WATER QUALITY MEMORANDUM

Utah Coal Regulatory Program

February 29, 2008

TO: Internal File

THRU: Daron Haddock, Permit Supervisor

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

RE: 2007 Third Quarter Water Monitoring, Canyon Fuel Company, LLC, SUFCO Mine, C/041/0002-WQ07-3 Task ID #2607

The SUFCO Mine is an operating longwall mine. Current operations are in the Quitchupah and Muddy Tracts. Water monitoring requirements can be found in Section 7.3.1.2 of the MRP, especially Tables 7-2, 7-3, 7-4, 7-5, and 7-5A. Page 7-48 contains the important statement that (non Box-Canyon, non-UPDES) "monitoring sites are sampled three times per year," meaning the second, third, and fourth quarters.

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

Springs

The MRP requires the Permittee to monitor 25 springs during the second 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 monitor16 streams during the second quarter.

The Permittee submitted all required samples for the stream sites.

Wells

The MRP requires the Permittee to monitor 9 wells during the second quarter.

The Permittee submitted all required samples for the wells.

UPDES

The UPDES Permit/MRP require bi-weekly monitoring of 3 outfalls: 001, mine water discharge to Pine Canyon; 002, sedimentation pond discharge to Pine Canyon; and 003, the mine water discharge to the North Fork of Quitchupah Creek.

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 ☒

Well WRDSB-5 did not have enough water in it to perform a full laboratory analysis. The Permittee submitted field parameters for the well.

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

Mining Related Flow Reductions

Pines 105 (North Water Spring) stopped flowing immediately after undermining in late 2005/early 2006. The water table was lowered into the alluvium, stopping flow to the surface, but total flow out of the subwatershed has remained constant. Canyon Fuel Company has put into action a plan for temporary water replacement, and has been studying the condition of the flow system at Pines 105. They are trying to find the best way to restore flow to Pines 105, and plan to implement a collection system that will take water from the alluvium back to the surface at Pines 105 in the spring of 2008. Attempts to place a grout curtain in the alluvium, damming up the water, and causing it to express at the surface have not been successful to date, but there have been no "high flow" periods since they were installed, so success cannot be properly evaluated yet. SUFCO will place a collection system in the tributaries to Pines 105, piping the water in the alluvium so that it expresses at the Pines 105 site as soon as practicable this summer. If the collection system is successful, SUFCO will install similar systems at the other Pines Tract springs. SUFCO has been diligent in their efforts to mitigate the situation.

SUFCO began monitoring Pines 310 (lower) and 311 as part of their investigation of and effort to mitigate the water table drop at Pines 105. Pines 310 and 311 were undermined in late 2006, and no flow has been recorded at either since September 2006. Just as it did at Pines 105, the water table seems to have dropped into the alluvium in this area, keeping it from expressing at the surface. The water flowing out of the subwatershed has remained constant, so no water is actually being lost. The mitigation efforts related to Pines 105 include the Pines 310 and 311 areas.

At Pines 214 flow remains low, and conductivity high since undermining in 2003. However, the flow seems to track well with both the Palmer Hydrologic Drought Index (PHDI), and Surface Water Supply Index (SWSI). A good wet period (hopefully this spring) will be a better measure of whether the flow has been impacted by mining.

At Pines 303 flow remains low since undermining in 2001. However, the flow here also seems to track well with both the Palmer Hydrologic Drought Index (PHDI), and Surface Water Supply Index (SWSI). A good wet period (hopefully this spring) will be a better measure of whether the flow has been impacted by mining.

Several parameters at Pines 106 have been increasing since it was undermined in the winter of 2004-2005. So far, these changes have not diminished the water quality in relation to its use. The Division will continue to scrutinize the quality changes at Pines 106, but no action is necessary at this time.

Parameters Outside of Two Standard Deviations from the Mean

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
Pines 106	Total Cations	6.2 meq/L	3.11	4.60 meq/L
Pines 106	Dissolved Calcium	72.7 mg/L	4.12	50.63 mg/L
Pines 106	Dissolved Magnesium	26 mg/L	3.94	18.91 mg/L
Pines 106	Total Hardness	289 mg/L	3.83	206.42 mg/L
Pines 106	Total Dissolved Solids	396 mg/L	4.16	259.10 mg/L
Pines 106	Specific Conductivity	520 µmhos/cm	2.01	399.9 µmhos/cm
Pines 106	Sulfate	117 mg/L	4.84	42.38 mg/L
SUFCO 006	Bicarbonate	128 mg/L	2.35	313.58 mg/L
SUFCO 006	Bicarbonate as $CaCO_3$	105 mg/L	4.10	213.86 mg/L
SUFCO 006	Cation/Anion Balance	5.9 %	3.07	1.86 %
SUFCO 006	Carbonate	79 mg/L	5.05	12.26 mg/L
01-8-1	Depth	1641.62 feet	4.23	1509.50 feet
UT-0022918-002 – Sep 6	Flow	70.2 gpm	2.69	10.06 gpm
UT-0022918-003 – July 3	pH	7.70	2.11	7.02
UT-0022918-003 – July 16	pH	7.73	2.21	7.02
UT-0022918-003 – Aug 7	pH	7.75	2.27	7.02
UT-0022918-003 – Aug 30	pH	7.74	2.24	7.02
UT-0022918-003 – Sep 6	pH	7.82	2.49	7.02

The bicarbonate as $CaCO_3$, and as HCO_3 was unusually low at SUFCO 006; while the

carbonate as CO_3 was unusually high. The correlation between total alkalinity and bicarbonate is 0.937, and carbonate is usually absent. The alkalinity is usually bicarbonate based and the trends in the two values are expectedly similar, but this quarter some carbonate was present. Alkalinity and pH values remained within expected limits.

Well 01-8-1 has been dropping since SUFCO first began to monitor it in 2001. The trend is fairly strong, with an R^2 value of 0.6784. This well is located in an area that has not been mined yet, but the well is screened in the Upper Hiawatha coal seam, the actively mined seam. As the mine progresses, water is pumped out of the working areas, to make it possible to mine. This is beneficial to the mining process and is a common and necessary practice. The mine currently discharges approximately 3.2 million gallons per day. This is much less than last year's average of 4.3 million gallons per day. Most other wells monitored at the SUFCO mine dropped less than 10' over a period of ten or more years. This is an expected result of underground coal mining, and water levels will equilibrate when mining is ceased.

Dissolved calcium and dissolved magnesium both have fairly strong upward trends at Pines 106 (R^2= 0.5817, and 0.4858), which are very strong since undermining occurred (R^2= 0.9099, and 0.9239 since 11-04). Dissolved calcium has no real correlation to flow (R^2 = 0.05), and dissolved magnesium has aweak negative correlation to flow (R^2 = 0.12). The concentration of these two constituents has come down slightly since last quarter. There are no criteria for these metals, but they do contribute to water hardness. The total hardness at Pines 106 also has a somewhat strong upward trend (R^2 = 0.5308, 0.9235 since undermining), with no correlation to flow (R^2 = 0.08). The hardness at this site has always fallen into the hard (150-300 mg/l) classification, and continues to be in that range.

The September 6th flow recorded at Outfall 002 was attributed to a storm event

The pH at Outfall 003 was a bit higher than usual, but does not have a trend (R^2 = 0.0115), and is well within UPDES limits.

There is a weak upward trend in the specific conductivity at Pines 106 (R^2 = 0.3283), and a very strong upward trend since undermining (R^2 = 0.9363), with no real correlation to flow. There is no standard for specific conductivity, but it is closely related to total dissolved solids (TDS).

There is also a weak upward trend in total cations at Pines 106 (R^2 = 0.4373), with no real correlation to flow. The cation/anion balance is within the 5% recommended limit. The number of cations also relates to the total dissolved solids in the water sample.

There is a weak upward trend in TDS at Pines 106 (R^2 = 0.4475), and a very strong upward trend since 11-04 (R^2 = 0.9173, with a very weak negative correlation to flow (R^2 = 0.12). The TDS at Pines 106 has always been below the secondary drinking water standard of 500 mg/L and periods of high TDS have generally been followed by periods of low TDS,

but the TDS level does seem to be rising since undermining occurred.

There is a strong upward trend in sulfate at Pines 106 (R^2 = .634), a very strong upward trend since 11-04 (R^2 = 0.9475), and no real correlation to flow. 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 Pines 106 has always been less than 120 mg/L.

Reliability Checks

Many routine reliability checks fell outside of standard values:

Site	Reliability Check	Value Should Be...	Value is...
Pines 106	TDS/Conductivity	>0.55 & <0.75	0.76
Pines 106	Conductivity/Cations	>90 & < 110	84
Pines 106	K/(Na + K)	< 20%	28%
Pines 106	Na/(Na + Cl)	> 50%	23%
Pines 403	Conductivity/Cations	>90 & < 110	82
Pines 403	K/(Na + K)	< 20%	41%
Pines 403	Mg/(Ca + Mg)	< 40 %	60%
Pines 403	Na/(Na + Cl)	> 50%	22%
SUFCO 006	Cation/Anion Balance	<5%	5.43%
SUFCO 006	Conductivity/Cations	>90 & < 110	84
SUFCO 006	K/(Na + K)	< 20%	24%
SUFCO 006	Mg/(Ca + Mg)	< 40 %	53%
SUFCO 007	Conductivity/Cations	>90 & < 110	85
SUFCO 007	Na/(Na + Cl)	> 50%	48%
SUFCO 041	Conductivity/Cations	>90 & < 110	76
SUFCO 041	Mg/(Ca + Mg)	< 40 %	58%
SUFCO 041	Ca/ (Ca + SO4)	> 50 %	36%
SUFCO 041	Na/(Na + Cl)	> 50%	46%
SUFCO 042	TDS/Conductivity	>0.55 & <0.75	0.80
SUFCO 042	Conductivity/Cations	>90 & < 110	73
SUFCO 042	K/(Na + K)	< 20%	24%
SUFCO 042	Mg/(Ca + Mg)	< 40 %	56%
SUFCO 042	Ca/ (Ca + SO4)	> 50 %	42%
SUFCO 042	Na/(Na + Cl)	> 50%	46%
SUFCO 046	Conductivity/Cations	>90 & < 110	82
SUFCO 046	K/(Na + K)	< 20%	30%
SUFCO 046	Mg/(Ca + Mg)	< 40 %	49%
SUFCO 046	Na/(Na + Cl)	> 50%	25%

SUFCO 047A	Conductivity/Cations	>90 & < 110	84
SUFCO 047A	Mg/(Ca + Mg)	< 40 %	50%
SUFCO 047A	Ca/ (Ca + SO4)	> 50 %	49%
SUFCO 047A	Na/(Na + Cl)	> 50%	24%
Pines 100	TDS/Conductivity	>0.55 & <0.75	0.79
Pines 100	Conductivity/Cations	>90 & < 110	81
Pines 100	Na/(Na + Cl)	> 50%	20%
SUFCO 047	K/(Na + K)	< 20%	32%
SUFCO 047	Mg/(Ca + Mg)	< 40 %	44%
SUFCO 047	Na/(Na + Cl)	> 50%	27%
WRDS B-6	TDS/Conductivity	>0.55 & <0.75	0.89
WRDS B-6	Conductivity/Cations	>90 & < 110	69
WRDS B-6	Mg/(Ca + Mg)	< 40 %	58%
WRDS B-6	Ca/ (Ca + SO4)	> 50 %	41%
WRDS B-6	Na/(Na + Cl)	> 50%	9%
WRDS B-8	Conductivity/Cations	>90 & < 110	88
WRDS B-8	Na/(Na + Cl)	> 50%	17%

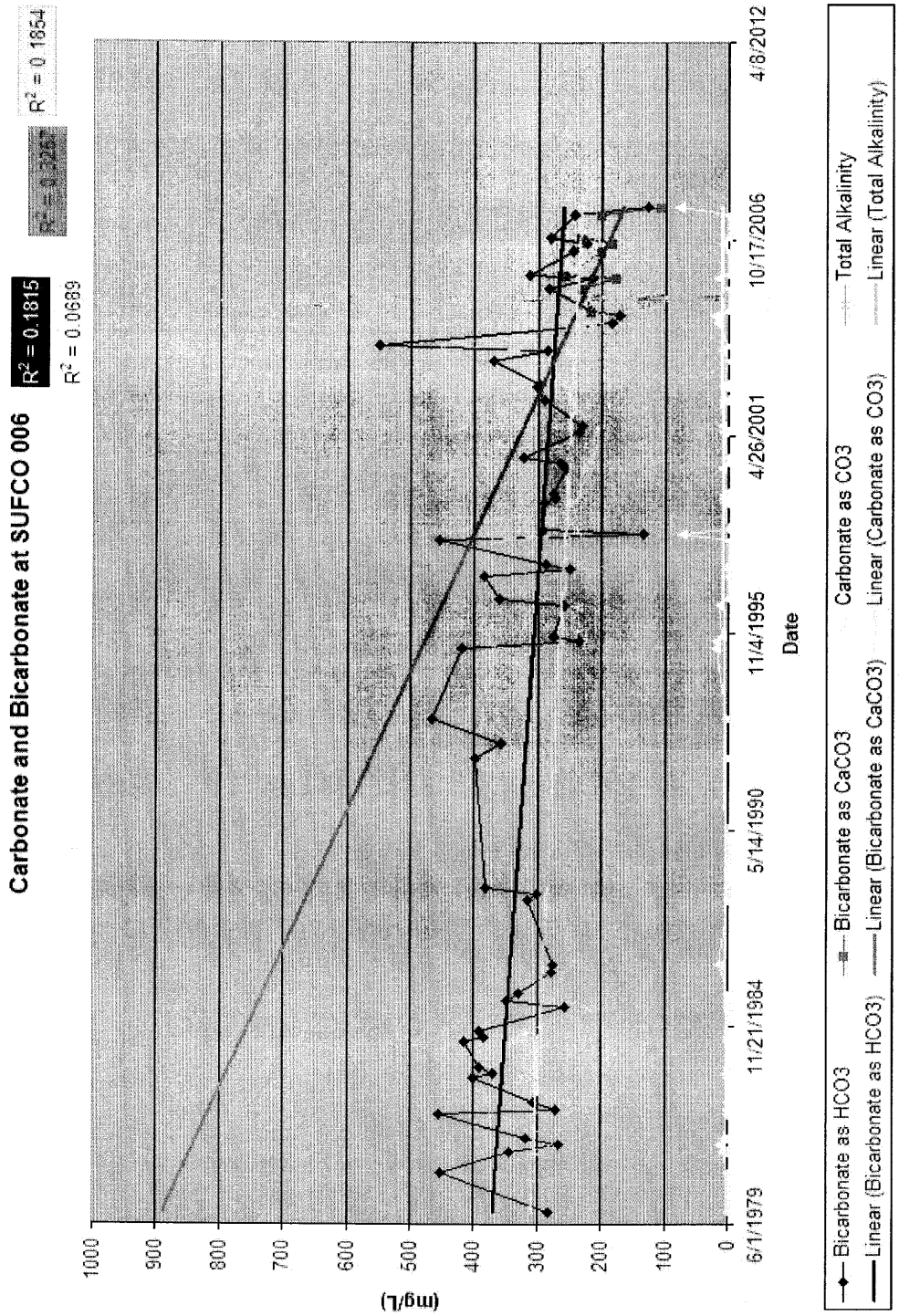
These inconsistencies do not necessarily mean that a sample is wrong, but it does indicate that something is unusual. An analysis and explanation of the inconsistencies by the Permittee would help to increase the Division's confidence in the samples. The Permittee should work with the lab to make sure 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.

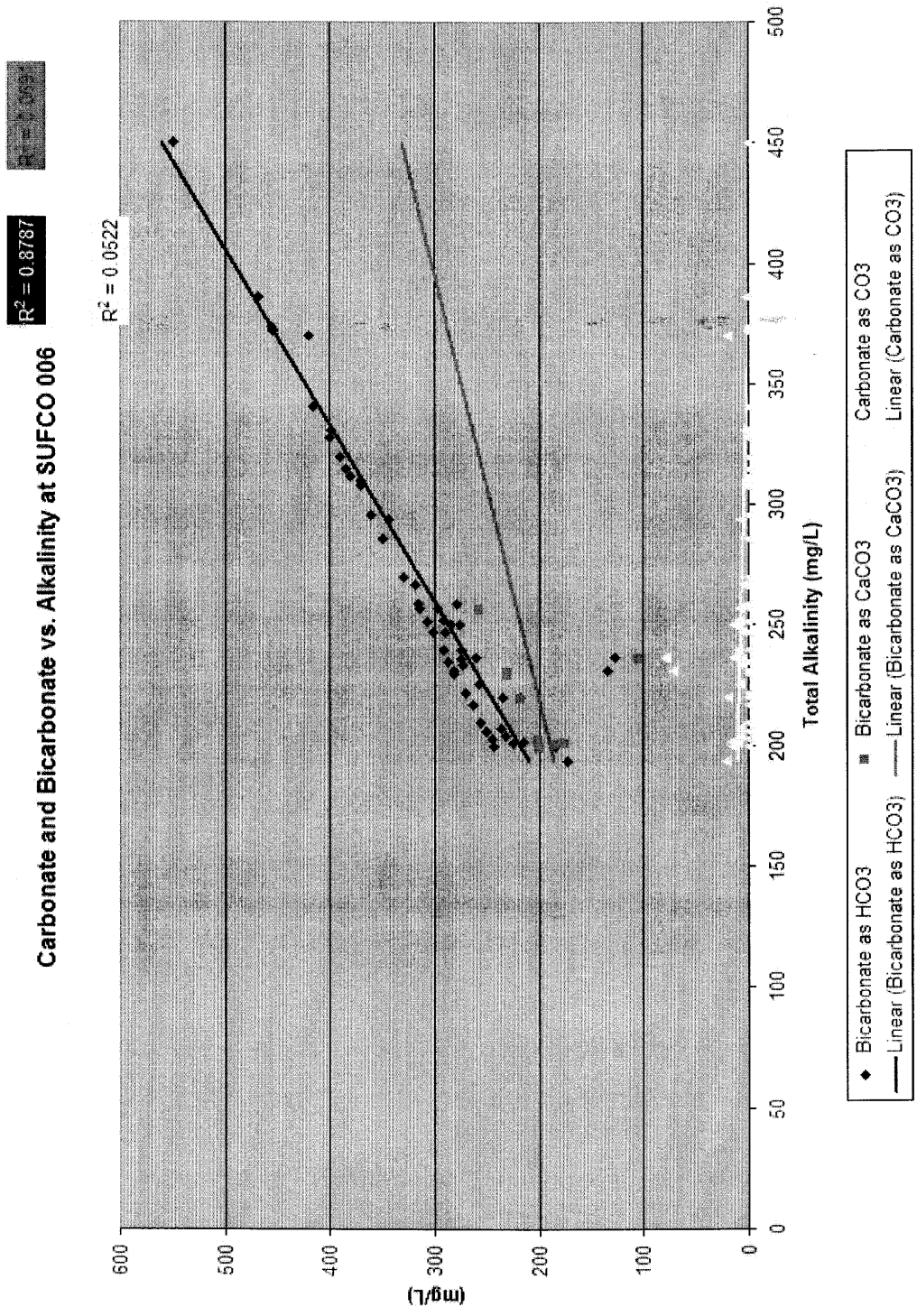
4. On what date does the MRP require a five-year re-sampling of baseline water data.

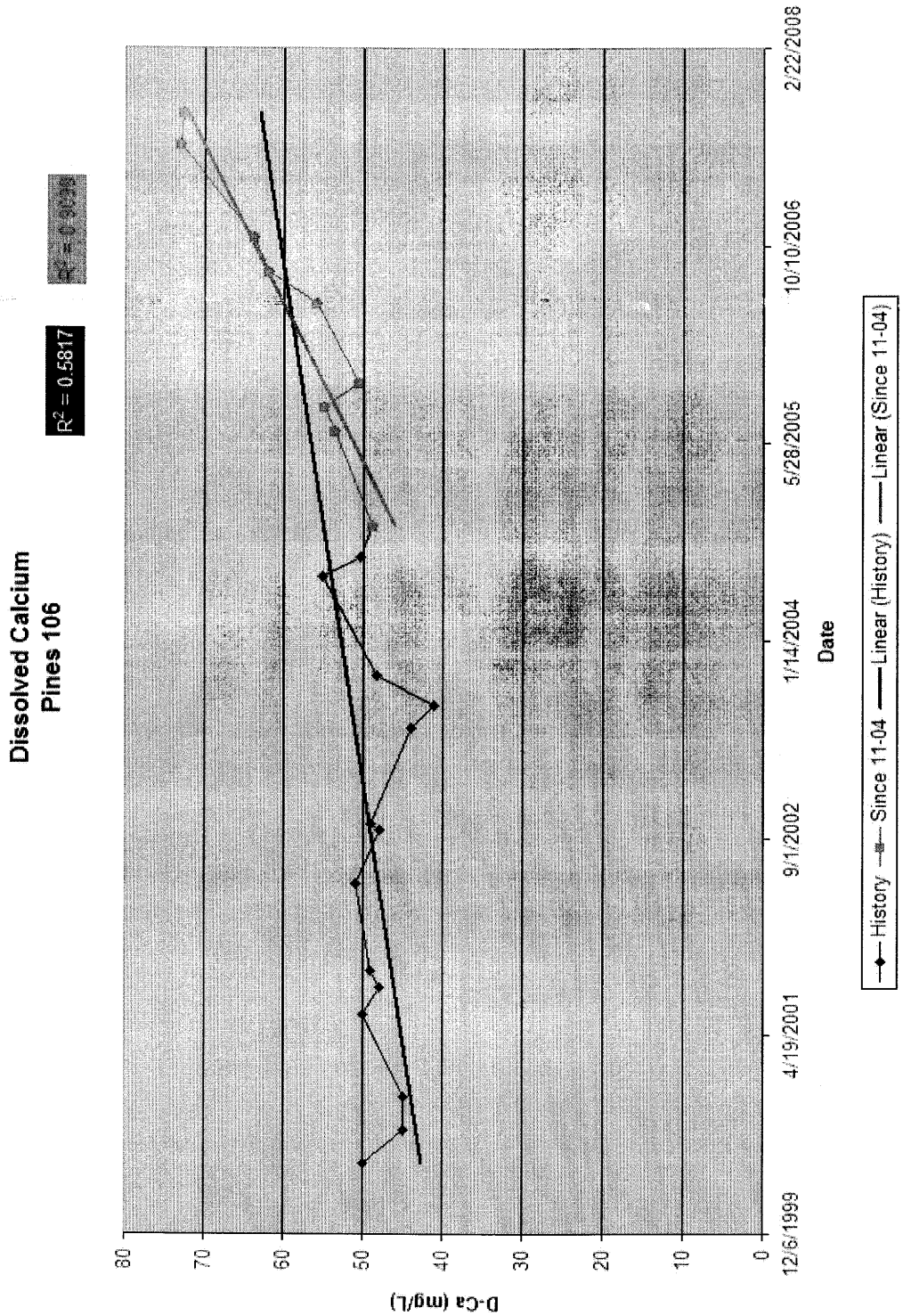
There is no commitment in the MRP to resample for baseline parameters.

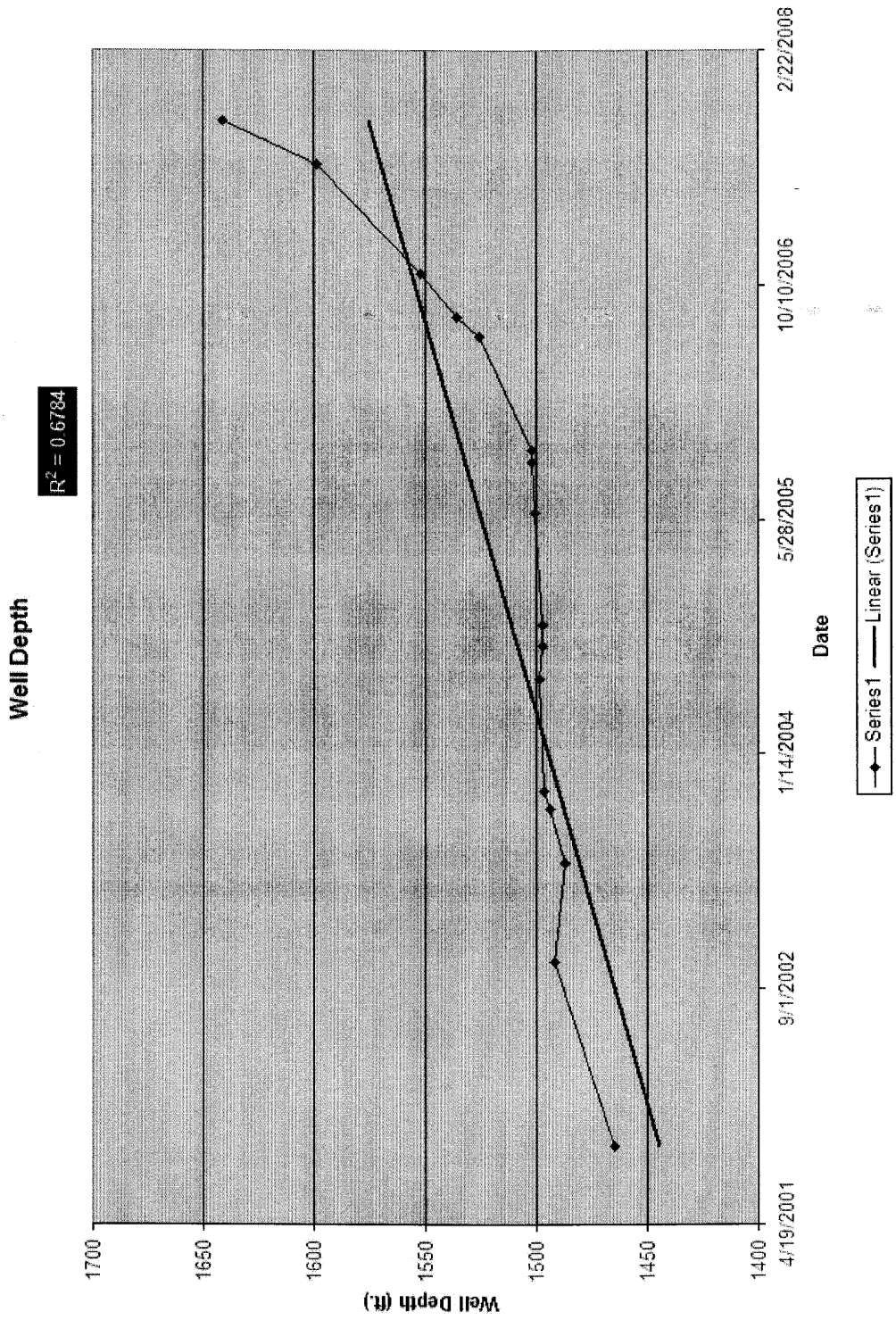
5. Based on your review, what further actions, if any, do you recommend?

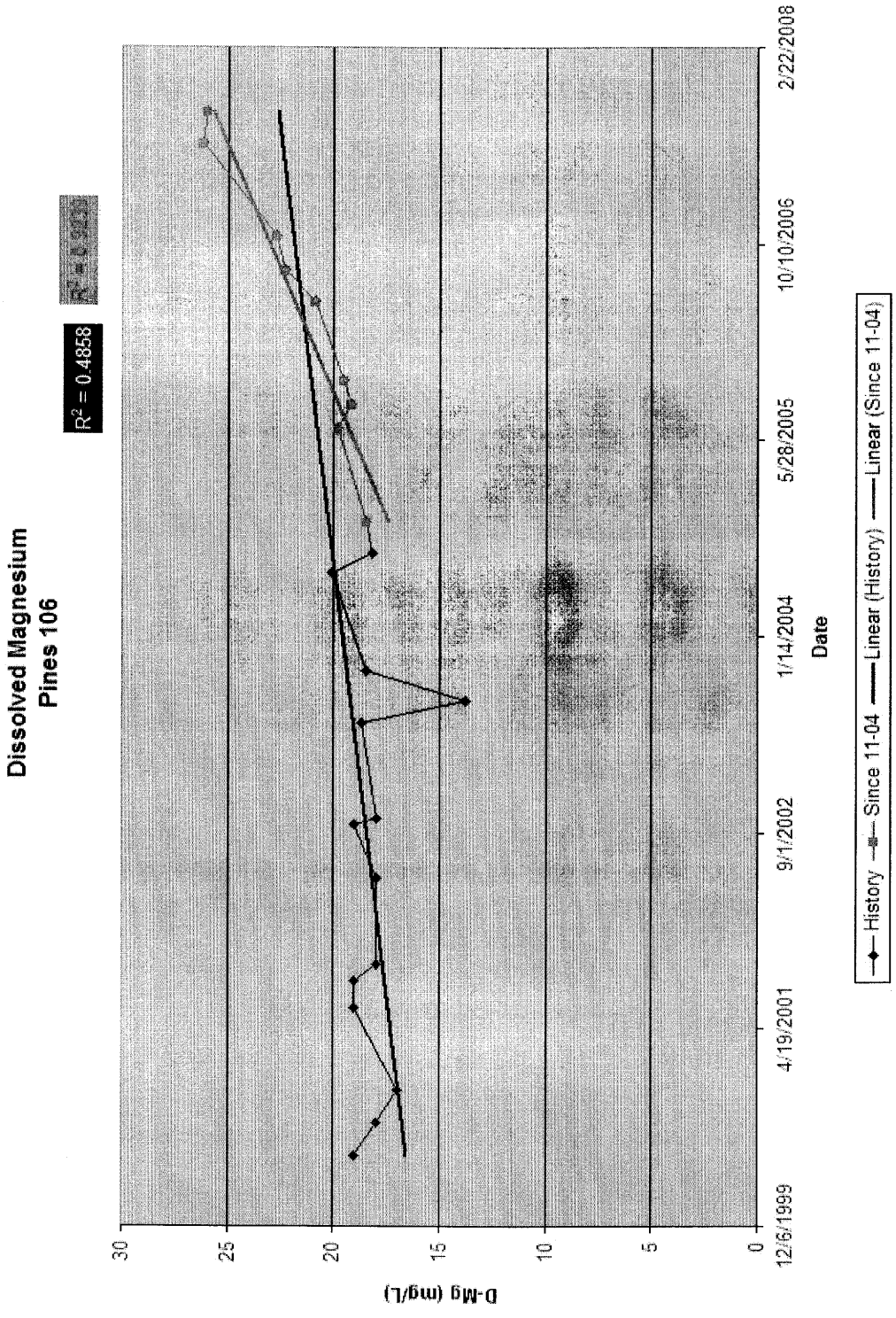
No further actions are necessary at this time. As described above, a separate action is underway concerning the Pines Springs.

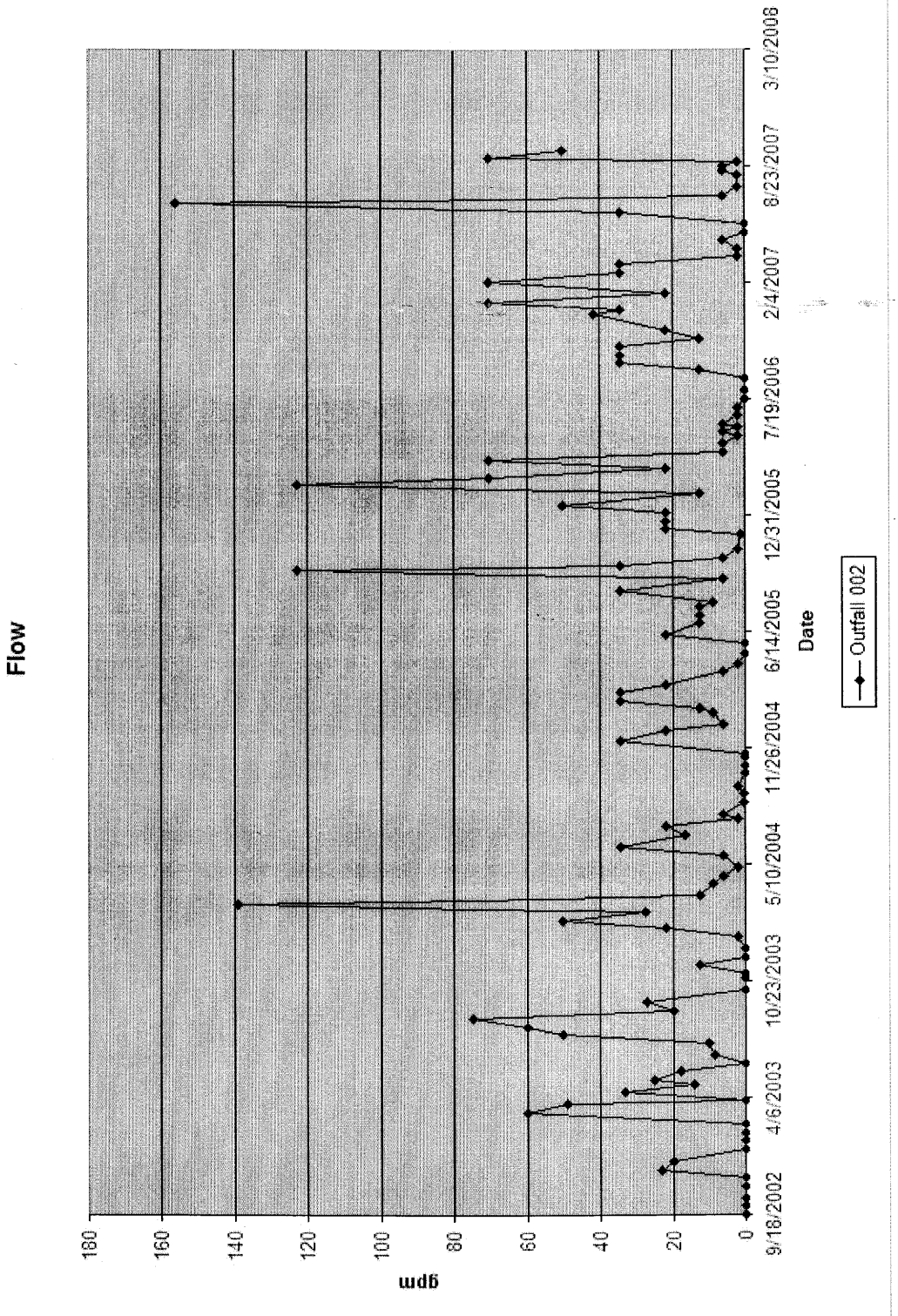

Carbonate and Bicarbonate at SUFCO 006
R² = 0.1815
R² = 0.0689
R² = 0.1654
(mg/L)
1000
900
800
700
600
500
400
300
200
100
0
6/1/1979
11/21/1984
5/14/1990
11/4/1995
4/26/2001
10/17/2006
4/8/2012
Date
Bicarbonate as HCO3
Linear (Bicarbonate as HCO3)
Bicarbonate as CaCO3
Linear (Bicarbonate as CaCO3)
Carbonate as CO3
Linear (Carbonate as CO3)
Total Alkalinity
Linear (Total Alkalinity)

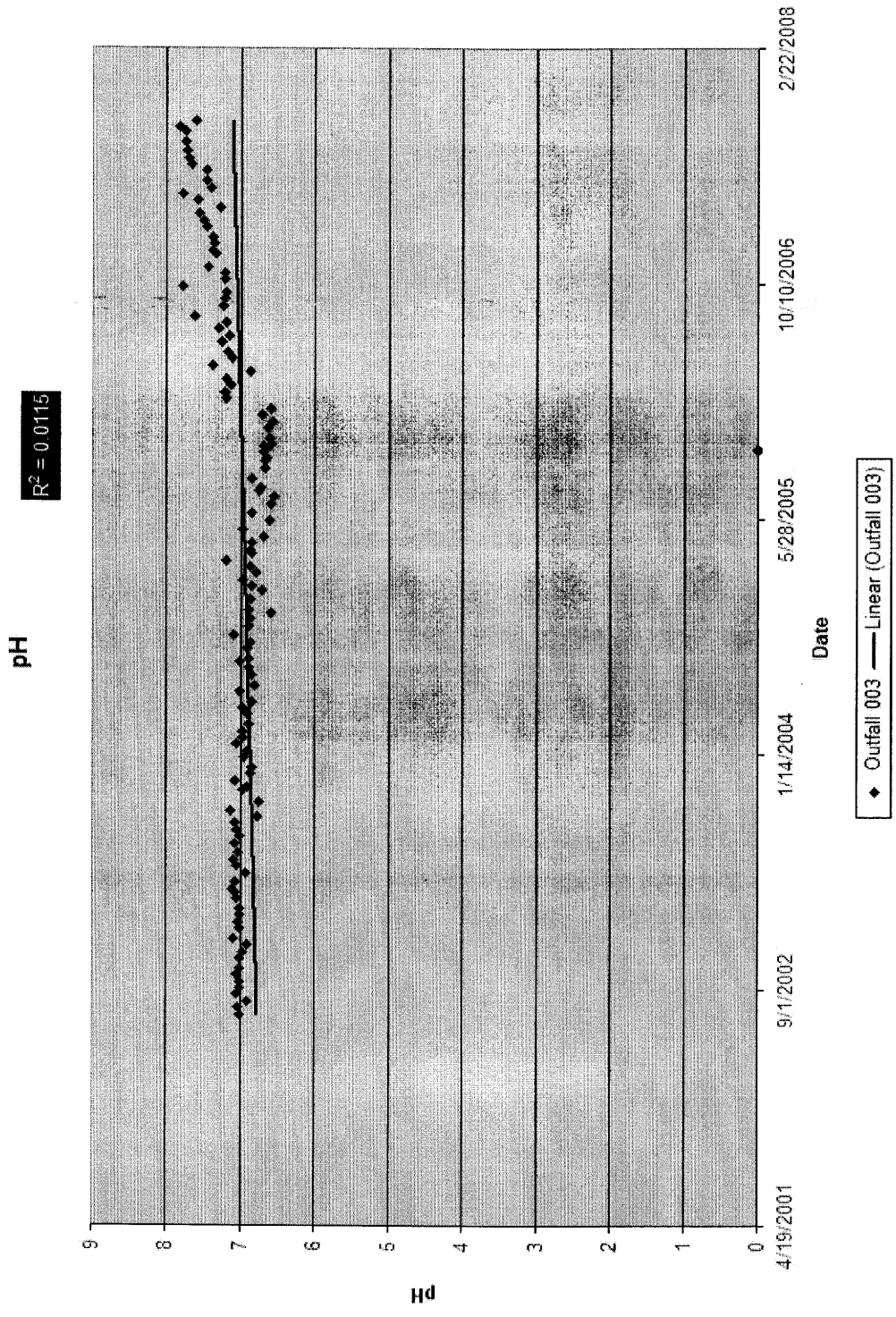

Carbonate and Bicarbonate vs. Alkalinity at SUFCO 006
R² = 0.8787
R² = 0.0522
(mg/L)
Total Alkalinity (mg/L)
0
50
100
150
200
250
300
350
400
450
500
600
Bicarbonate as HCO3
Linear (Bicarbonate as HCO3)
Bicarbonate as CaCO3
Linear (Bicarbonate as CaCO3)
Carbonate as CO3
Linear (Carbonate as CO3)

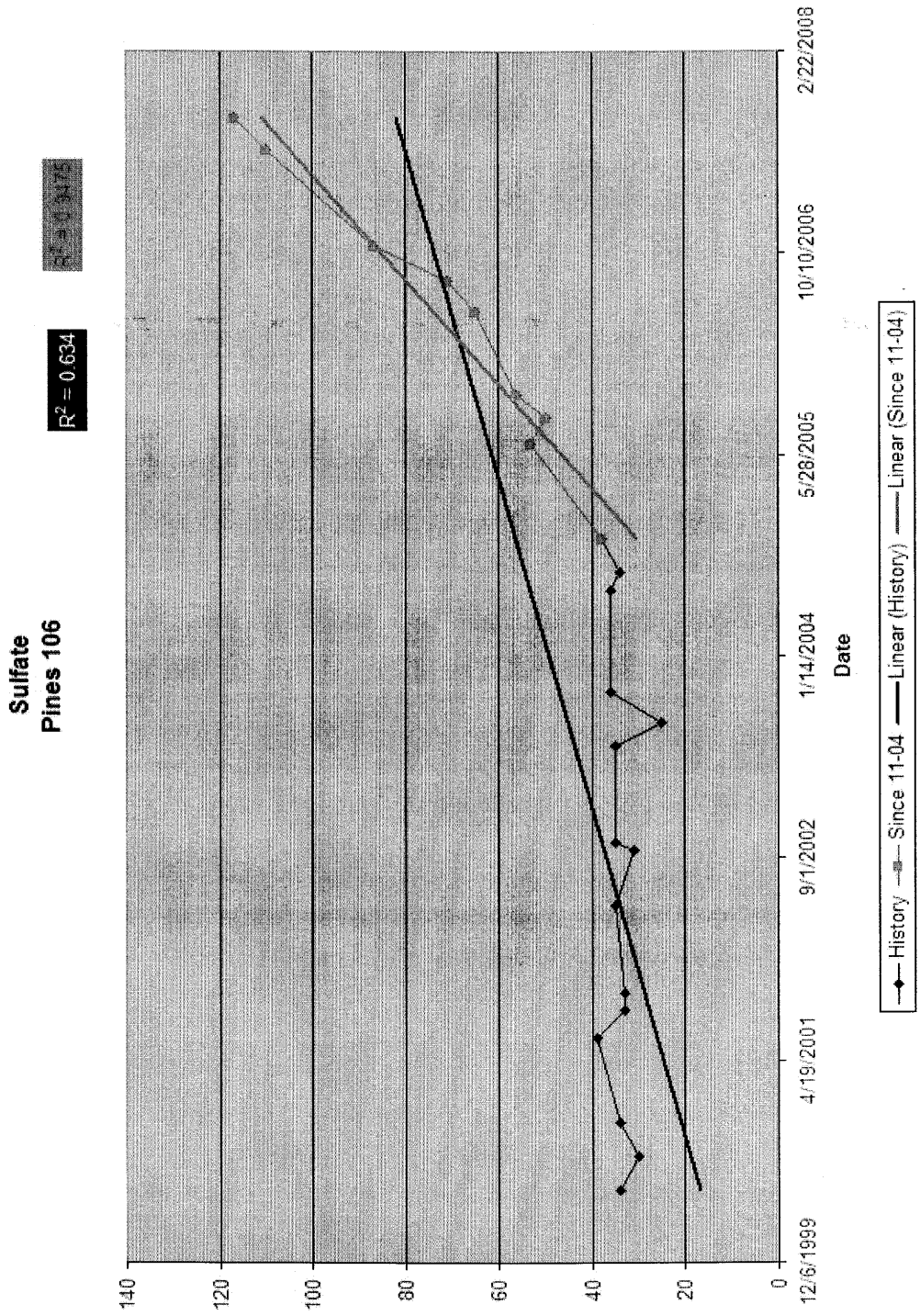

Dissolved Calcium
Pines 106
R² = 0.5817
R² = 0.9036
D-Ca (mg/L)
0
10
20
30
40
50
60
70
80
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)

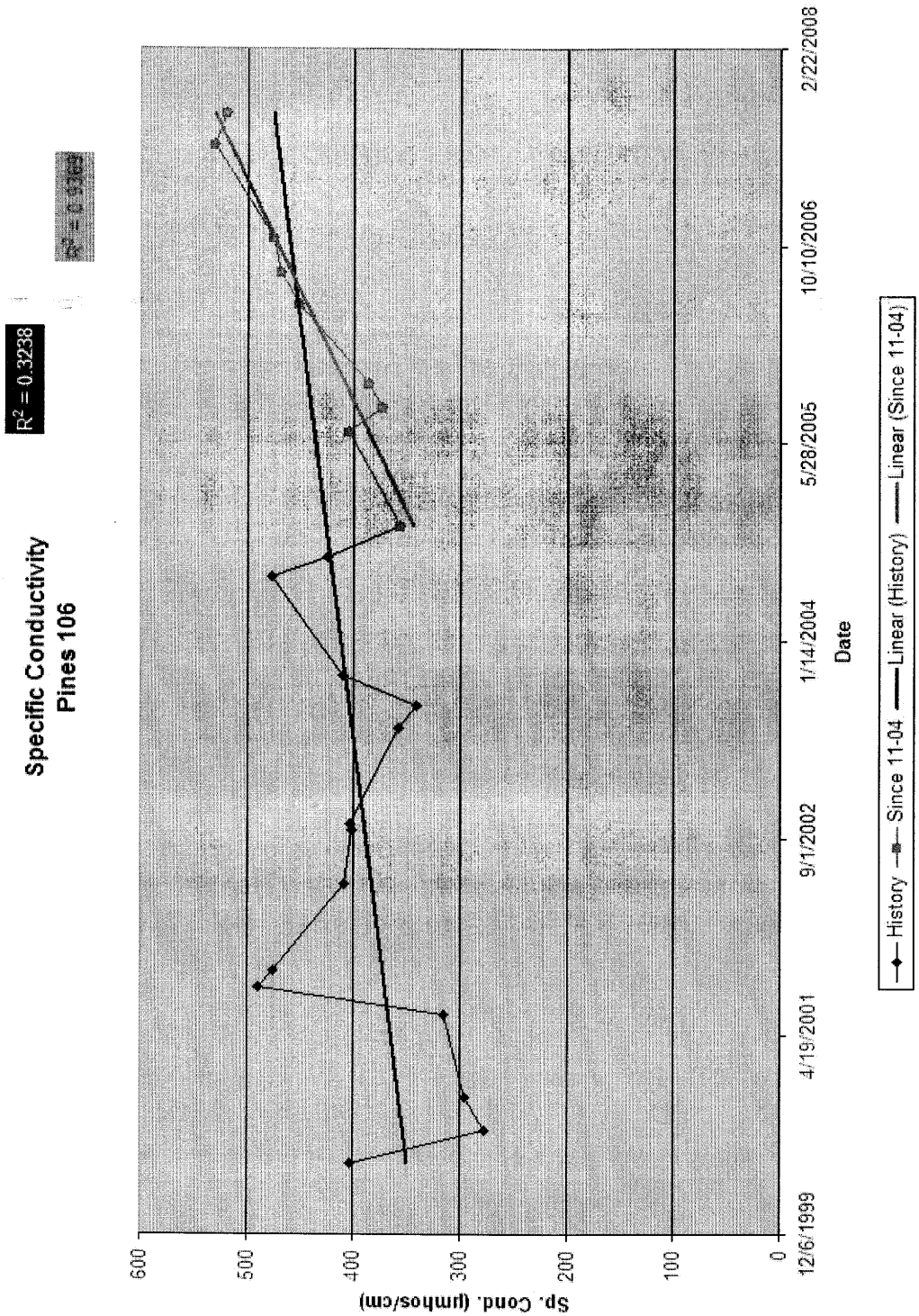

Well Depth
R^2 = 0.6784
Well Depth (ft.)
1700
1650
1600
1550
1500
1450
1400
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
Series1
Linear (Series1)

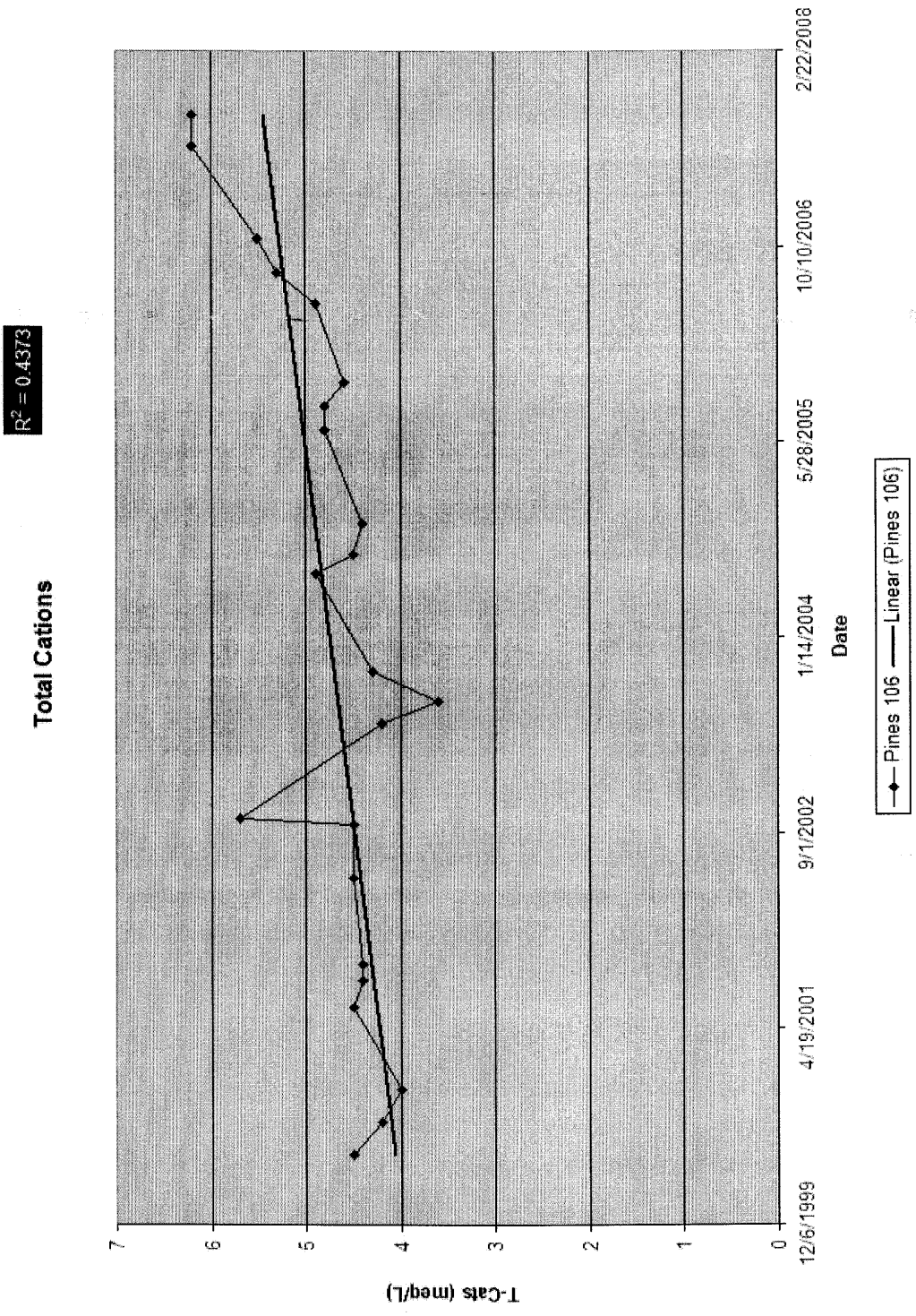

Dissolved Magnesium
Pines 106
R² = 0.4858
R² = 0.9991
D-Mg (mg/L)
30
25
20
15
10
5
0
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)

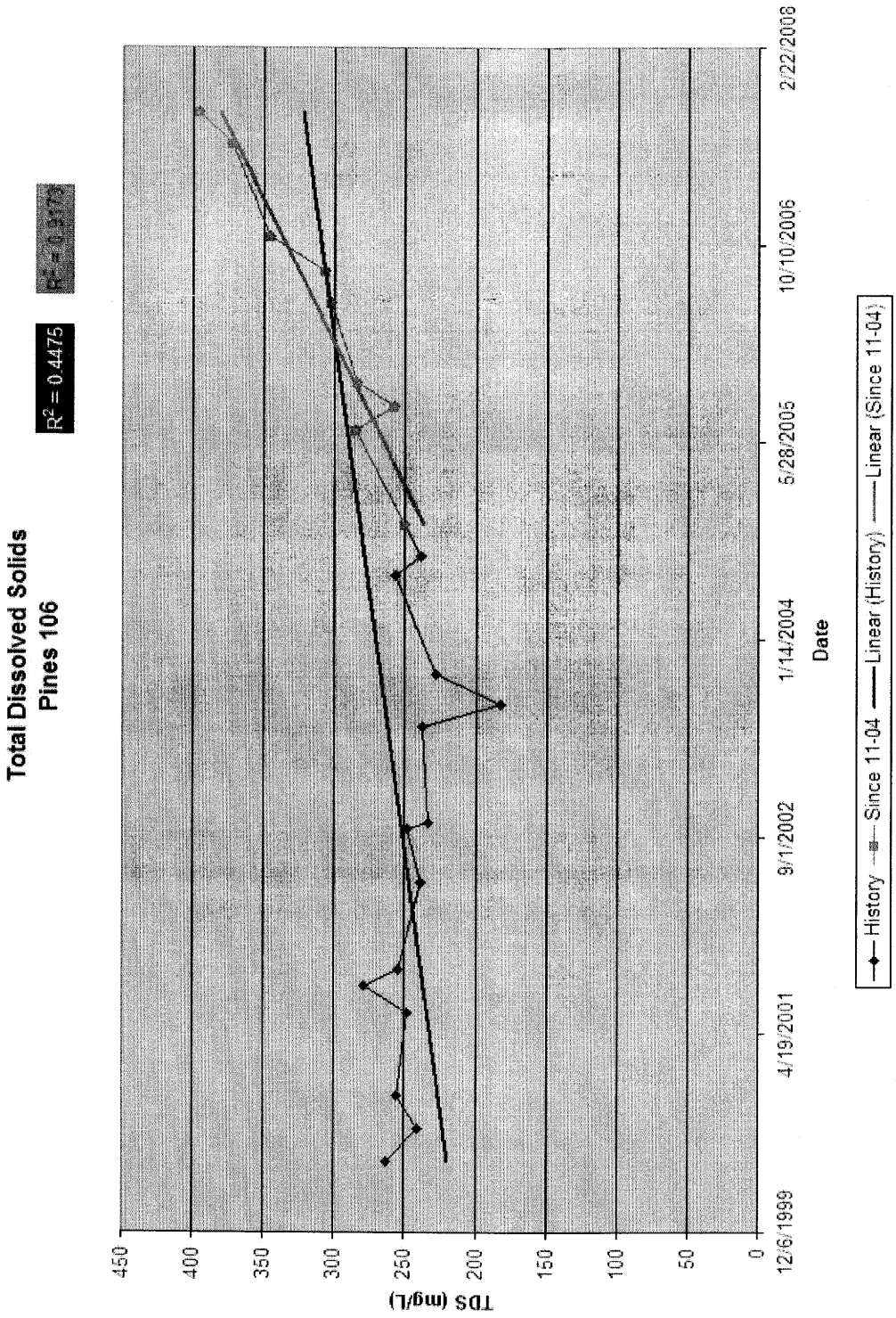

Flow
gpm
180
160
140
120
100
80
60
40
20
0
9/18/2002
4/6/2003
10/23/2003
5/10/2004
11/26/2004
6/14/2005
12/31/2005
7/19/2006
2/4/2007
8/23/2007
3/10/2008
Date
Outfall 002

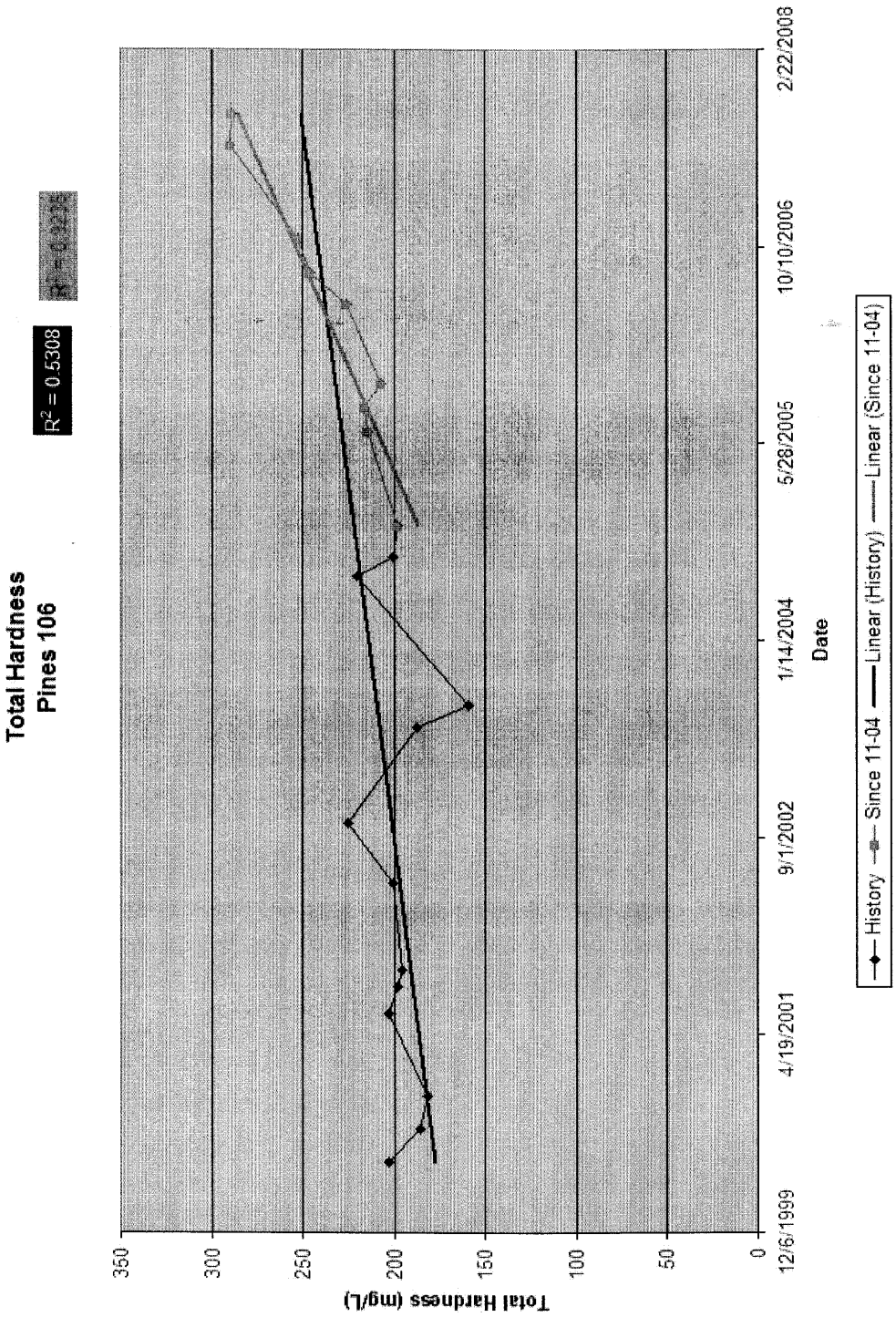

pH
R^2 = 0.0115
pH
0
1
2
3
4
5
6
7
8
9
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
Outfall 003
Linear (Outfall 003)


Sulfate
Pines 106
R² = 0.634
SO4 (mg/L)
0
20
40
60
80
100
120
140
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)


Specific Conductivity
Pines 106
R² = 0.3238
R² = 0.9368
Sp. Cond. (µmhos/cm)
600
500
400
300
200
100
0
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)


Total Cations
$R^2 = 0.4373$
T-Cats (meq/L)
0
1
2
3
4
5
6
7
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
Pines 106
Linear (Pines 106)


Total Dissolved Solids
Pines 106
R² = 0.4475
R² = 0.3173
TDS (mg/L)
450
400
350
300
250
200
150
100
50
0
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)


Total Hardness
Pines 106
R² = 0.5308
R² = 0.6334
Total Hardness (mg/L)
350
300
250
200
150
100
50
0
12/6/1999
4/19/2001
9/1/2002
1/14/2004
5/28/2005
10/10/2006
2/22/2008
Date
History
Since 11-04
Linear (History)
Linear (Since 11-04)