	> 50%	33%
IBC-1	Conductivity/Cations	>90 & < 110	82
IBC-1	K/(Na + K)	< 20%	43%
IBC-1	Mg/(Ca + Mg)	< 40 %	54%
Indian Creek	TDS/Conductivity	>0.55 & <0.75	0.54
Indian Creek	Conductivity/Cations	>90 & < 110	82
Indian Creek	K/(Na + K)	< 20%	37%
Indian Creek	Na/(Na + Cl)	> 50%	36%
Little Bear Creek	Conductivity/Cations	>90 & < 110	86
Little Bear Creek	K/(Na + K)	< 20%	44%
Little Bear Creek	Mg/(Ca + Mg)	< 40 %	57%
Little Bear Creek	Na/(Na + Cl)	> 50%	27%
LOF-1	Conductivity/Cations	>90 & < 110	79
LOF-1	K/(Na + K)	< 20%	38%
LOF-1	Mg/(Ca + Mg)	< 40 %	43%
LOF-1	Na/(Na + Cl)	> 50%	28%
Section 4 Creek	Cation/Anion Balance	< 5%	5.41%
Section 4 Creek	Conductivity/Cations	>90 & < 110	79
Section 4 Creek	K/(Na + K)	< 20%	48%
Section 4 Creek	Mg/(Ca + Mg)	< 40 %	60%
Section 4 Creek	Na/(Na + Cl)	> 50%	27%
Section 5 Creek	Conductivity/Cations	>90 & < 110	79
Section 5 Creek	K/(Na + K)	< 20%	41%
Section 5 Creek	Mg/(Ca + Mg)	< 40 %	60%
Section 5 Creek	Na/(Na + Cl)	> 50%	31%
UPF-1	Conductivity/Cations	>90 & < 110	80
UPF-1	K/(Na + K)	< 20%	45%
UPF-1	Mg/(Ca + Mg)	< 40 %	41%
LB-5A	Conductivity/Cations	>90 & < 110	78
LB-5A	K/(Na + K)	< 20%	40%
LB-5A	Mg/(Ca + Mg)	< 40 %	49%
LB-5A	Na/(Na + Cl)	> 50%	33%
Little Bear Spring	Conductivity/Cations	>90 & < 110	88
Little Bear Spring	K/(Na + K)	< 20%	40%
Little Bear Spring	Mg/(Ca + Mg)	< 40 %	47%
Little Bear Spring	Na/(Na + Cl)	> 50%	35%

SP1-33	Conductivity/Cations	>90 & < 110	85
SP1-33	K/(Na + K)	< 20%	41%
SP1-33	Na/(Na + Cl)	> 50%	42%
SP1-9	Conductivity/Cations	>90 & < 110	87
SP1-9	K/(Na + K)	< 20%	59%
SP1-9	Na/(Na + Cl)	> 50%	41%
SP2-24	Cation/Anion Balance	< 5%	8.72%
SP2-24	Conductivity/Cations	>90 & < 110	87
SP2-24	K/(Na + K)	< 20%	91%
SP2-24	Na/(Na + Cl)	> 50%	13%
SP2-9	K/(Na + K)	< 20%	57%
SP2-9	Na/(Na + Cl)	> 50%	38%
SP-36	Conductivity/Cations	>90 & < 110	80
SP-36	K/(Na + K)	< 20%	34%
SP-36	Mg/(Ca + Mg)	< 40 %	55%
SP-36	Na/(Na + Cl)	> 50%	27%
SP-58	Conductivity/Cations	>90 & < 110	81
SP-58	K/(Na + K)	< 20%	55%
SP-58	Mg/(Ca + Mg)	< 40 %	44%
SP-58	Na/(Na + Cl)	> 50%	35%
SP-79	Conductivity/Cations	>90 & < 110	79
SP-79	K/(Na + K)	< 20%	53%
SP-79	Mg/(Ca + Mg)	< 40 %	60%
SP-79	Na/(Na + Cl)	> 50%	26%

These inconsistencies do not necessarily mean that a sample is wrong, but it does indicate that something is unusual. An analysis and explanation of the inconsistencies by the Permittee would help to increase the Division's confidence in the samples. The Permittee should work with the lab to make sure that samples pass all quality checks so that the reliability of the samples does not come into question. The Permittee can learn more about these reliability checks and some of the geological and other factors that could influence them by reading Chapter 4 of *Water Quality Data: Analysis and Interpretation* by Arthur W. Hounslow. A geological influence is most likely here, since most samples have the same inconsistencies, and they recur each quarter.

4. On what date does the MRP require a five-year re-sampling of baseline water data.

Page 7-33 of the MRP states that groundwater samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Page 7-35 of the MRP states that surface water samples collected during the low flow period every 5 years will be analyzed for baseline parameters.

Therefore, the next re-sampling of baseline parameters is required by the fourth quarter of 2010.

5. Based on your review, what further actions, if any, do you recommend?

No further actions are necessary at this time.

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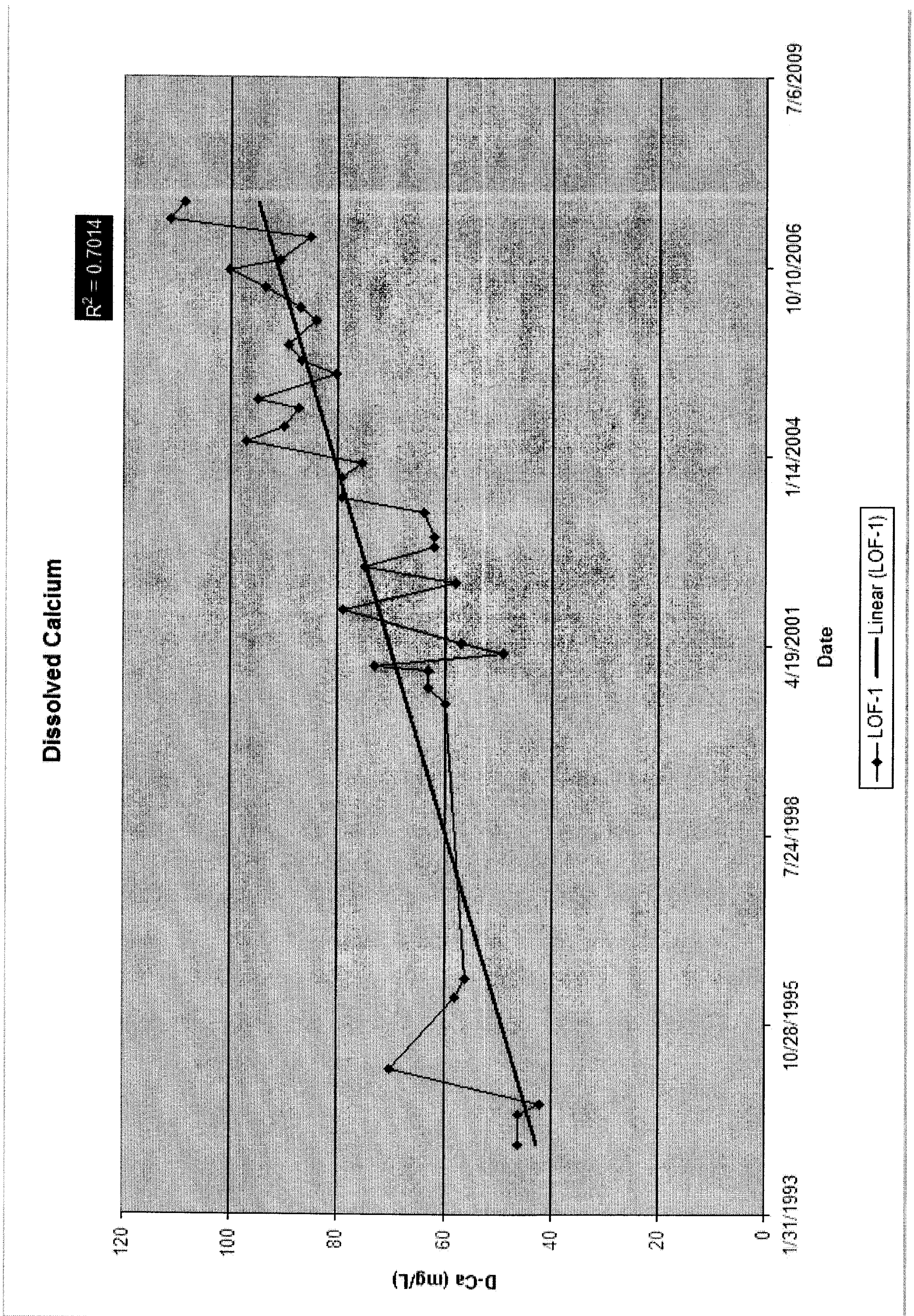
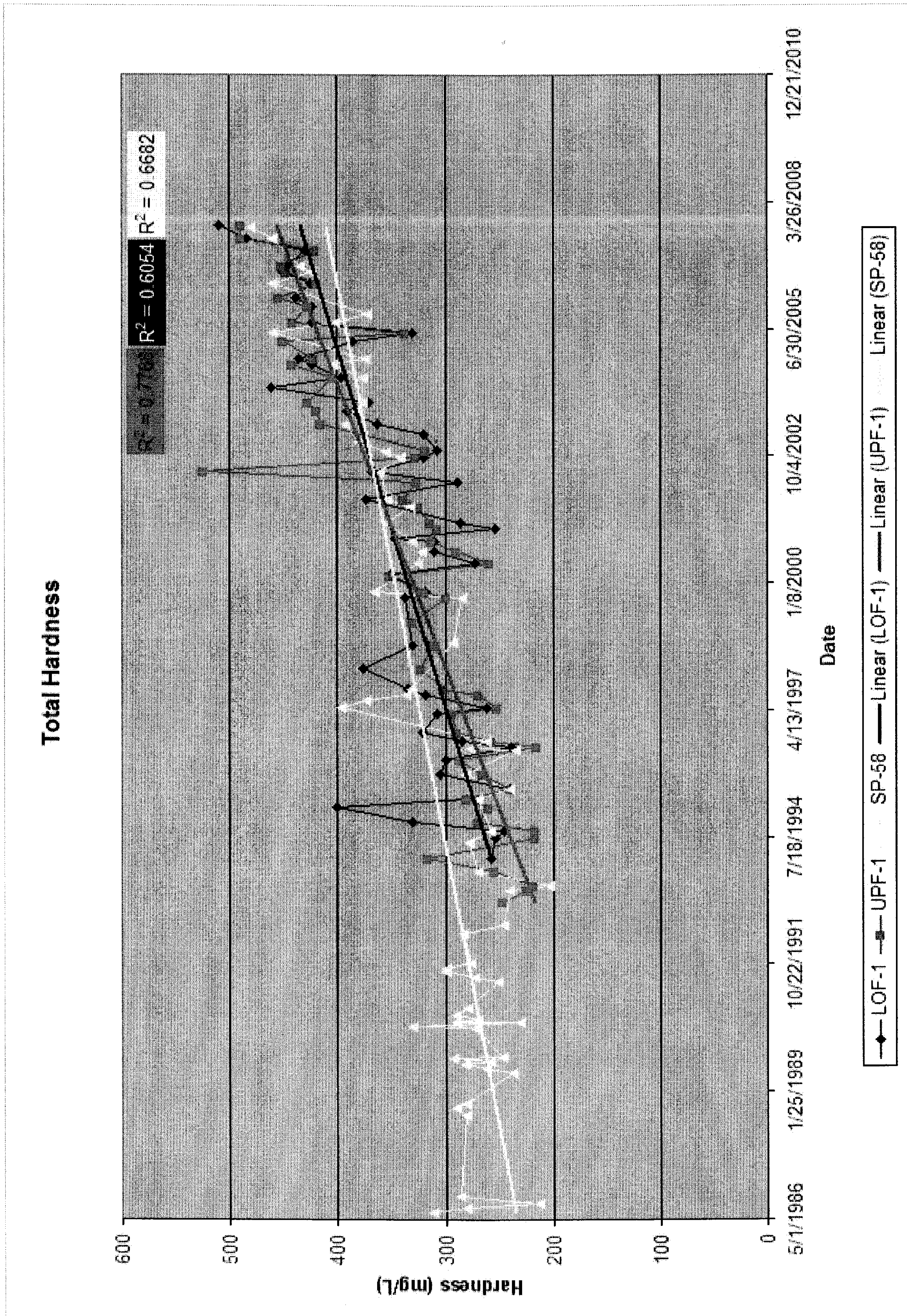
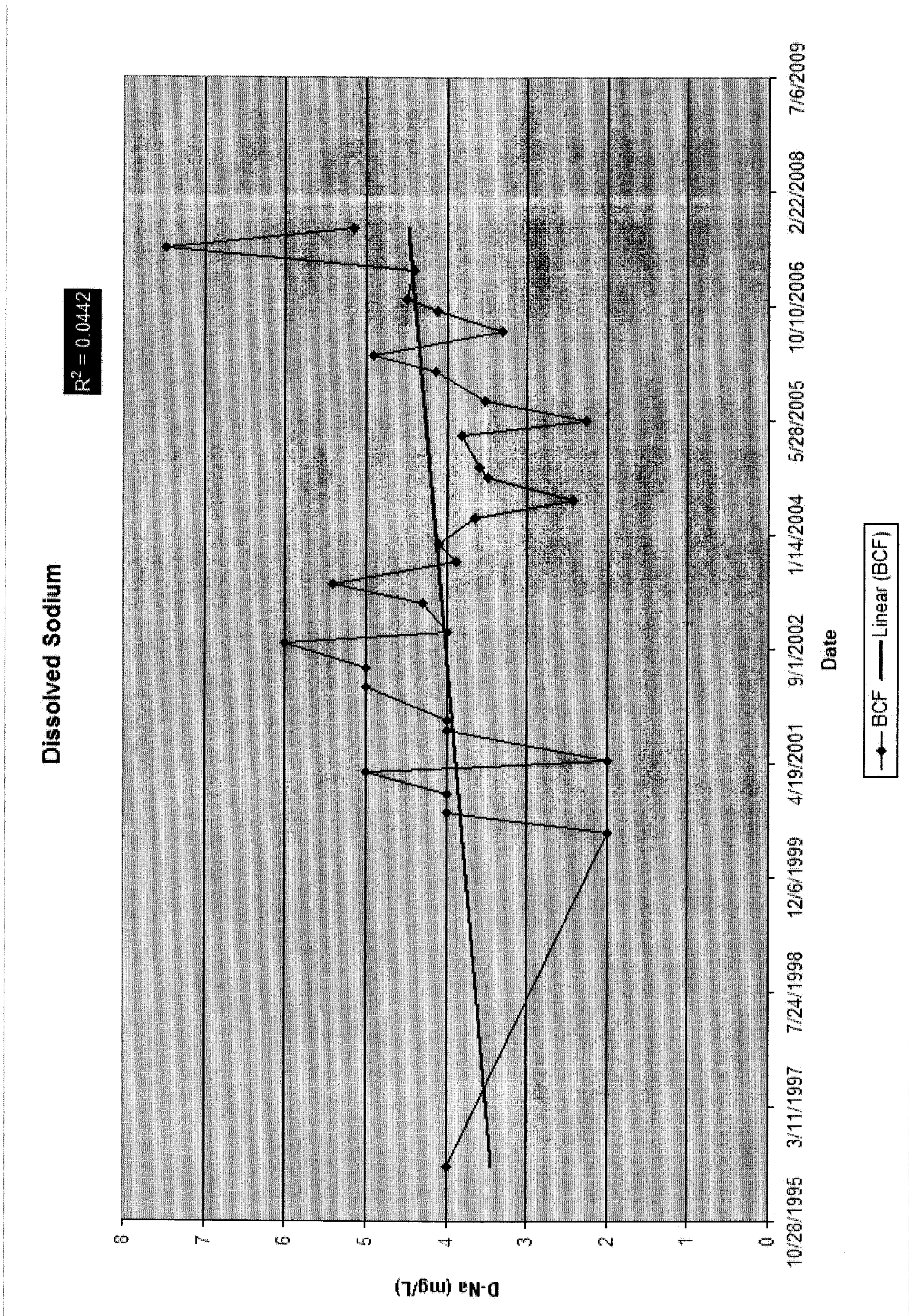
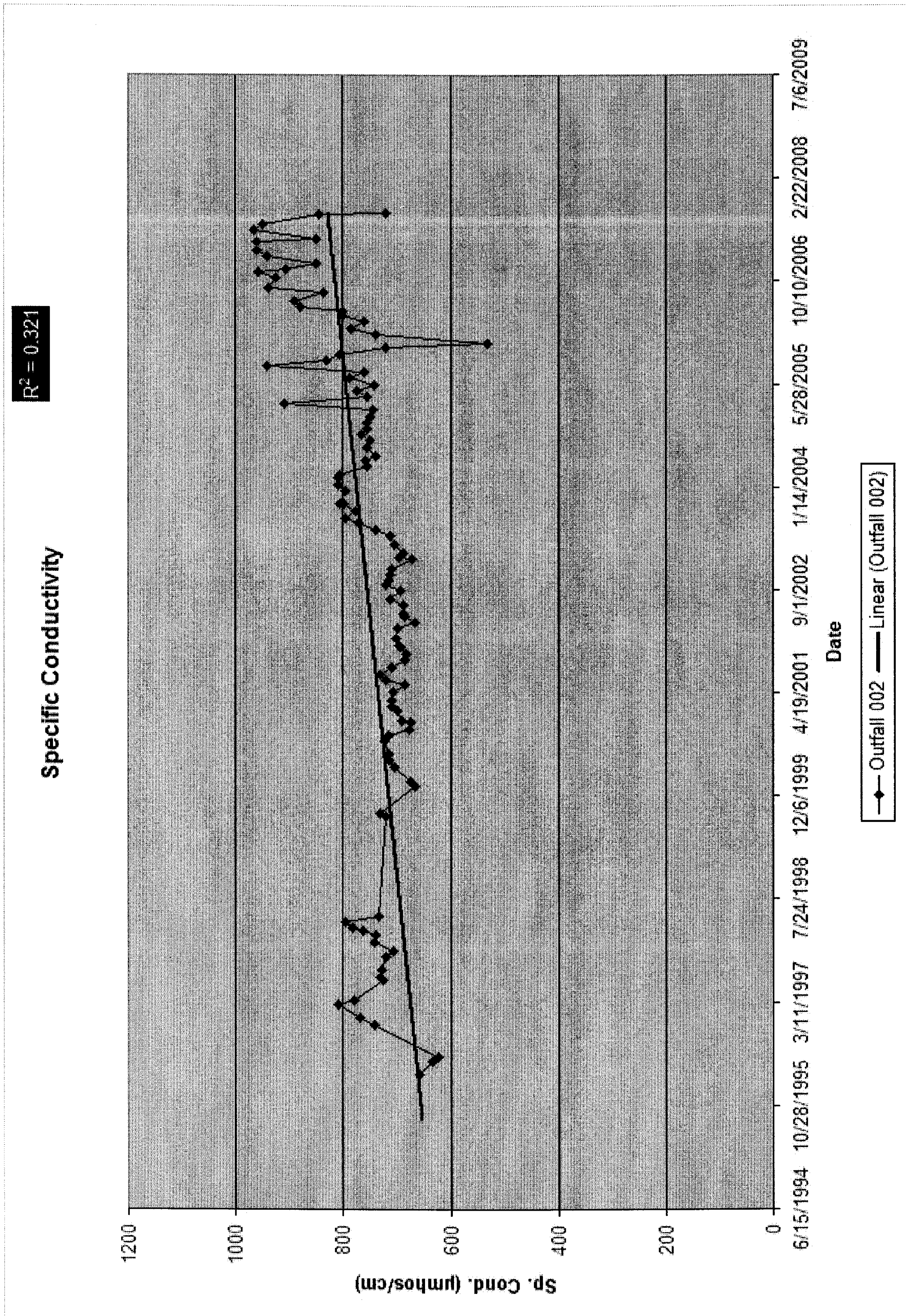

Dissolved Calcium
R2 = 0.7014
D-Ca (mg/L)
120
100
80
60
40
20
0
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
Date
LOF-1
Linear (LOF-1)


Total Hardness
Hardness (mg/L)
600
500
400
300
200
100
0
Date
5/1/1986
1/25/1989
10/22/1991
7/18/1994
4/13/1997
1/8/2000
10/4/2002
6/30/2005
3/26/2008
12/21/2010
R² = 0.7768
R² = 0.6054
R² = 0.6682
LOF-1
UPF-1
SP-58
Linear (LOF-1)
Linear (UPF-1)
Linear (SP-58)


Dissolved Sodium
R² = 0.0442
D-Na (mg/L)
0
1
2
3
4
5
6
7
8
10/28/1995
3/11/1997
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date
BCF
Linear (BCF)


Specific Conductivity
R^2 = 0.321
Sp. Cond. (µmhos/cm)
1200
1000
800
600
400
200
0
6/15/1994
10/28/1995
3/11/1997
7/24/1998
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
7/6/2009
Date
Outfall 002
Linear (Outfall 002)

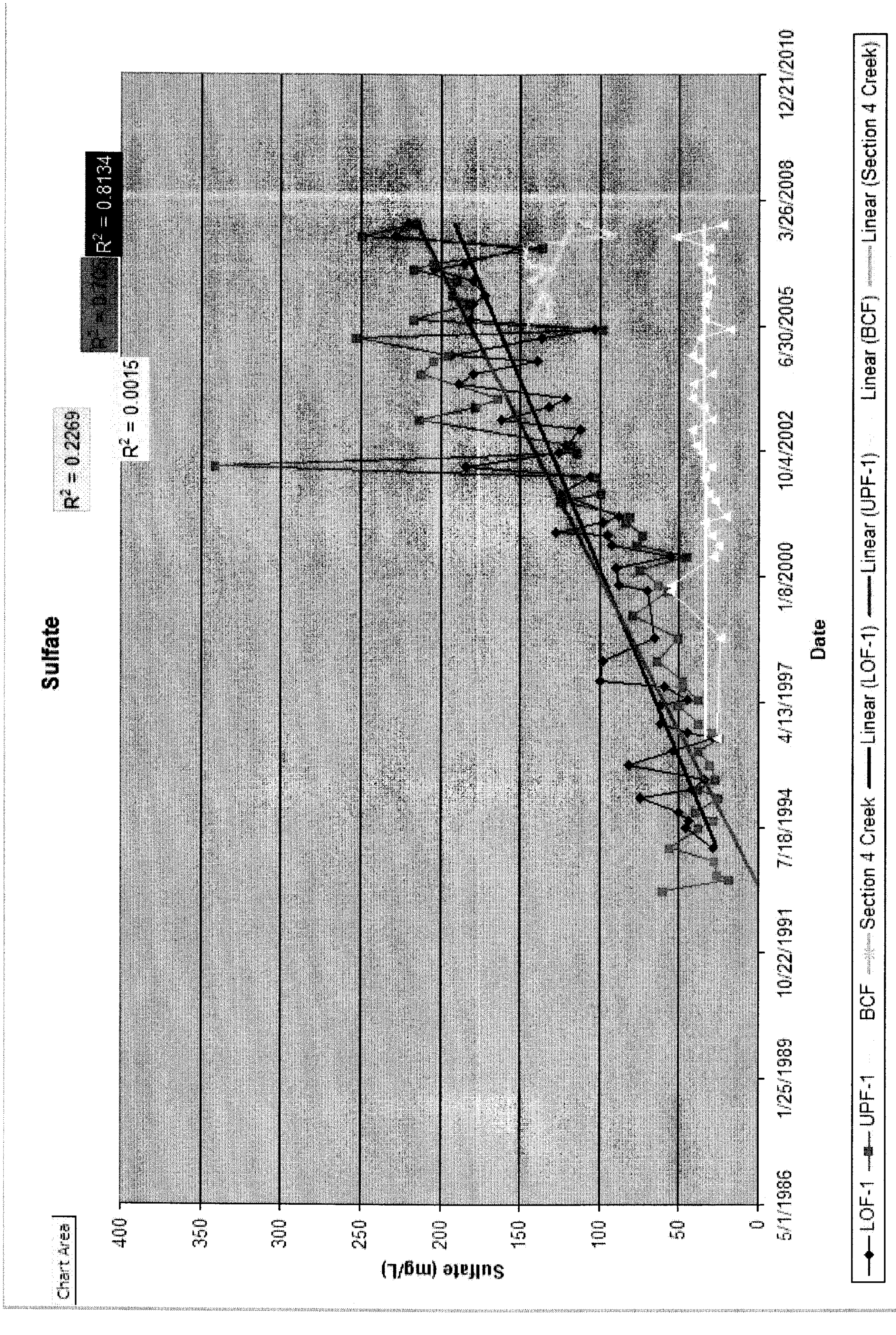
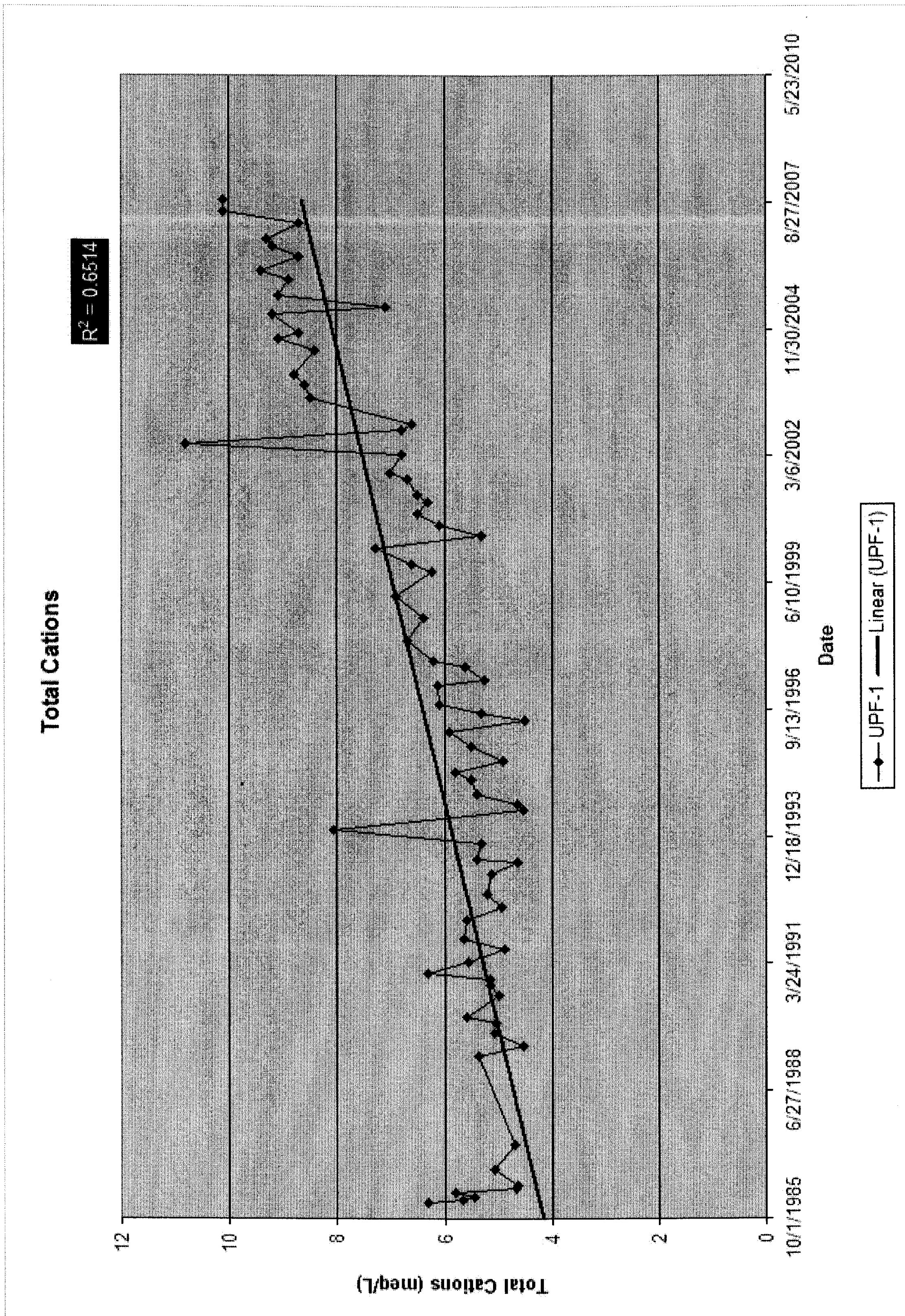
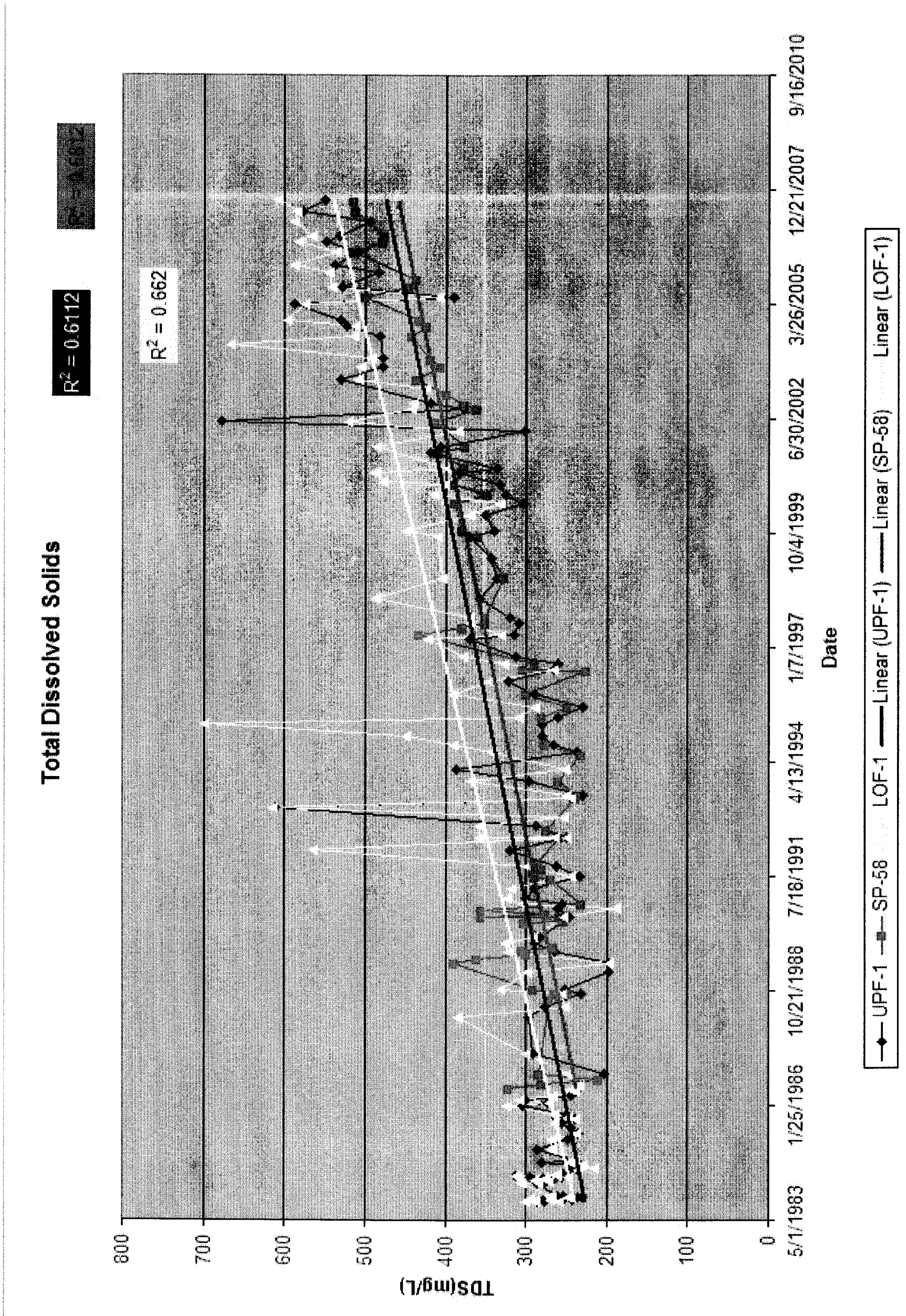


Chart Area
Sulfate
Sulfate (mg/L)
400
350
300
250
200
150
100
50
0
5/1/1986
1/25/1989
10/22/1991
7/18/1994
4/13/1997
1/8/2000
10/4/2002
6/30/2005
3/26/2008
12/21/2010
Date
R² = 0.2269
R² = 0.0015
R² = 0.8134
LOF-1
UPF-1
BCF
Section 4 Creek
Linear (LOF-1)
Linear (UPF-1)
Linear (BCF)
Linear (Section 4 Creek)


Total Cations
R² = 0.6514
Total Cations (meq/L)
0
2
4
6
8
10
12
10/1/1985
6/27/1988
3/24/1991
12/18/1993
9/13/1996
6/10/1999
3/6/2002
11/30/2004
8/27/2007
5/23/2010
Date
UPF-1
Linear (UPF-1)


Total Dissolved Solids
R² = 0.6112
R² = 0.662
TDS(mg/L)
800
700
600
500
400
300
200
100
0
5/1/1983
1/25/1986
10/21/1988
7/18/1991
4/13/1994
1/7/1997
10/4/1999
6/30/2002
3/26/2005
12/21/2007
9/16/2010
Date
UPF-1
SP-58
LOF-1
Linear (UPF-1)
Linear (SP-58)
Linear (LOF-1)