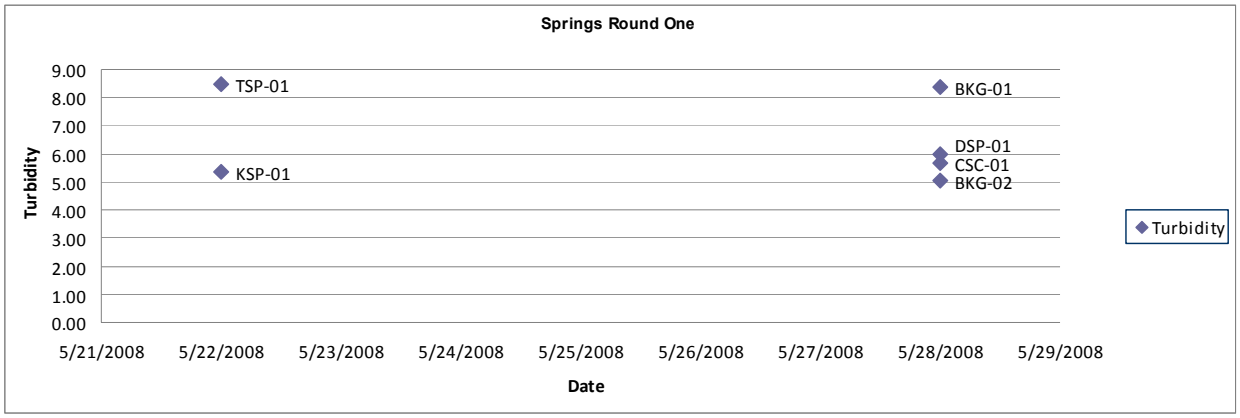
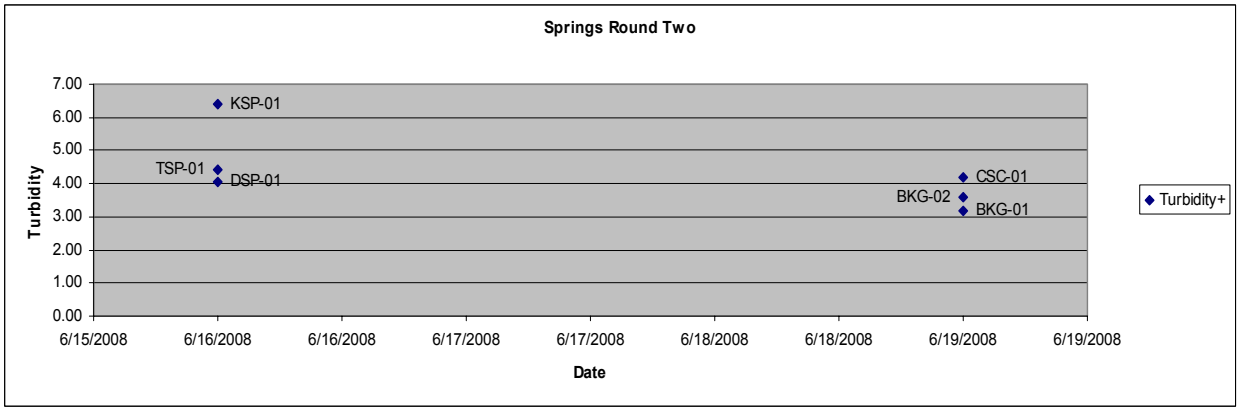
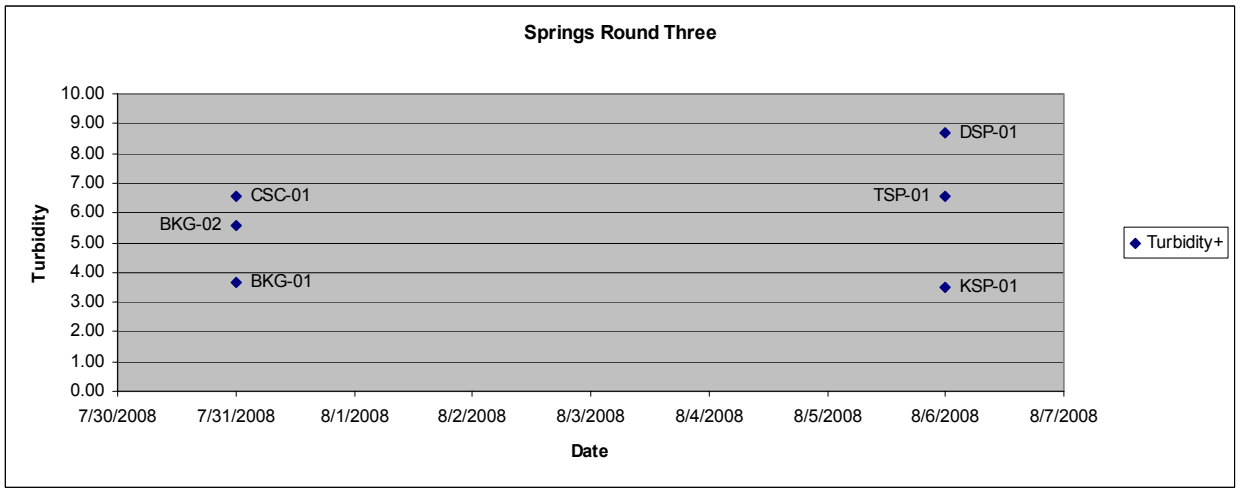
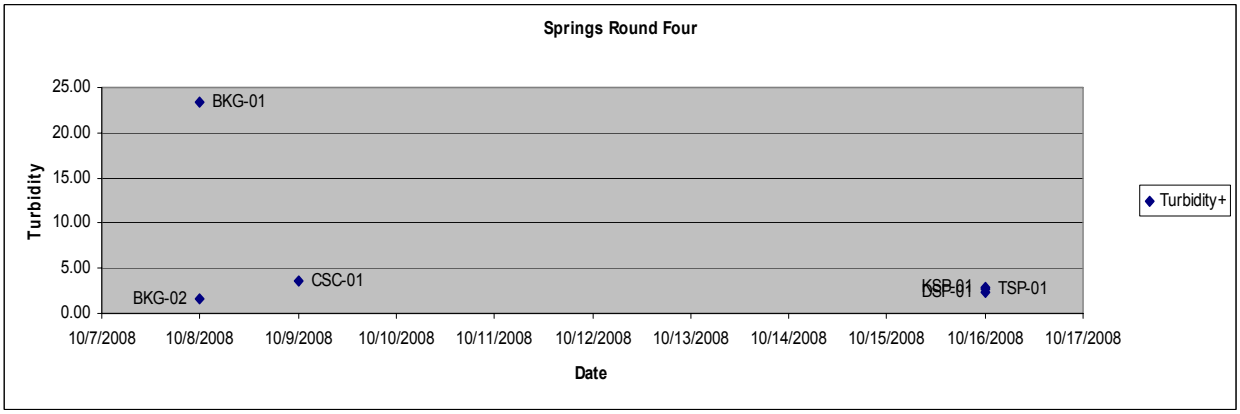
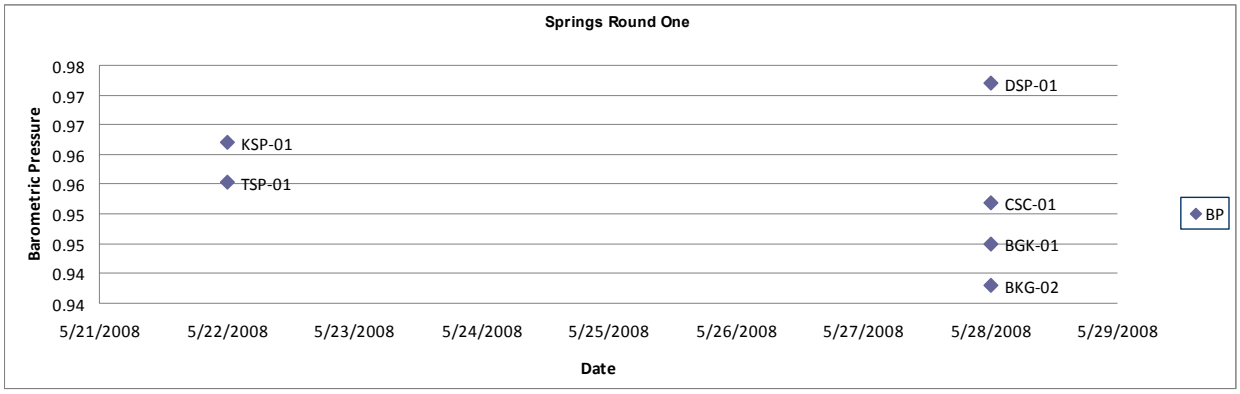
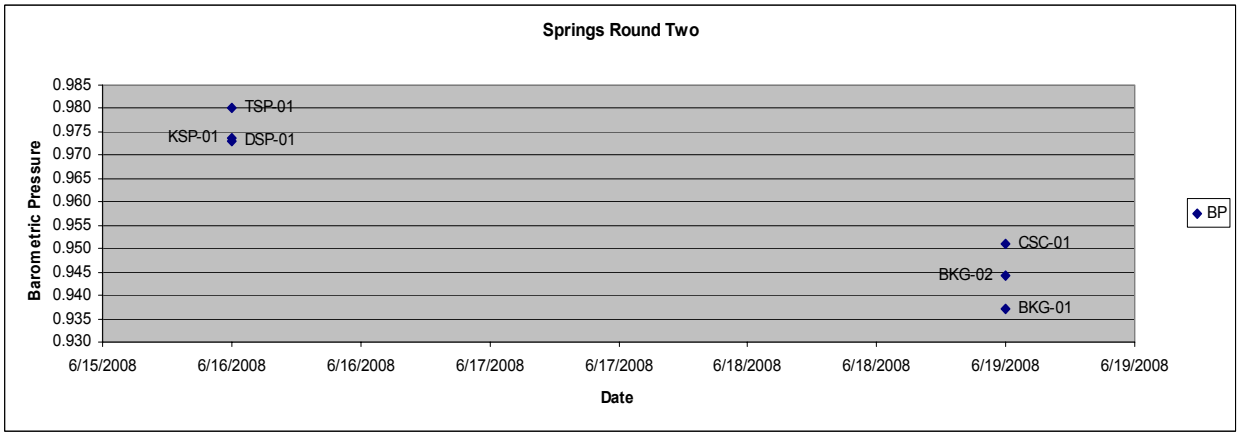

Springs Round One
Turbidity
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
TSP-01
KSP-01
BKG-01
DSP-01
CSC-01
BKG-02
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date
Turbidity

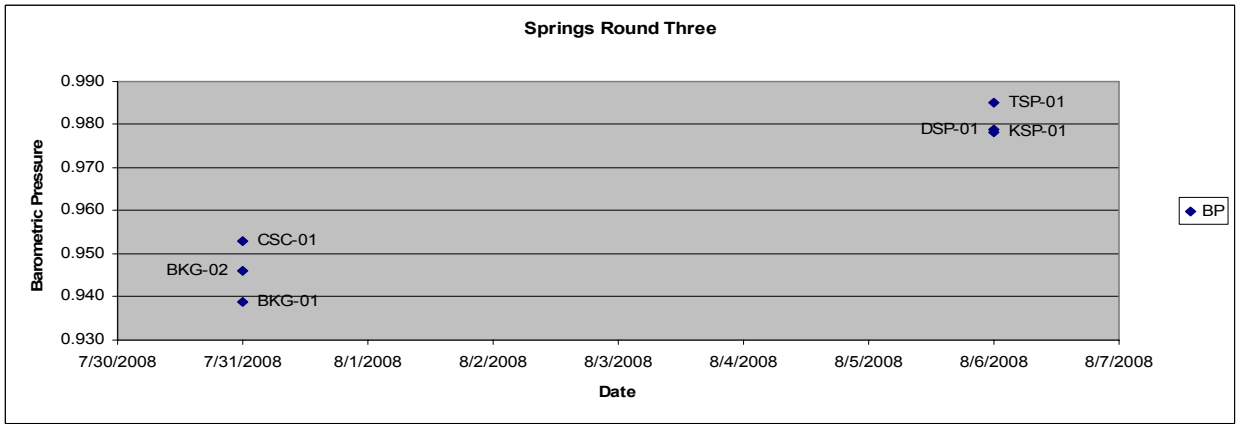

Springs Round Two
Turbidity
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
KSP-01
TSP-01
DSP-01
CSC-01
BKG-02
BKG-01
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
6/19/2008
6/19/2008
Date
Turbidity+

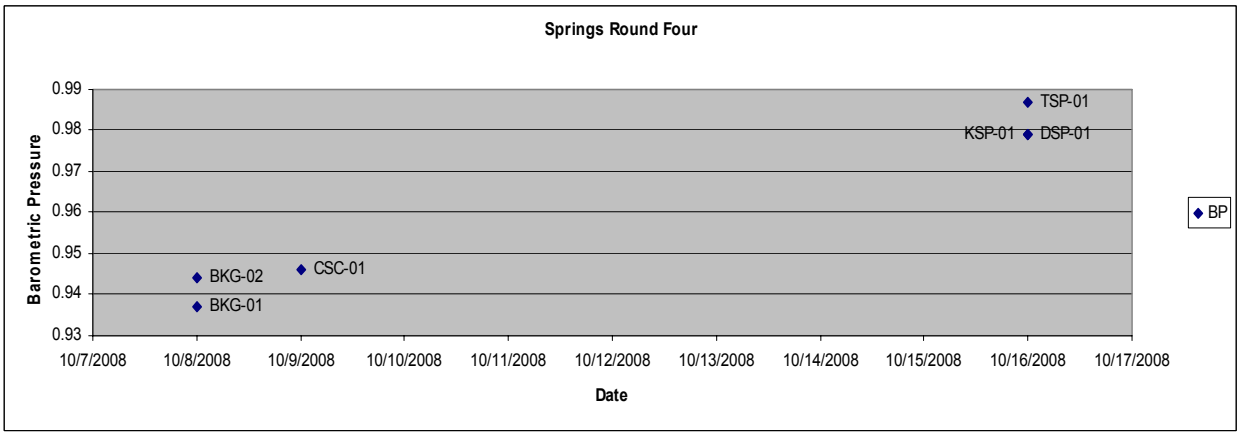

Springs Round Three
Turbidity
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DSP-01
CSC-01
TSP-01
BKG-02
BKG-01
KSP-01
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
Date
Turbidity+


Springs Round Four
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
BKG-01
CSC-01
BKG-02
KSP-01
DSP-01
TSP-01
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
10/17/2008
Date
Turbidity+

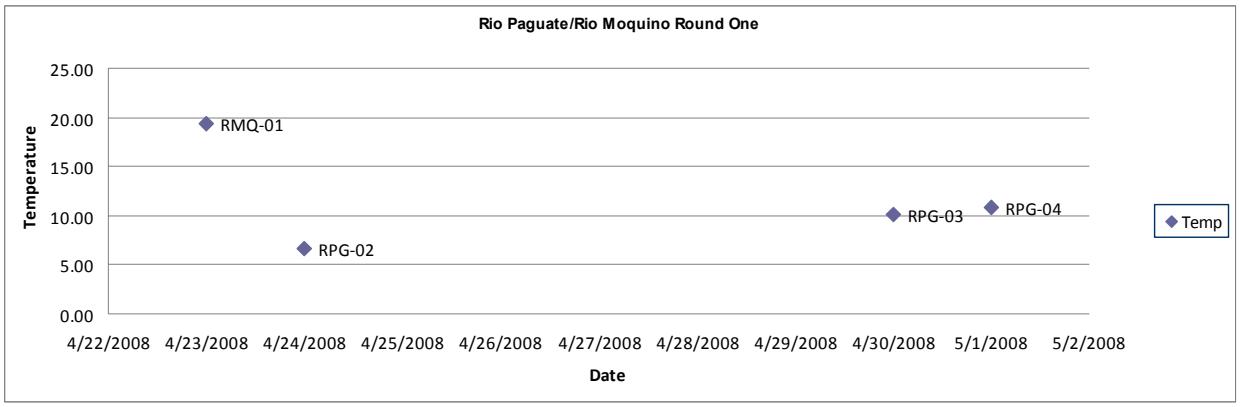

Springs Round One
Barometric Pressure
0.98
0.97
0.97
0.96
0.96
0.95
0.95
0.94
0.94
DSP-01
KSP-01
TSP-01
CSC-01
BGK-01
BKG-02
BP
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

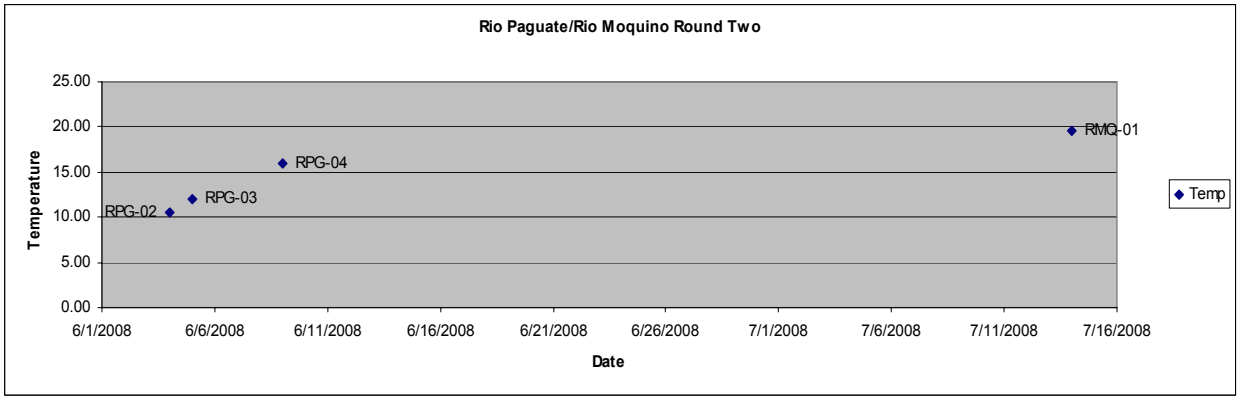

Springs Round Two
Barometric Pressure
0.985
0.980
0.975
0.970
0.965
0.960
0.955
0.950
0.945
0.940
0.935
0.930
TSP-01
KSP-01
DSP-01
CSC-01
BKG-02
BKG-01
BP
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
6/19/2008
6/19/2008
Date

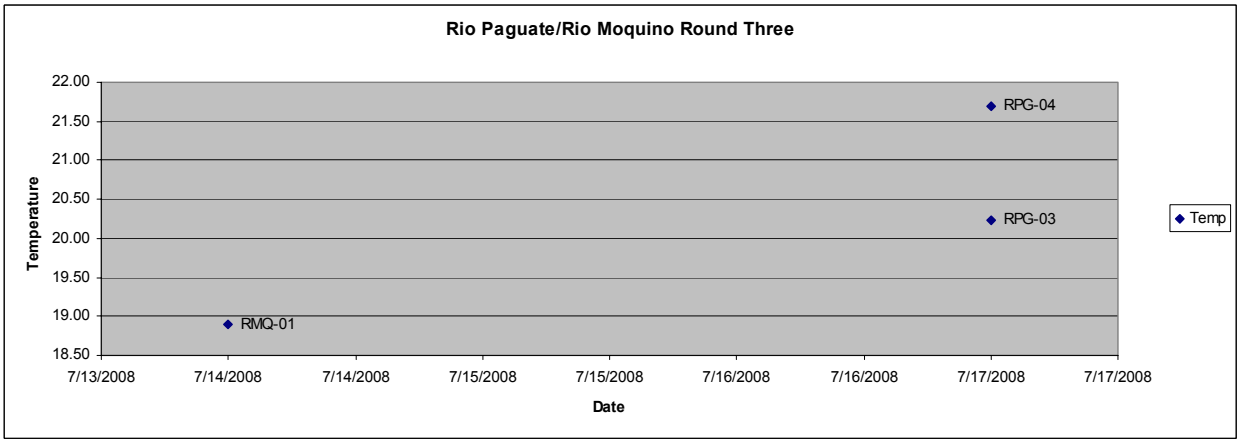

Springs Round Three
Barometric Pressure
0.990
0.980
0.970
0.960
0.950
0.940
0.930
TSP-01
DSP-01
KSP-01
CSC-01
BKG-02
BKG-01
BP
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
Date

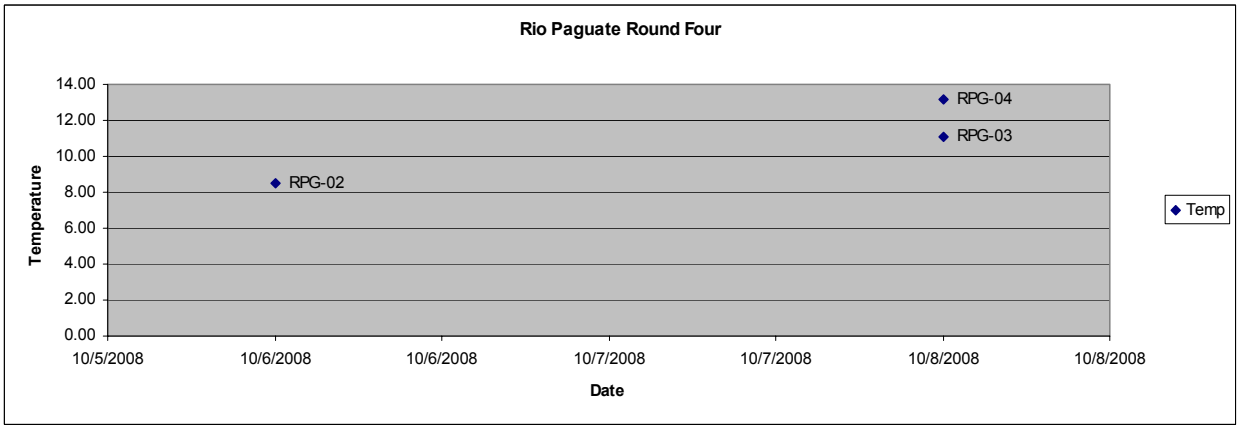

Springs Round Four
Barometric Pressure
0.99
0.98
0.97
0.96
0.95
0.94
0.93
TSP-01
KSP-01
DSP-01
BKG-02
CSC-01
BKG-01
BP
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
10/17/2008
Date

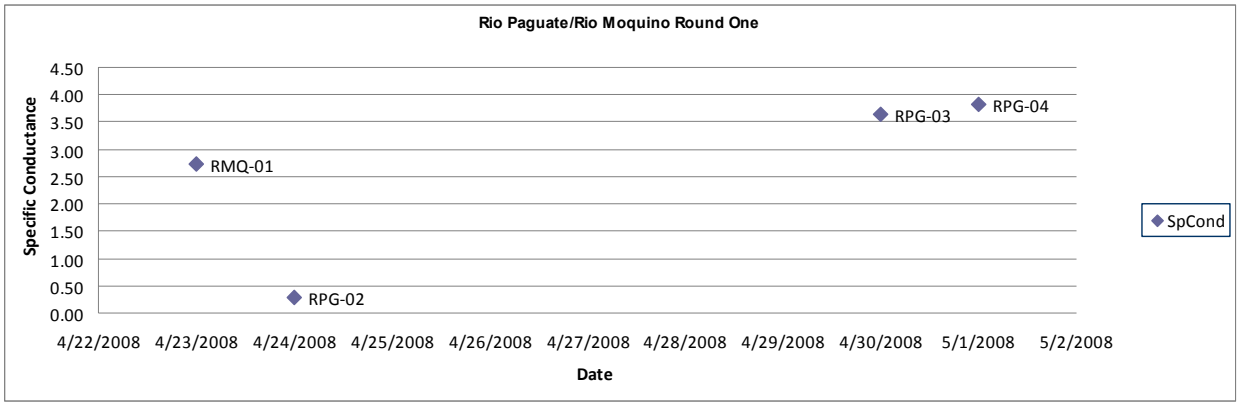
Rio Paguate/Rio Moquino

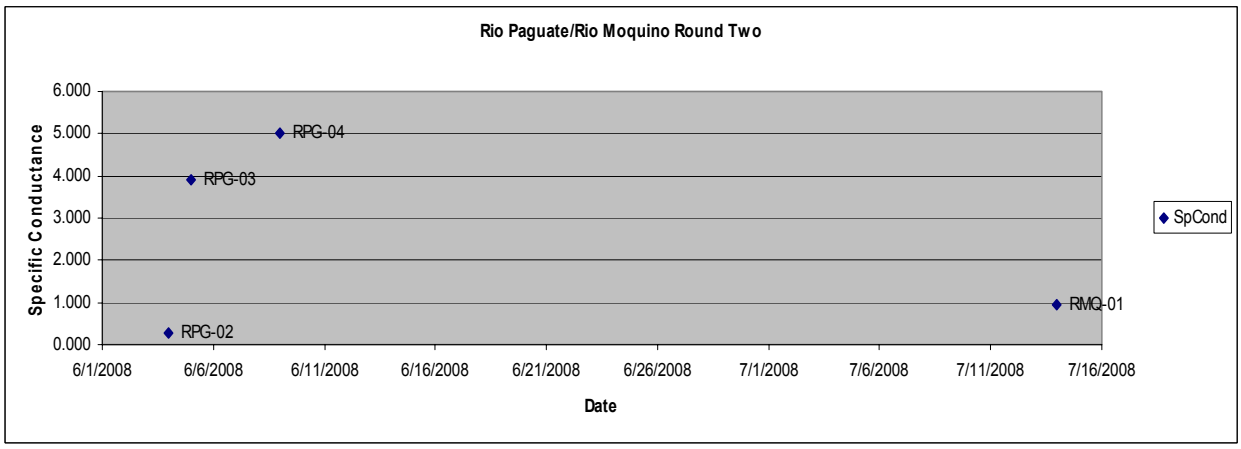


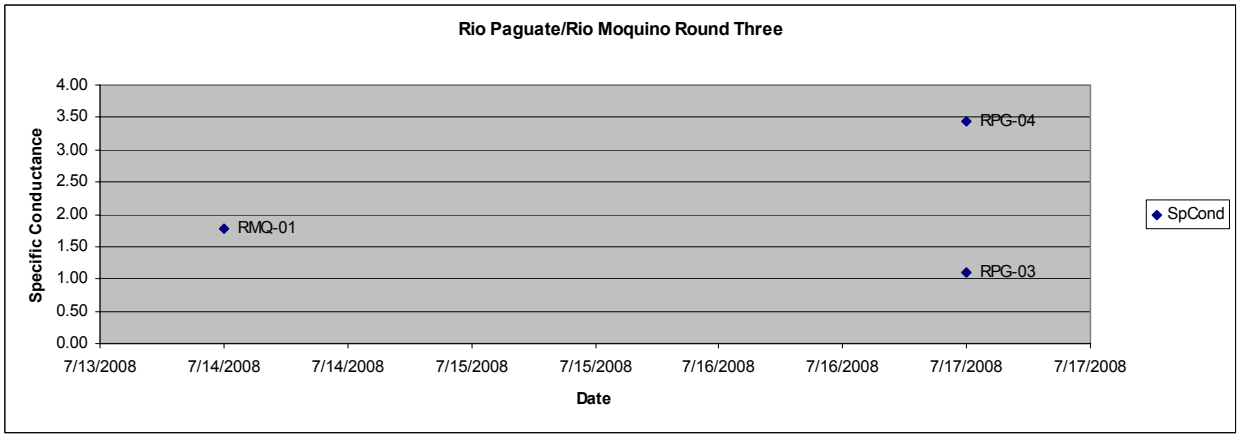


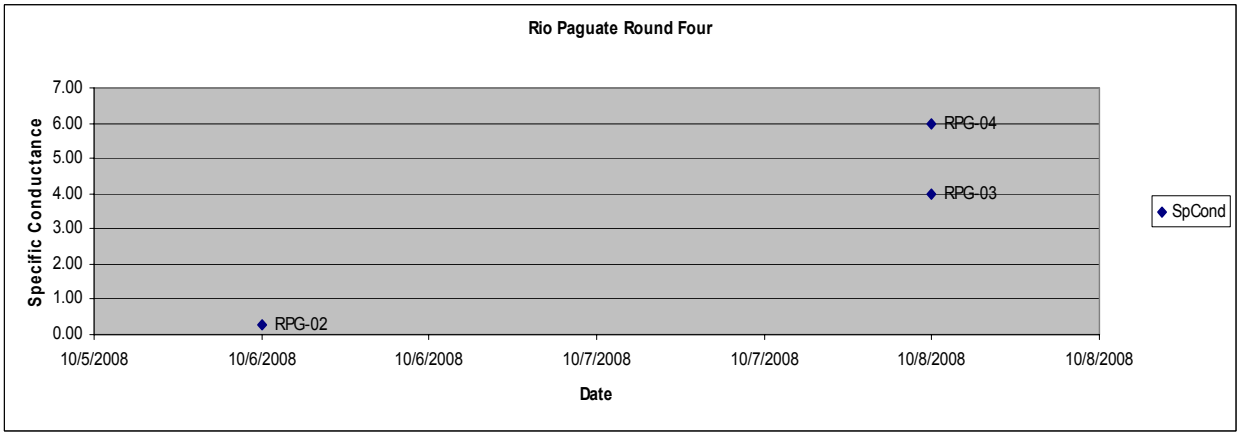


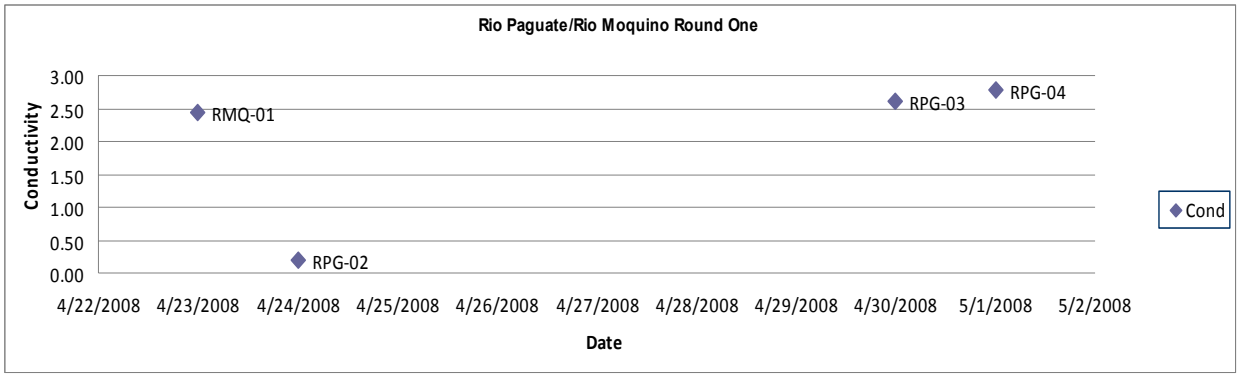


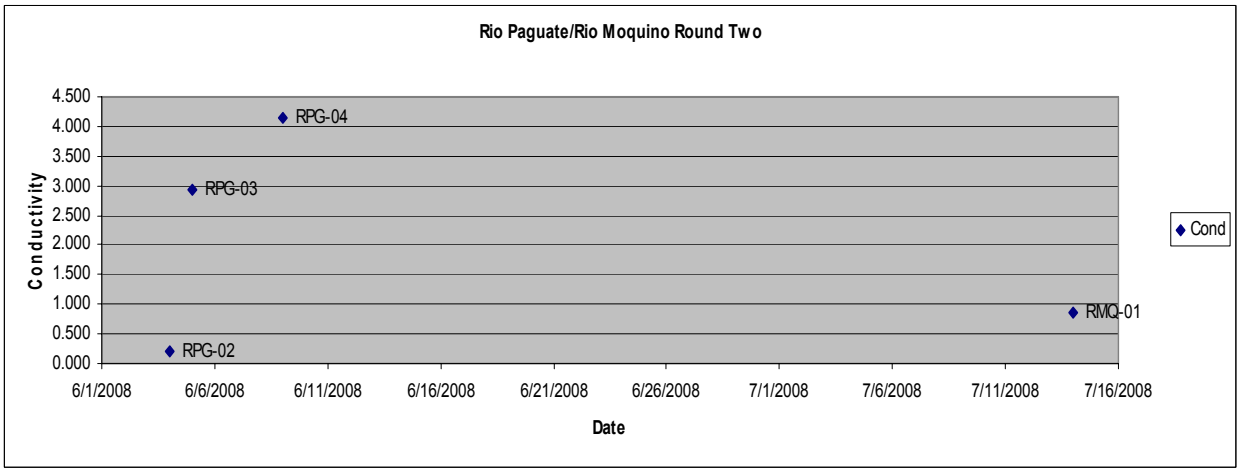

Rio Paguate/Rio Moquino Round One
Specific Conductance
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
SpCond

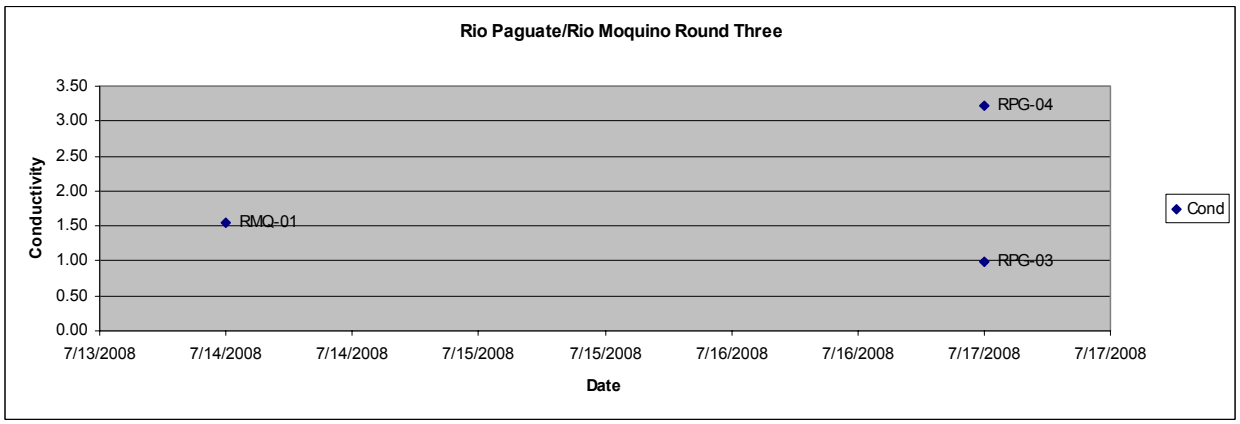

Rio Paguate/Rio Moquino Round Two
Specific Conductance
6.000
5.000
4.000
3.000
2.000
1.000
0.000
RPG-04
RPG-03
RPG-02
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
SpCond

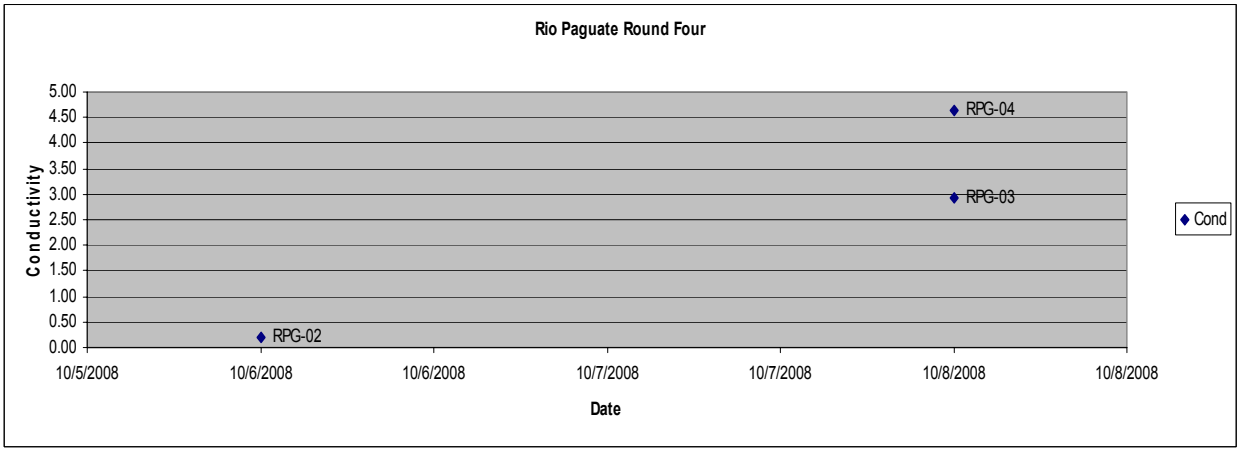

Rio Paguate/Rio Moquino Round Three
Specific Conductance
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RMQ-01
RPG-03
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
SpCond

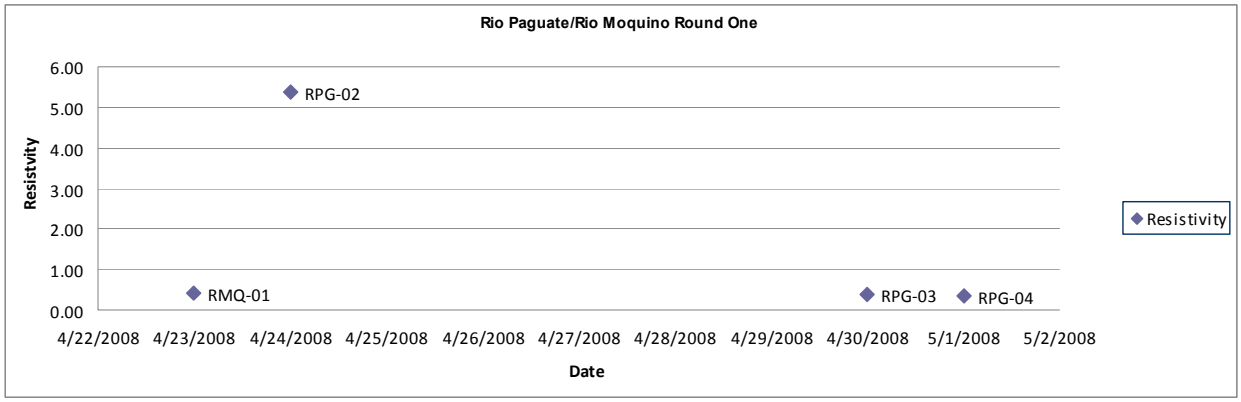

Rio Paguate Round Four
Specific Conductance
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RPG-04
RPG-03
RPG-02
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
SpCond

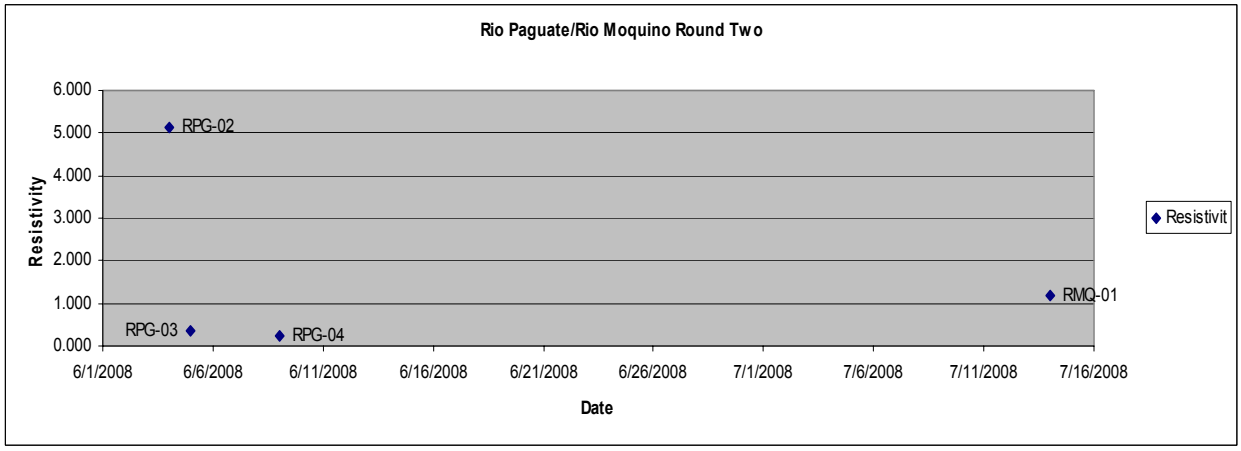

Rio Paguate/Rio Moquino Round One
Conductivity
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
Cond

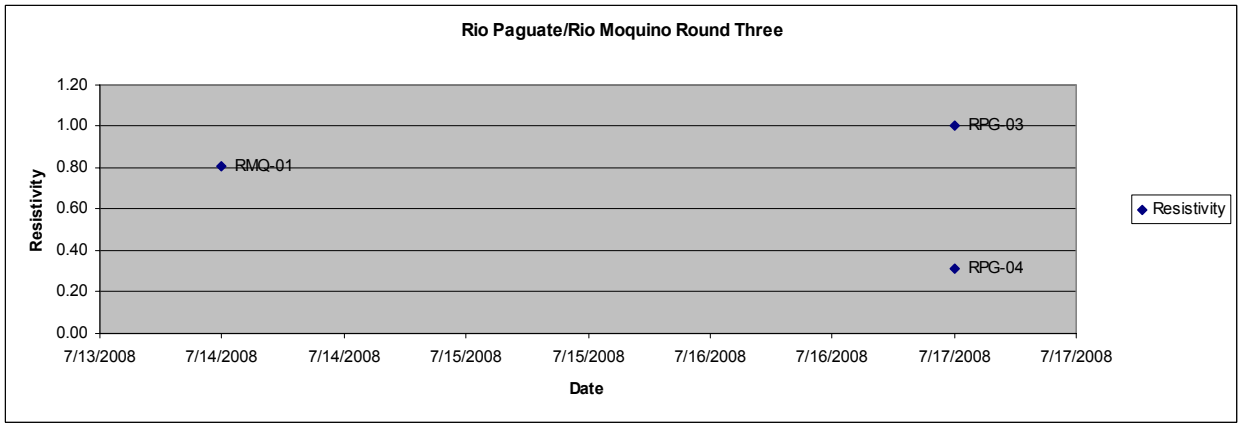

Rio Paguate/Rio Moquino Round Two
Conductivity
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
RPG-04
RPG-03
RPG-02
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
Cond

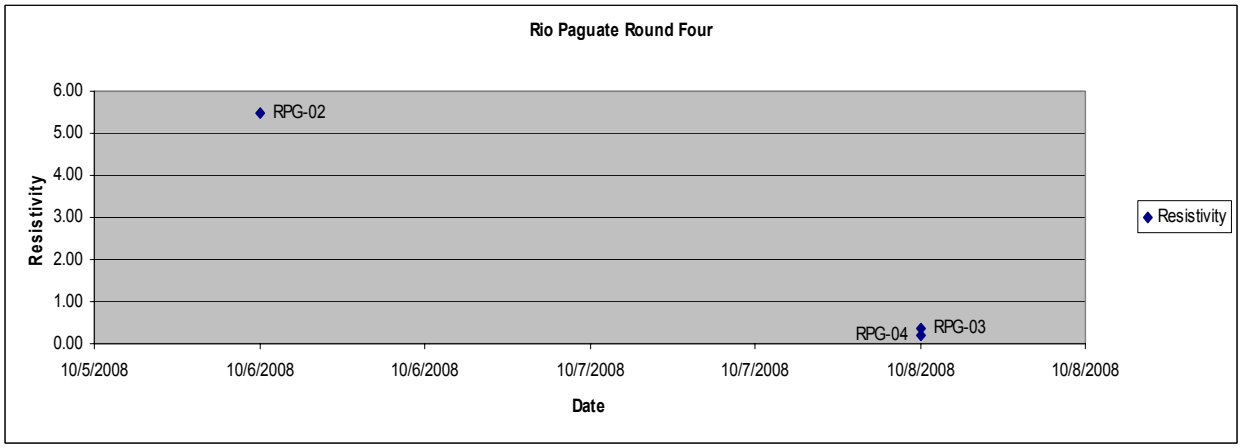

Rio Paguate/Rio Moquino Round Three
Conductivity
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RMQ-01
RPG-03
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
Cond

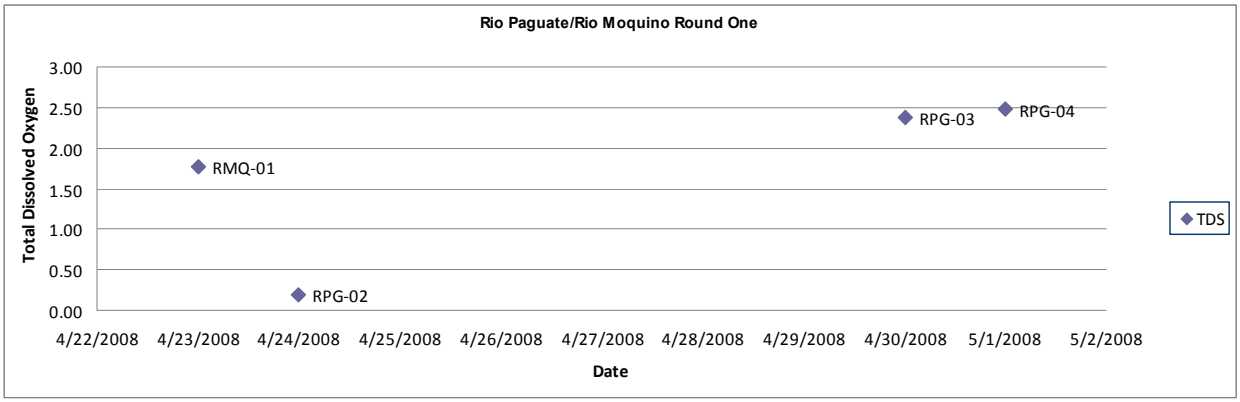

Rio Paguate Round Four
Conductivity
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RPG-03
RPG-02
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
Cond

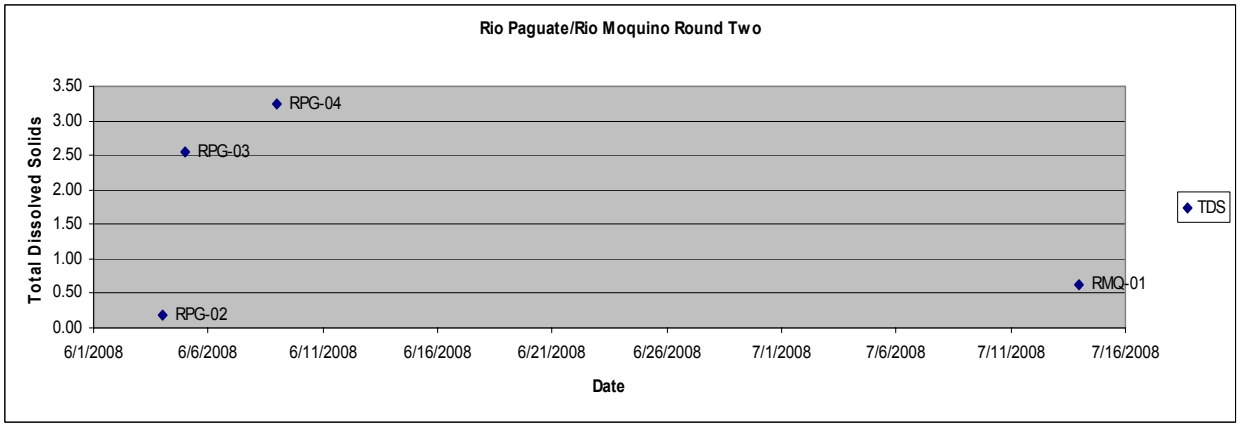

Rio Paguate/Rio Moquino Round One
Resistivity
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RPG-02
RMQ-01
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
Resistivity

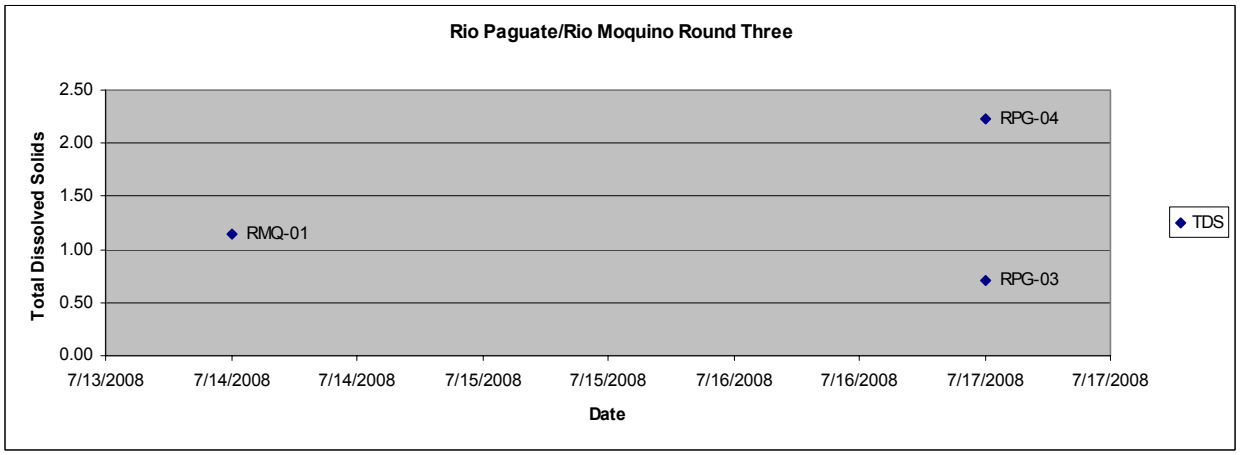

Rio Paguate/Rio Moquino Round Two
Resistivity
6.000
5.000
4.000
3.000
2.000
1.000
0.000
RPG-02
RPG-03
RPG-04
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
Resistivit

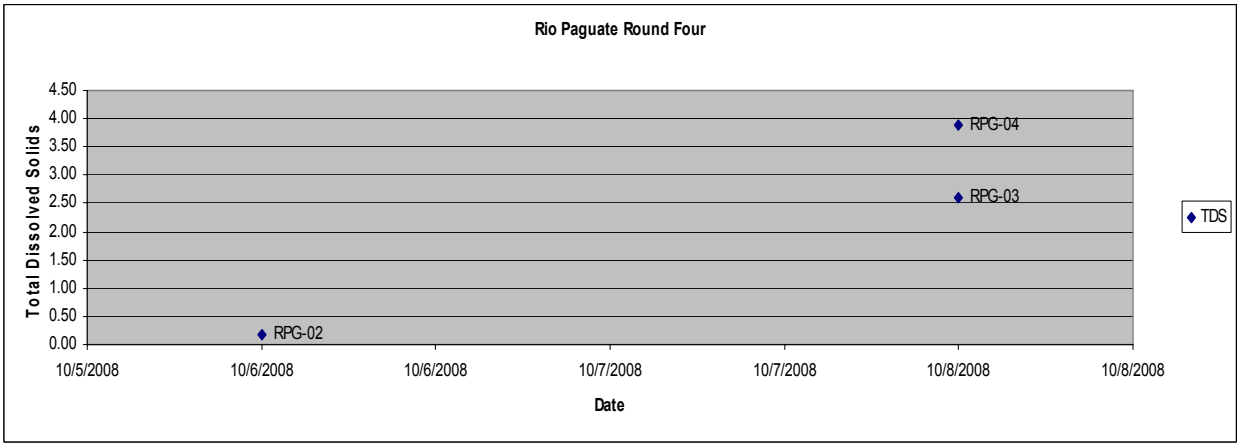

Rio Paguate/Rio Moquino Round Three
Resistivity
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPG-03
RMQ-01
RPG-04
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
Resistivity

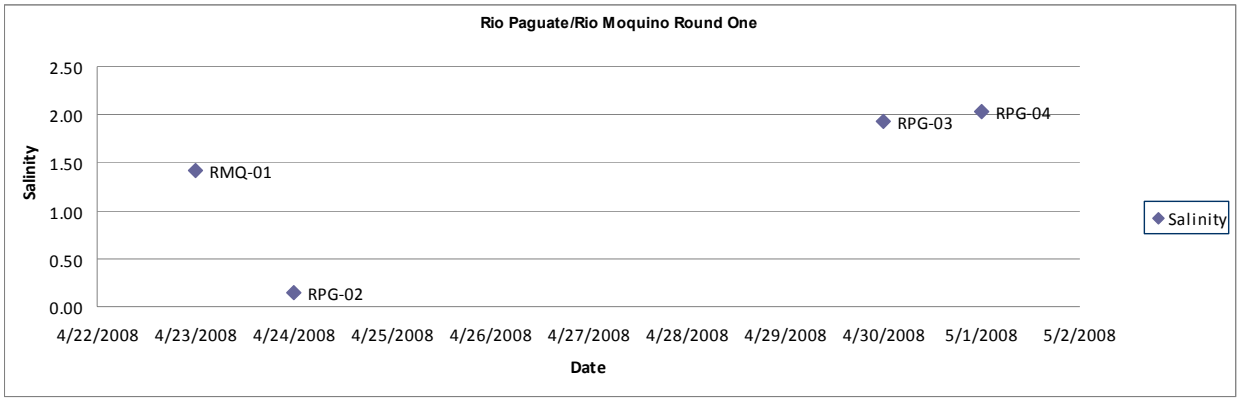

Rio Paguate Round Four
Resistivity
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RPG-02
RPG-04
RPG-03
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
Resistivity

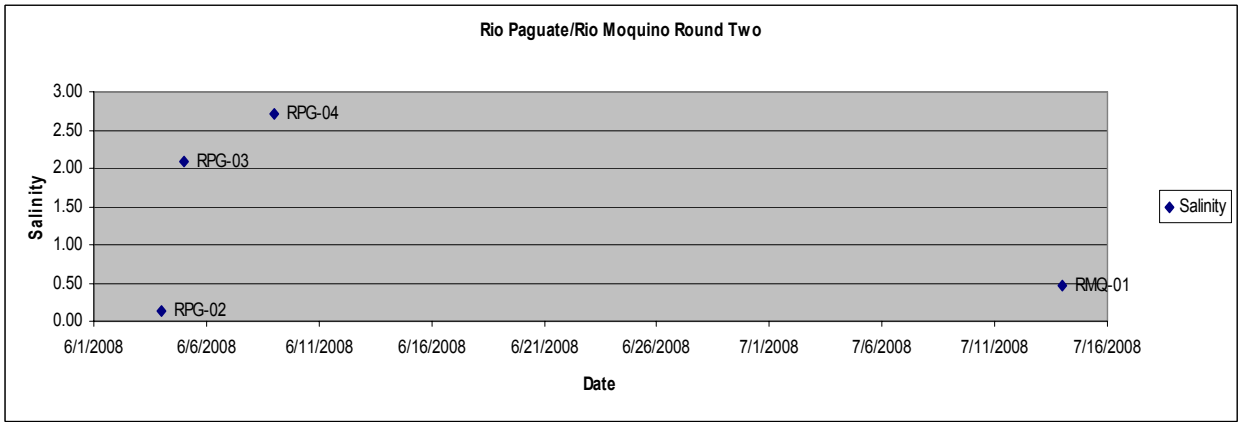

Rio Paguate/Rio Moquino Round One
Total Dissolved Oxygen
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
TDS
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date

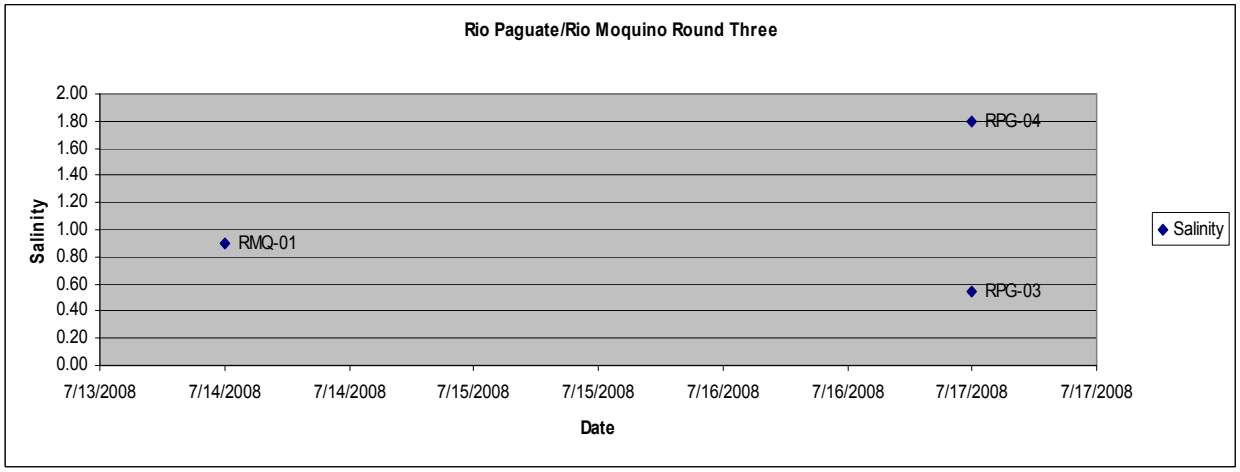

Rio Paguate/Rio Moquino Round Two
Total Dissolved Solids
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RPG-03
RPG-02
RMQ-01
TDS
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date

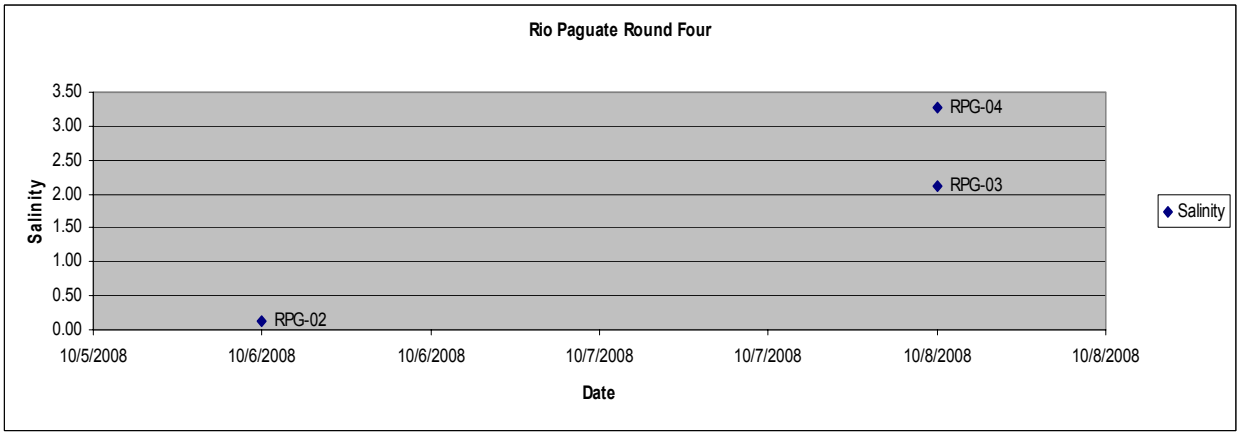

Rio Paguate/Rio Moquino Round Three
Total Dissolved Solids
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RMQ-01
RPG-03
TDS
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date

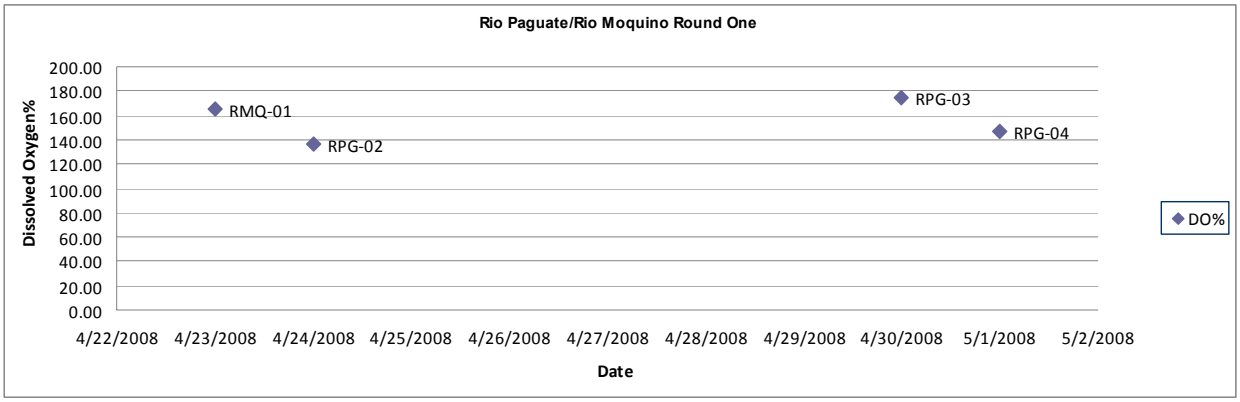

Rio Paguate Round Four
Total Dissolved Solids
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RPG-03
RPG-02
TDS
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date

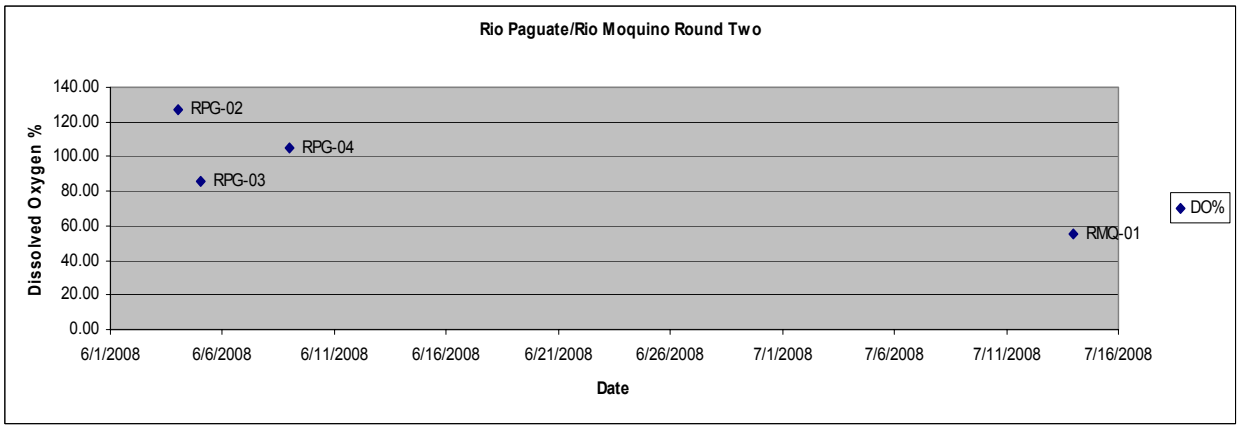

Rio Paguate/Rio Moquino Round One
Salinity
2.50
2.00
1.50
1.00
0.50
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
Salinity

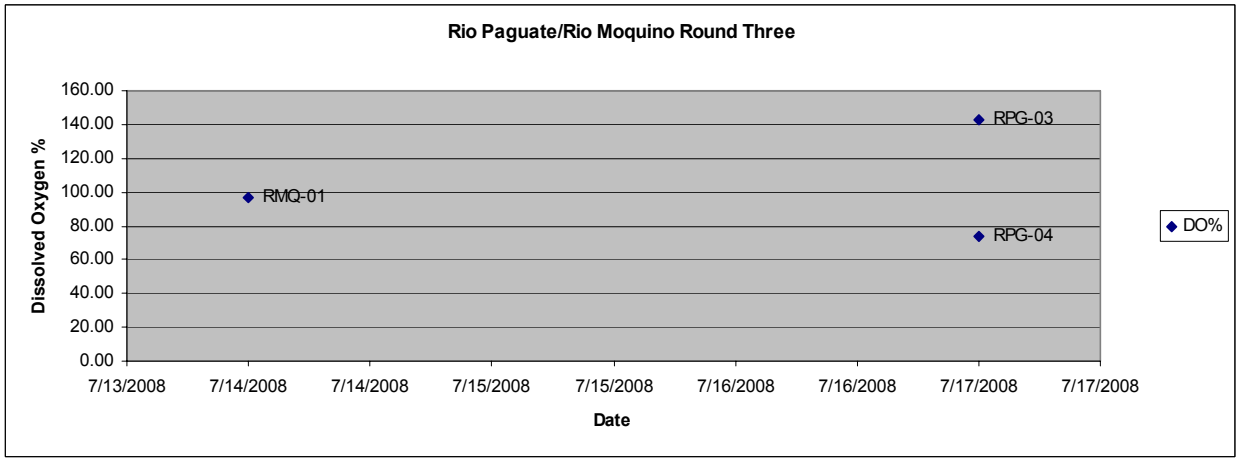

Rio Paguate/Rio Moquino Round Two
Salinity
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RPG-03
RPG-02
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
Salinity

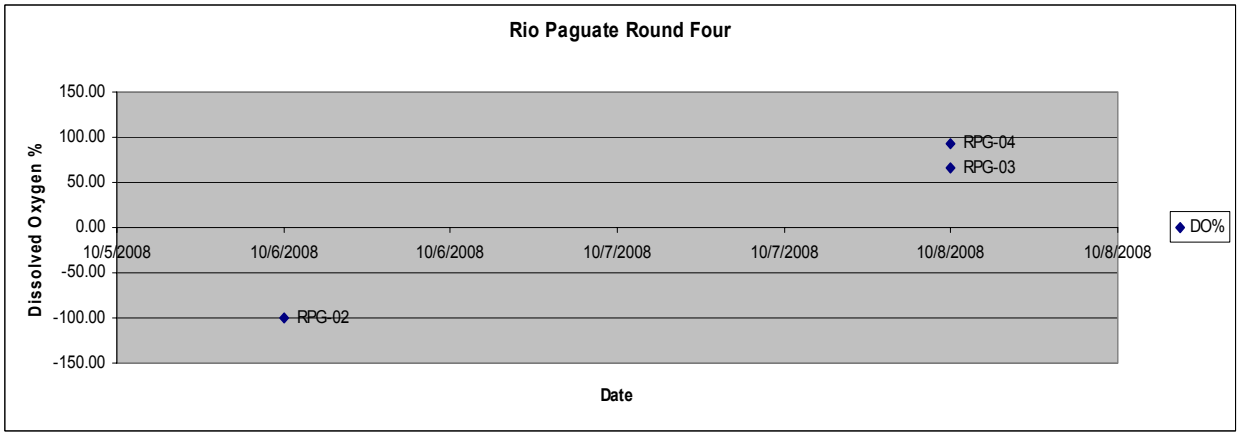

Rio Paguate/Rio Moquino Round Three
Salinity
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPG-04
RMQ-01
RPG-03
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
Salinity

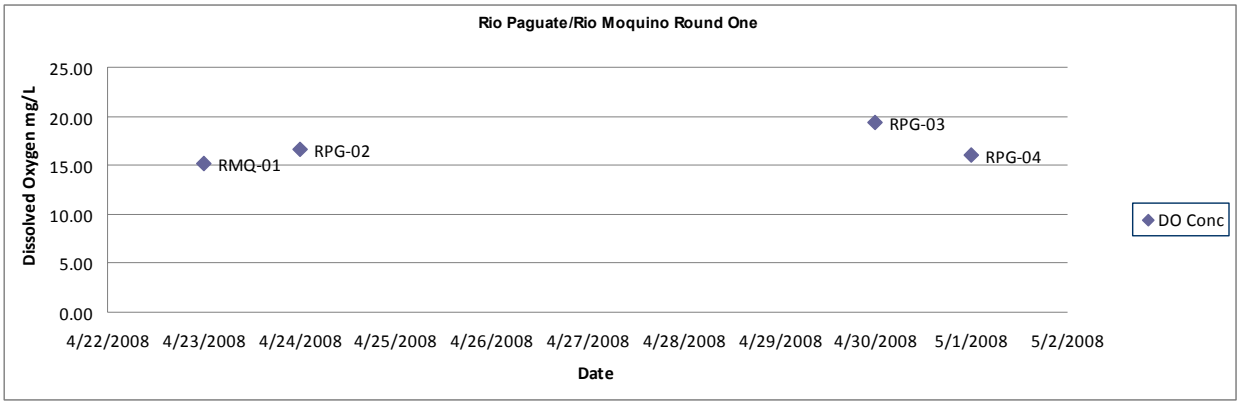

Rio Paguate Round Four
Salinity
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-04
RPG-03
RPG-02
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
Salinity

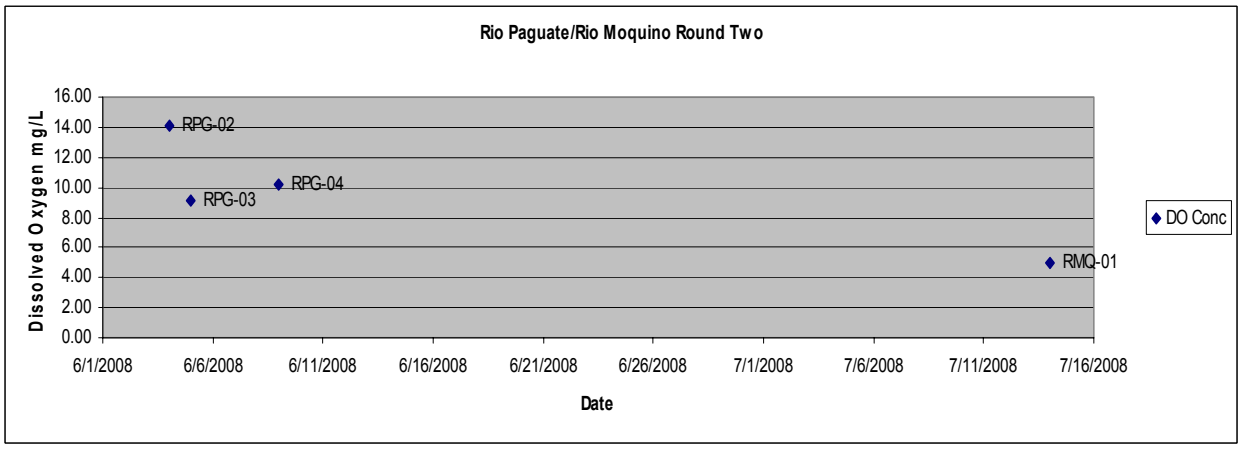

Rio Paguate/Rio Moquino Round One
Dissolved Oxygen%
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
DO%
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date

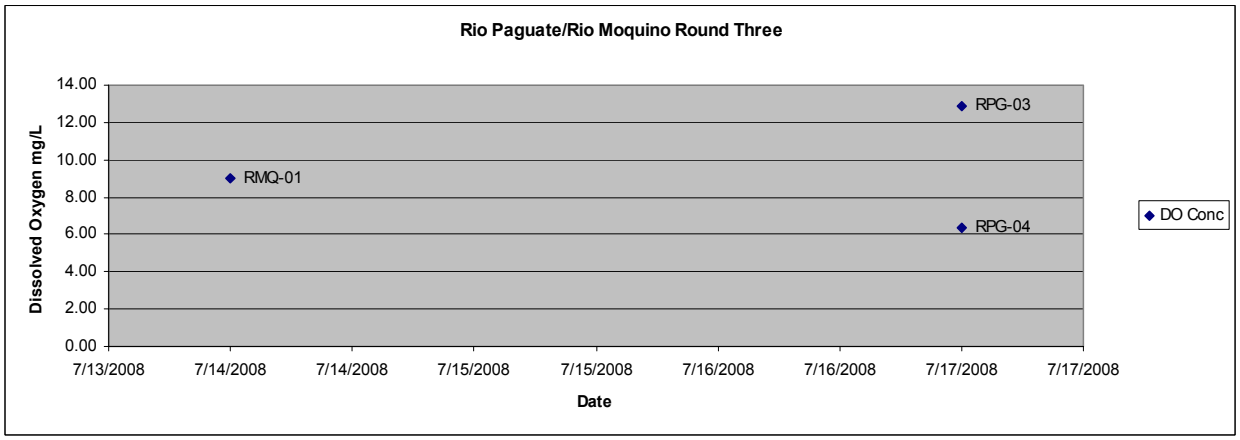

Rio Paguate/Rio Moquino Round Two
Dissolved Oxygen %
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPG-02
RPG-04
RPG-03
RMQ-01
DO%
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date

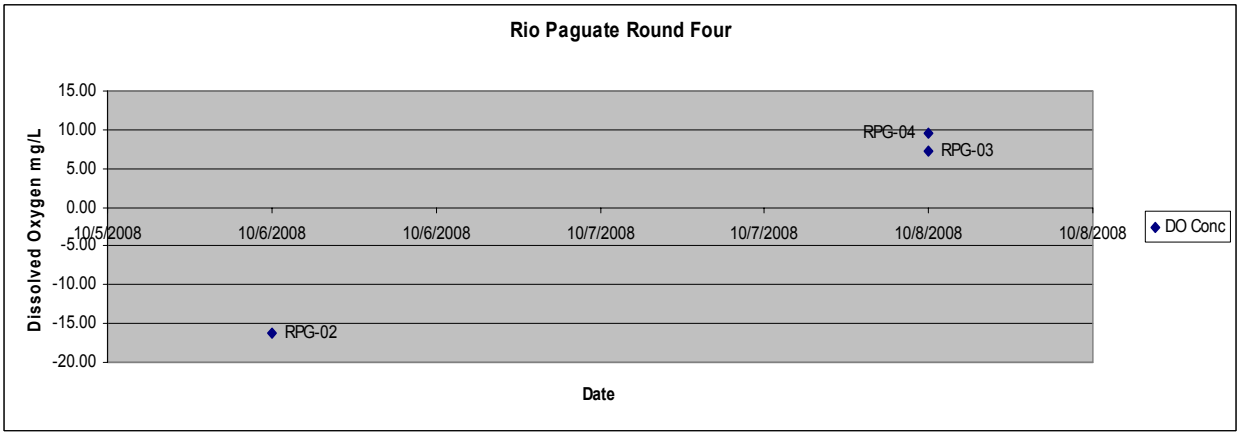

Rio Paguate/Rio Moquino Round Three
Dissolved Oxygen %
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPG-03
RMQ-01
RPG-04
DO%
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date

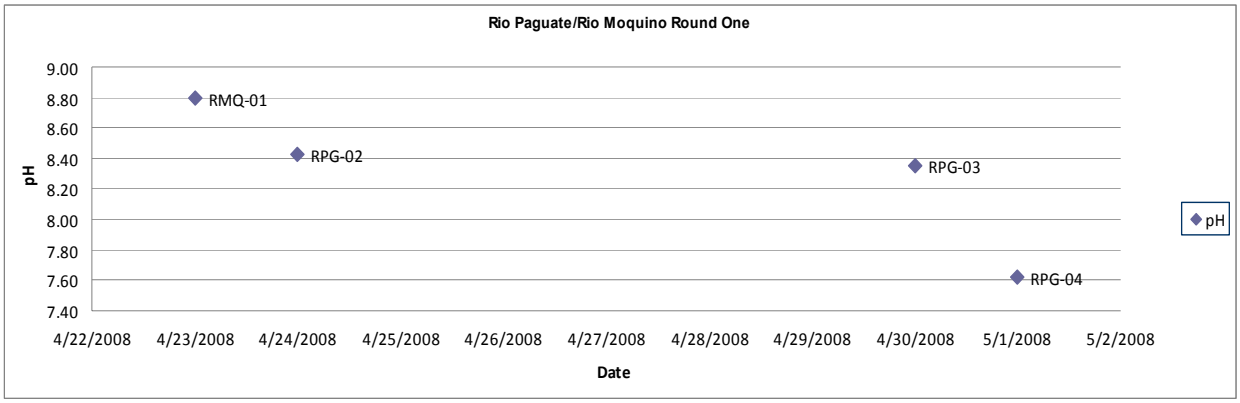

Rio Paguate Round Four
Dissolved Oxygen %
150.00
100.00
50.00
0.00
-50.00
-100.00
-150.00
RPG-04
RPG-03
RPG-02
DO%
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date

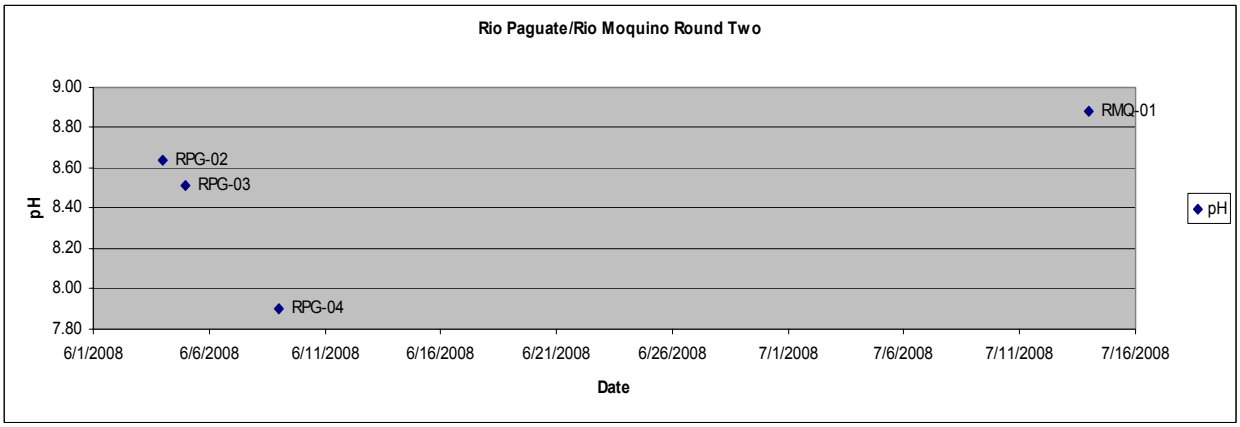

Rio Paguate/Rio Moquino Round One
Dissolved Oxygen mg/L
25.00
20.00
15.00
10.00
5.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
DO Conc

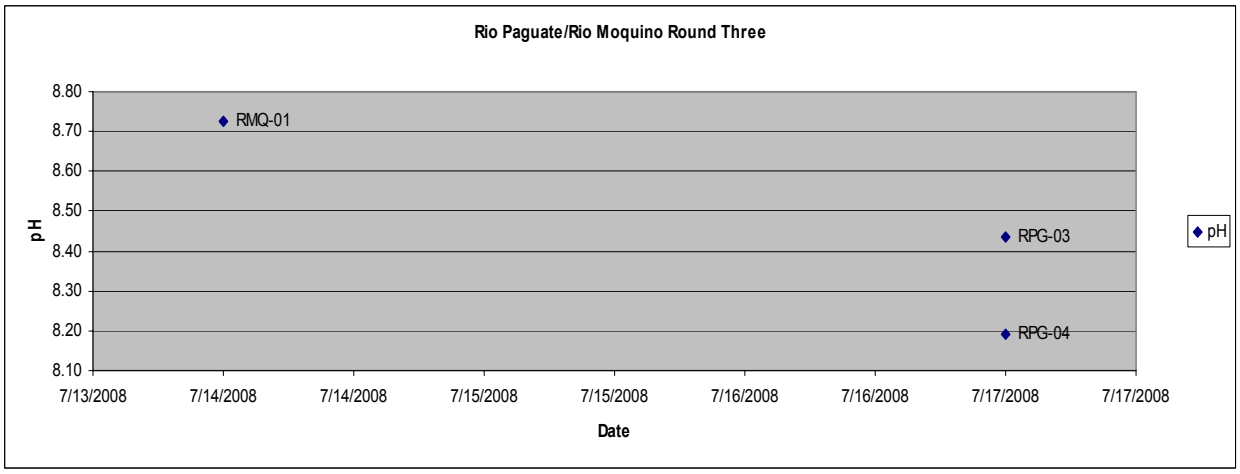

Rio Paguate/Rio Moquino Round Two
Dissolved Oxygen mg/L
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPG-02
RPG-03
RPG-04
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
DO Conc

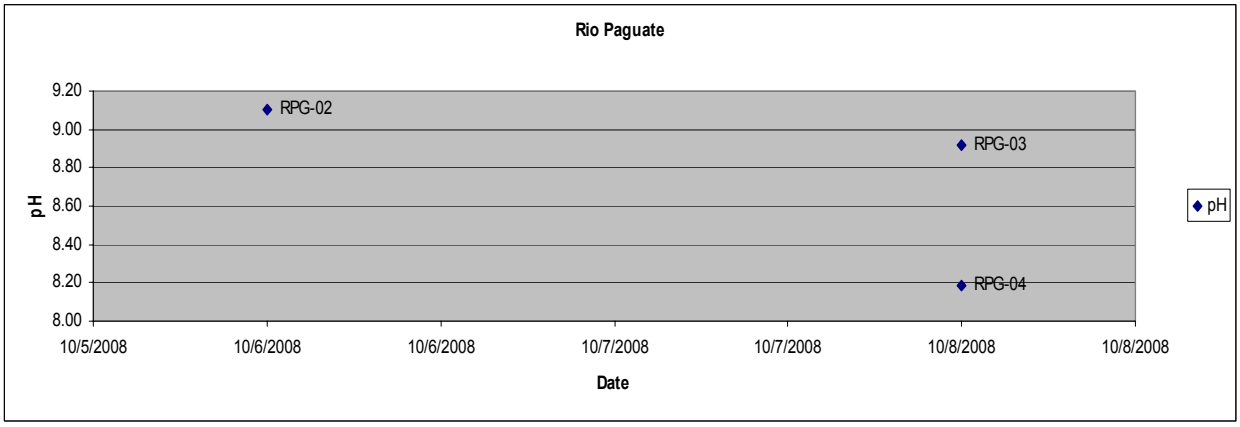

Rio Paguate/Rio Moquino Round Three
Dissolved Oxygen mg/L
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPG-03
RMQ-01
RPG-04
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
DO Conc

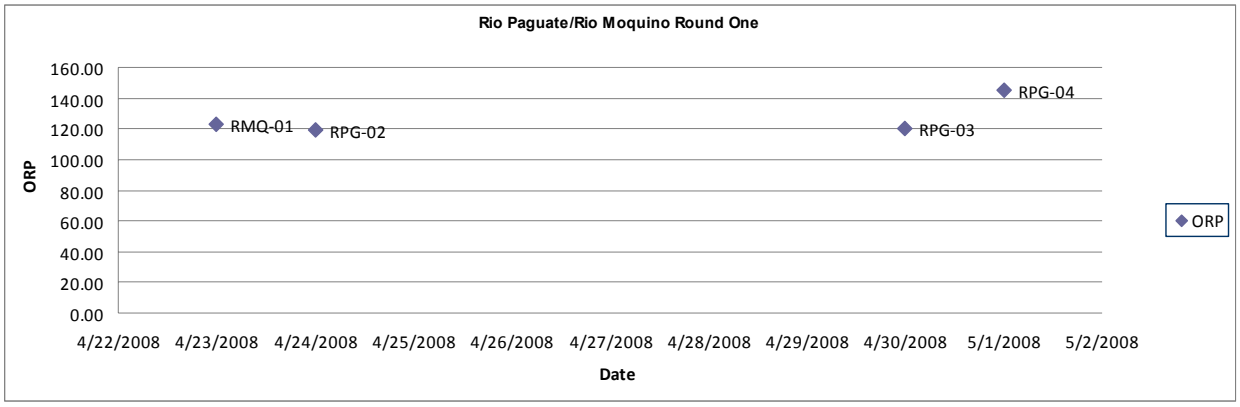

Rio Paguate Round Four
Dissolved Oxygen mg/L
15.00
10.00
5.00
0.00
-5.00
-10.00
-15.00
-20.00
RPG-04
RPG-03
RPG-02
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
DO Conc

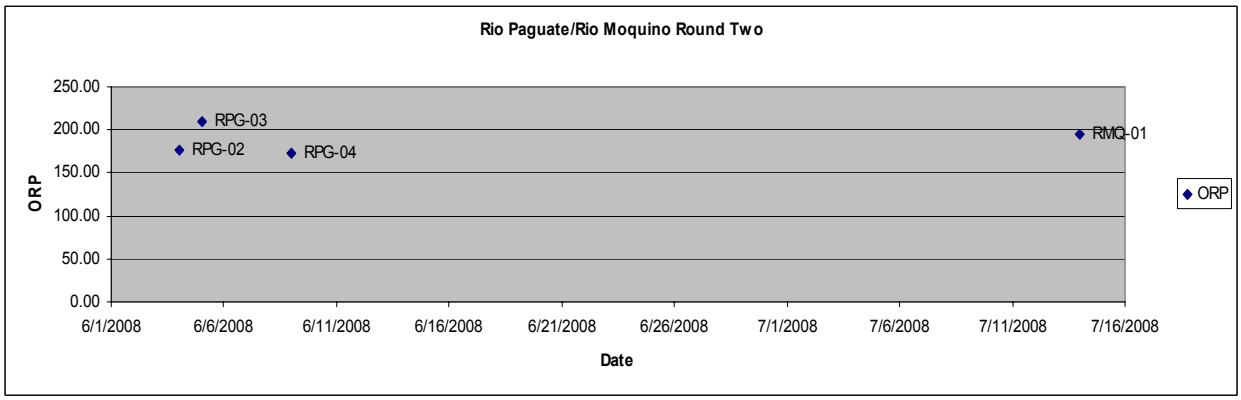

Rio Paguate/Rio Moquino Round One
9.00
8.80
8.60
8.40
8.20
8.00
7.80
7.60
7.40
pH
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
pH

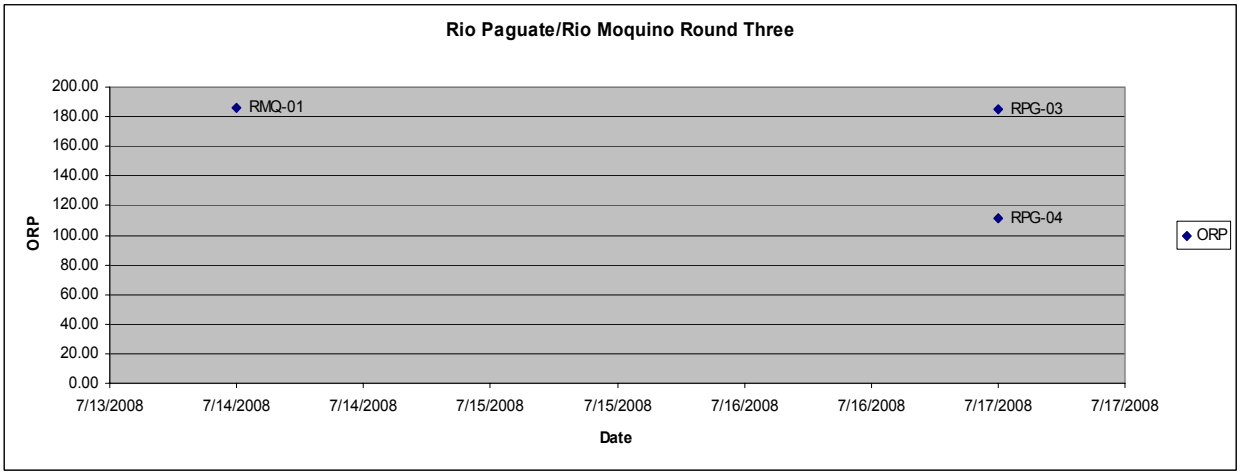

Rio Paguate/Rio Moquino Round Two
9.00
8.80
8.60
8.40
8.20
8.00
7.80
pH
RMQ-01
RPG-02
RPG-03
RPG-04
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
pH

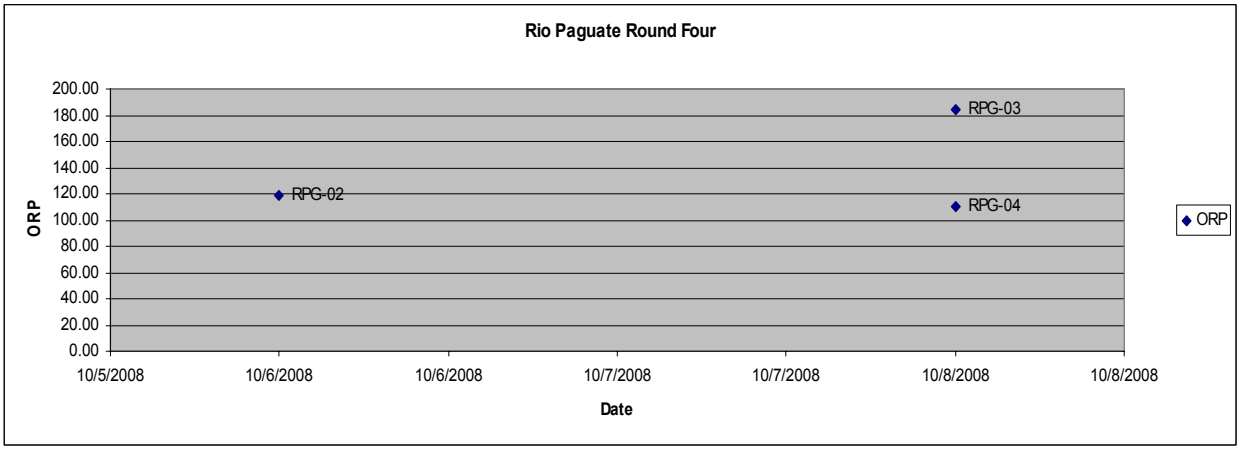

Rio Paguate/Rio Moquino Round Three
8.80
8.70
8.60
8.50
8.40
8.30
8.20
8.10
pH
RMQ-01
RPG-03
RPG-04
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
pH

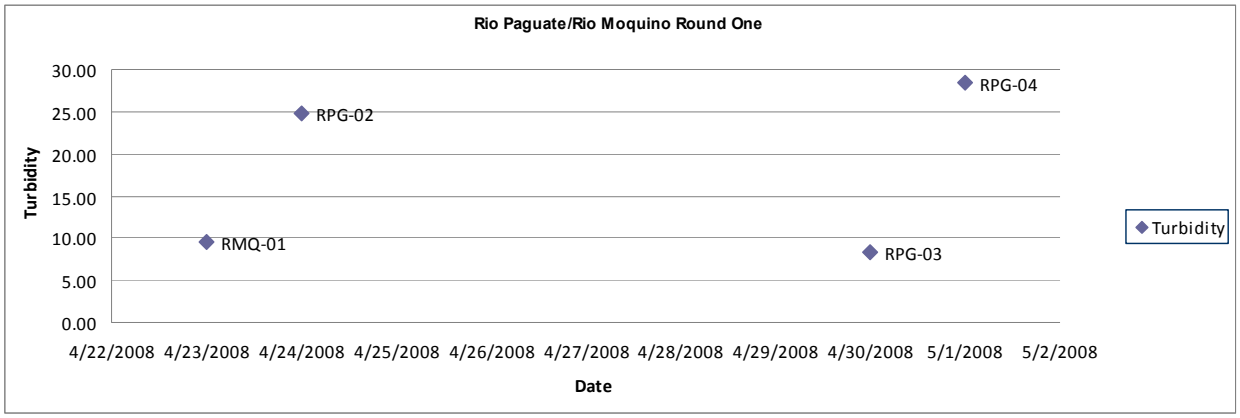

Rio Paguate
9.20
9.00
8.80
8.60
8.40
8.20
8.00
pH
RPG-02
RPG-03
RPG-04
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
pH

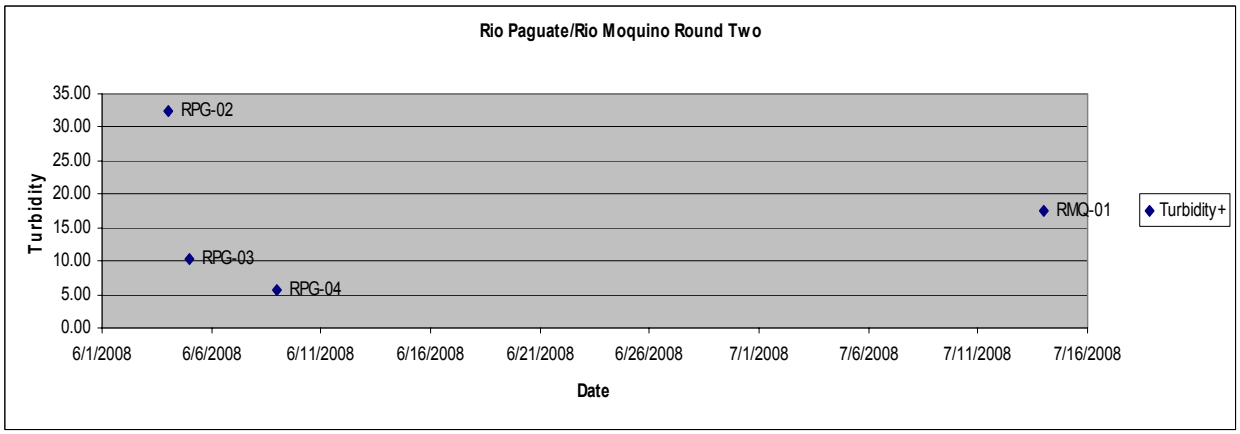

Rio Paguate/Rio Moquino Round One
ORP
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
ORP

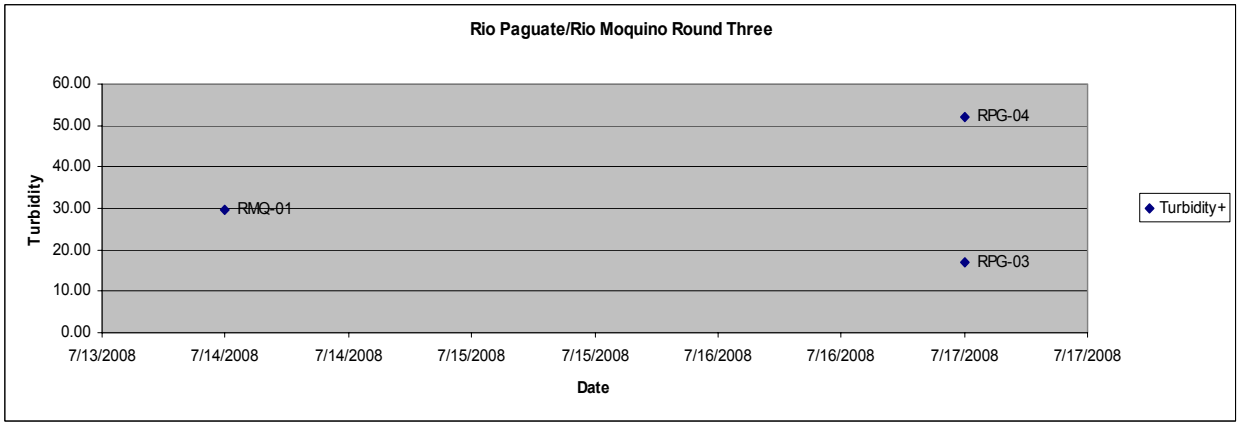

Rio Paguate/Rio Moquino Round Two
ORP
250.00
200.00
150.00
100.00
50.00
0.00
RPG-03
RPG-02
RPG-04
RMQ-01
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
ORP

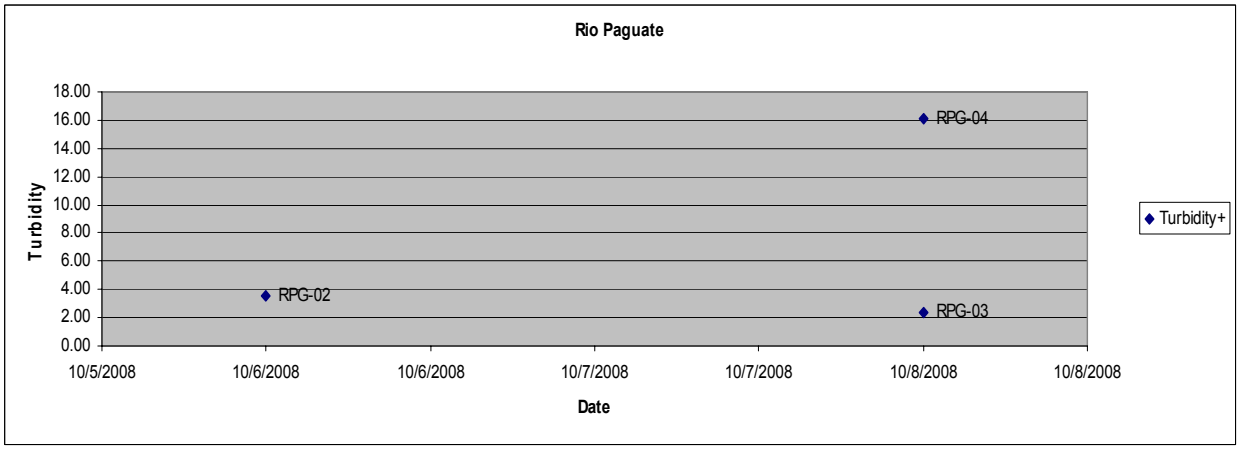

Rio Paguate/Rio Moquino Round Three
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RMQ-01
RPG-03
RPG-04
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
ORP

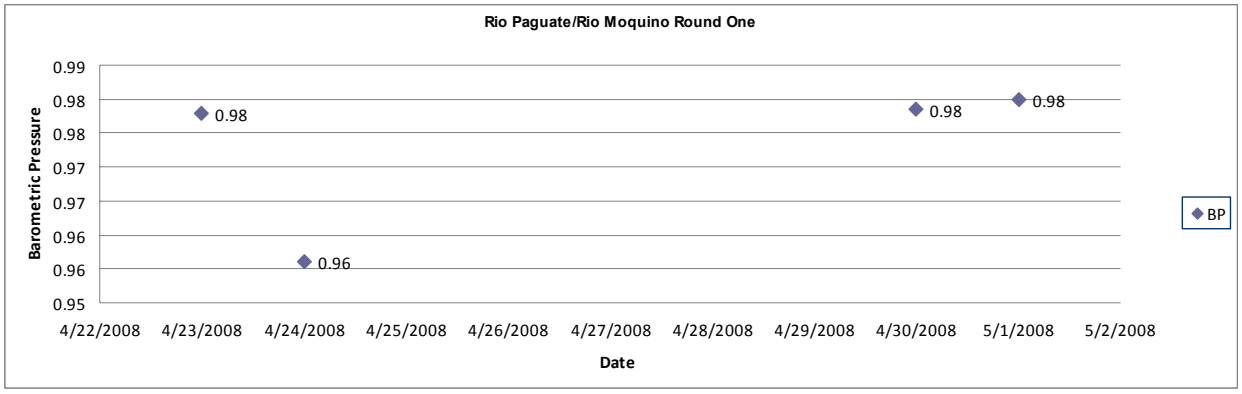

Rio Paguate Round Four
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPG-03
RPG-02
RPG-04
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
ORP

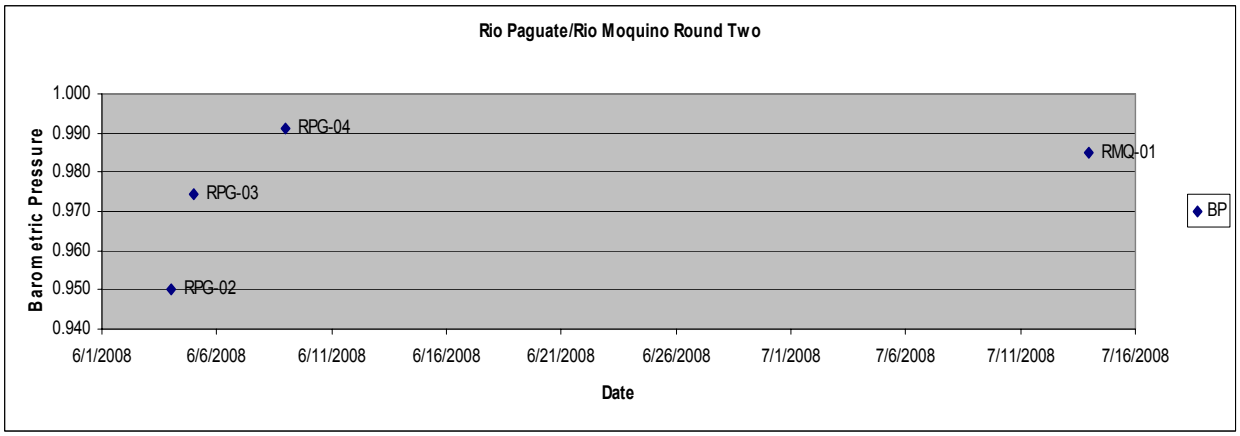

Rio Paguate/Rio Moquino Round One
Turbidity
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RPG-04
RPG-02
RMQ-01
RPG-03
Turbidity
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date

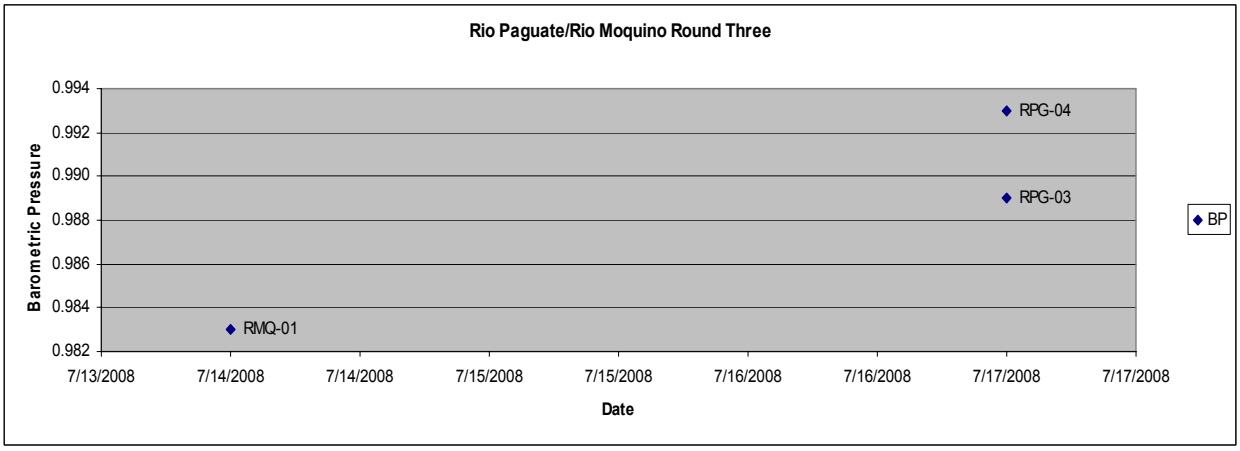

Rio Paguate/Rio Moquino Round Two
Turbidity
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RPG-02
RMQ-01
RPG-03
RPG-04
Turbidity+
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date

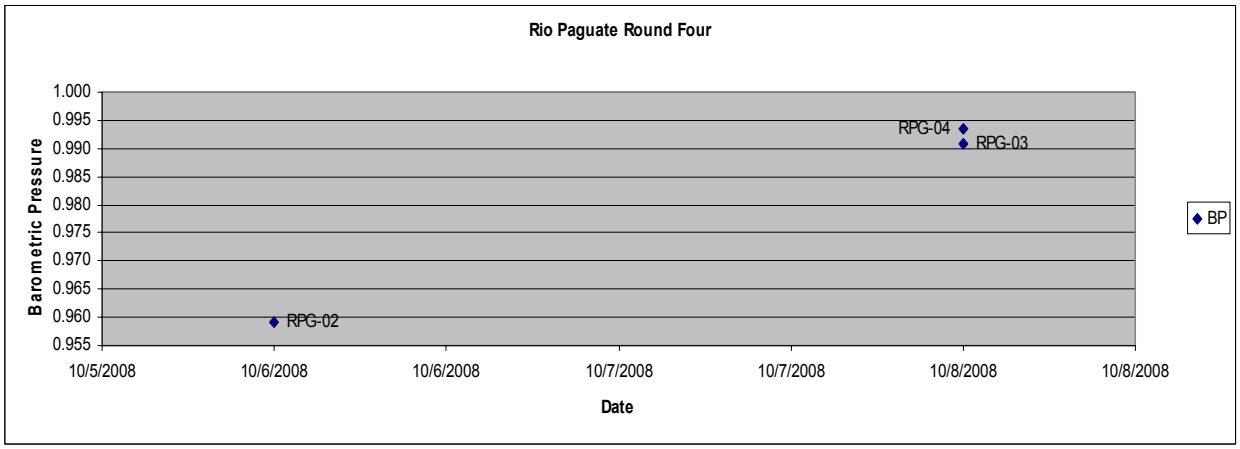

Rio Paguate/Rio Moquino Round Three
Turbidity
60.00
50.00
40.00
30.00
20.00
10.00
0.00
RPG-04
RMQ-01
RPG-03
Turbidity+
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date


Rio Paguate
Turbidity
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPG-04
RPG-02
RPG-03
Turbidity+
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date

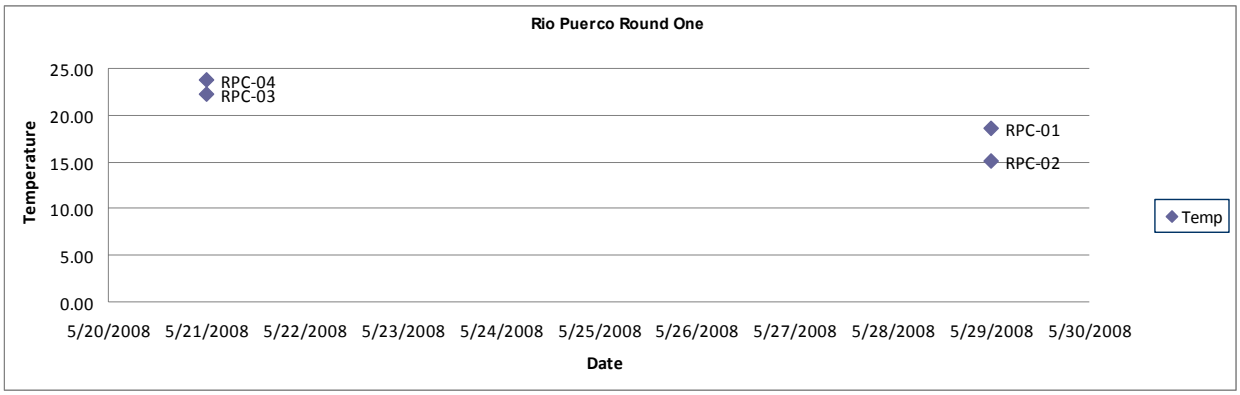

Rio Paguate/Rio Moquino Round One
Barometric Pressure
0.99
0.98
0.98
0.97
0.97
0.96
0.96
0.95
0.98
0.96
0.98
0.98
4/22/2008
4/23/2008
4/24/2008
4/25/2008
4/26/2008
4/27/2008
4/28/2008
4/29/2008
4/30/2008
5/1/2008
5/2/2008
Date
BP

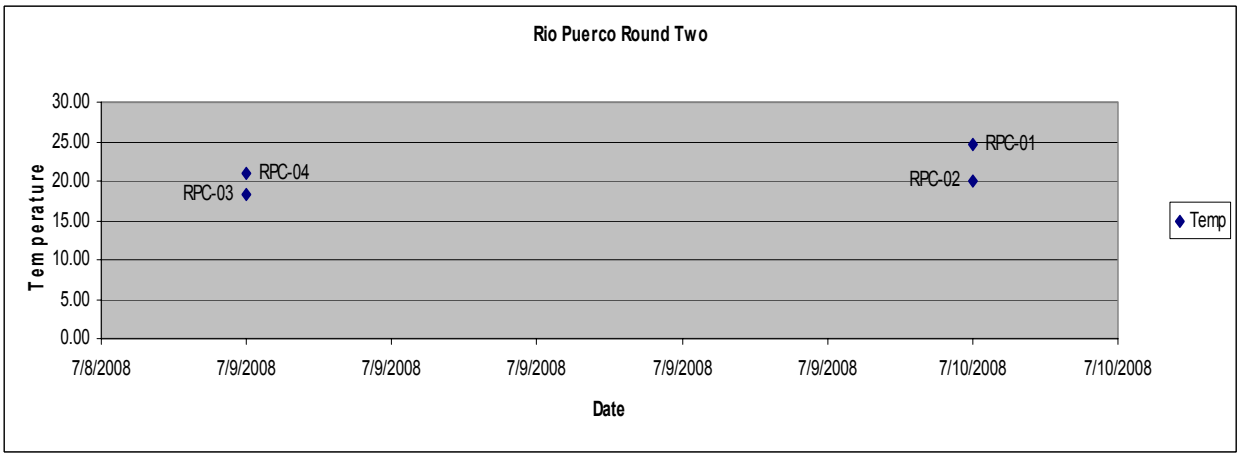

Rio Paguate/Rio Moquino Round Two
Barometric Pressure
1.000
0.990
0.980
0.970
0.960
0.950
0.940
RPG-04
RMQ-01
RPG-03
RPG-02
6/1/2008
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
7/16/2008
Date
BP

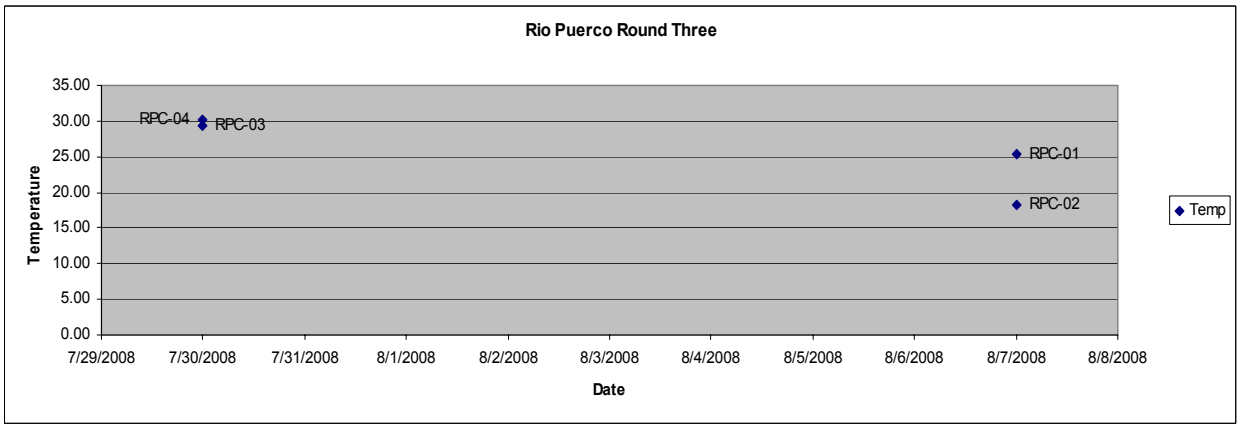

Rio Paguate/Rio Moquino Round Three
Barometric Pressure
0.994
0.992
0.990
0.988
0.986
0.984
0.982
RPG-04
RPG-03
RMQ-01
7/13/2008
7/14/2008
7/14/2008
7/15/2008
7/15/2008
7/16/2008
7/16/2008
7/17/2008
7/17/2008
Date
BP

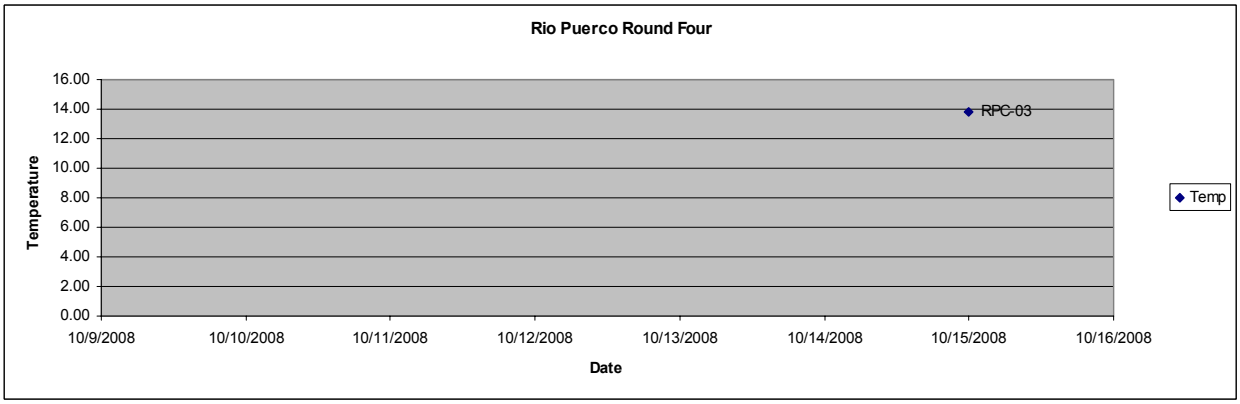

Rio Paguate Round Four
Barometric Pressure
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0.965
0.960
0.955
RPG-04
RPG-03
RPG-02
10/5/2008
10/6/2008
10/6/2008
10/7/2008
10/7/2008
10/8/2008
10/8/2008
Date
BP

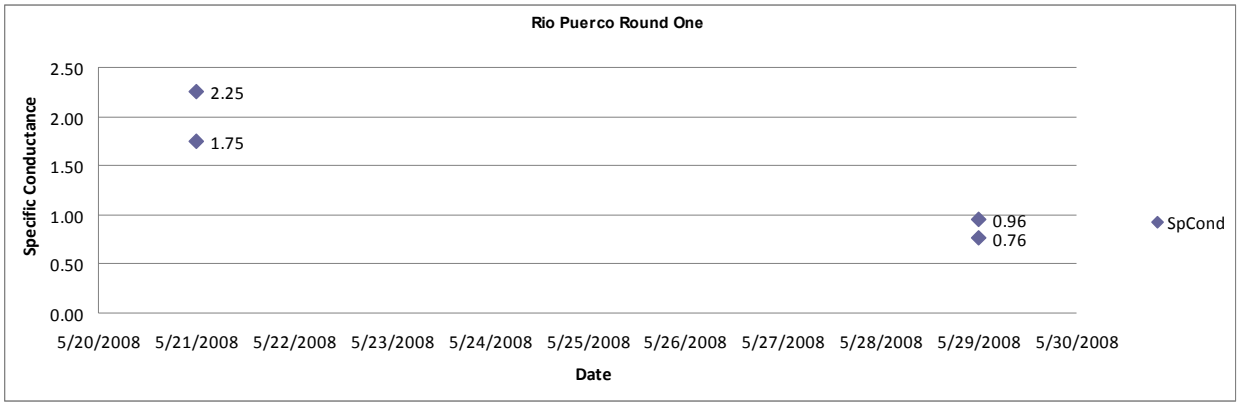
Rio Puerco/Rio Salado

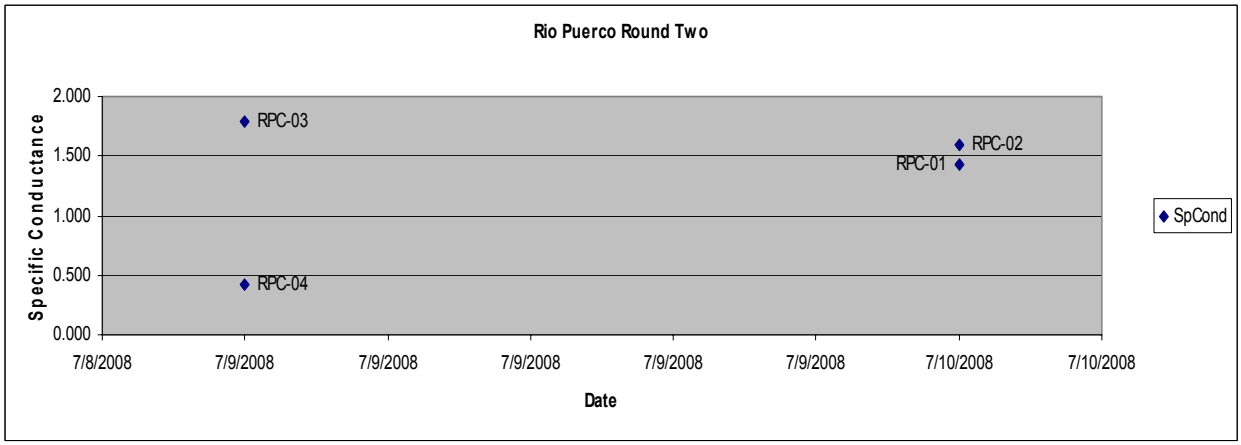


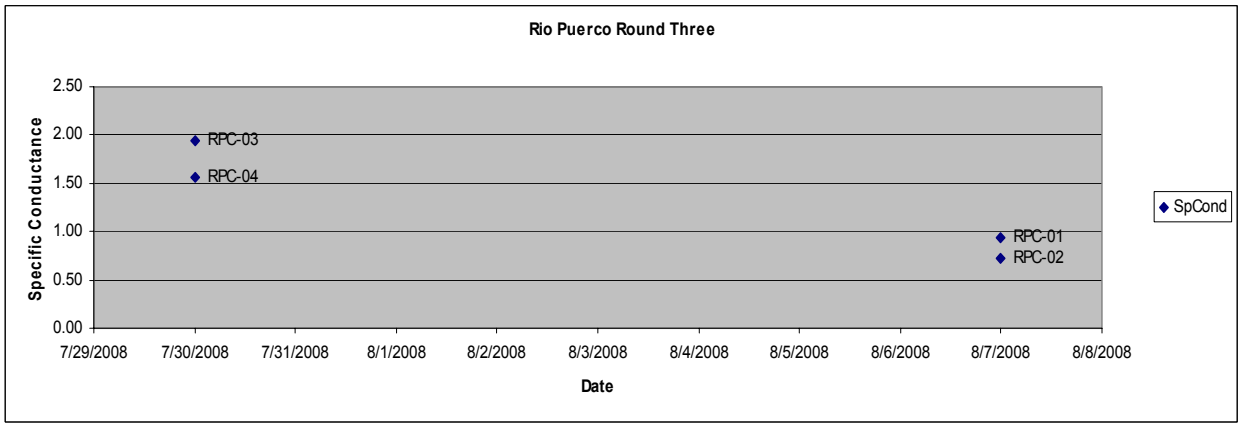


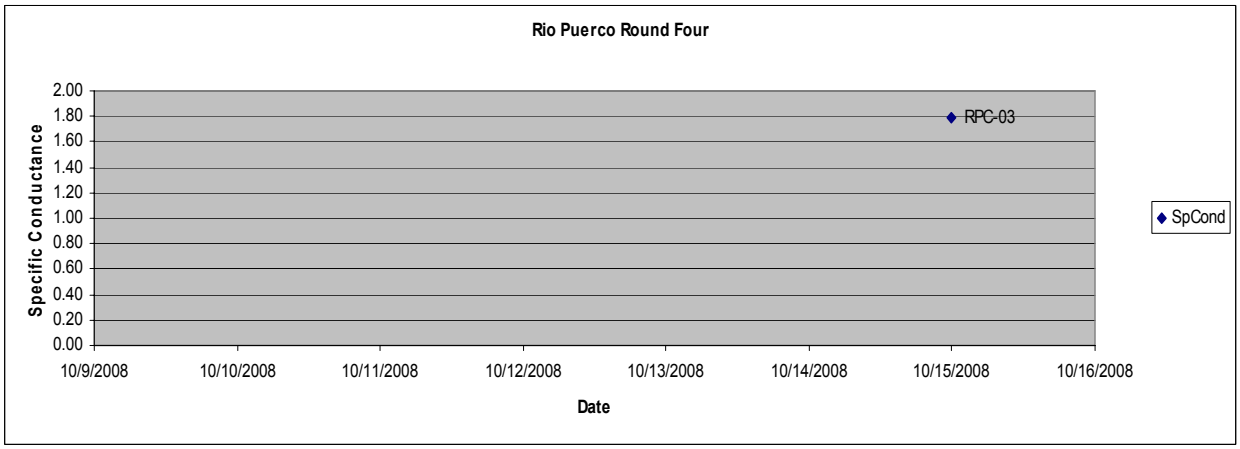


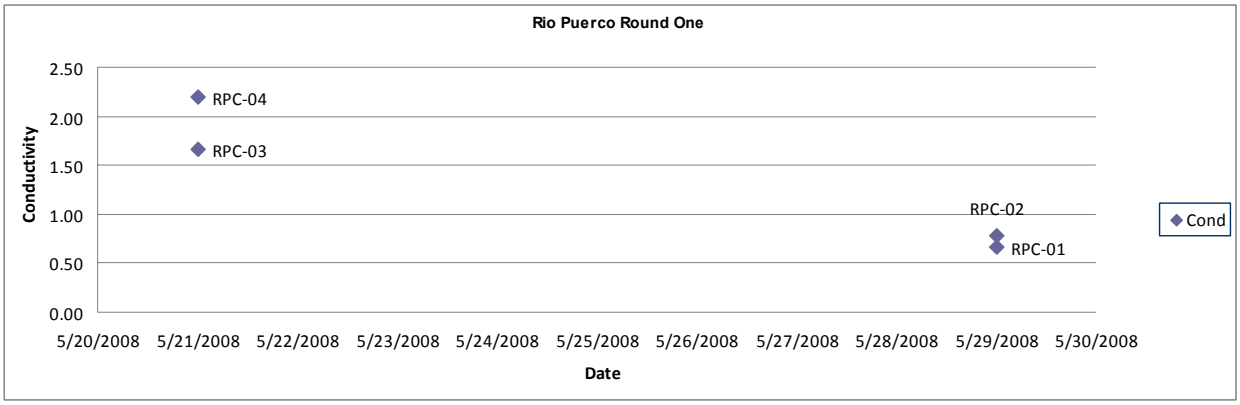


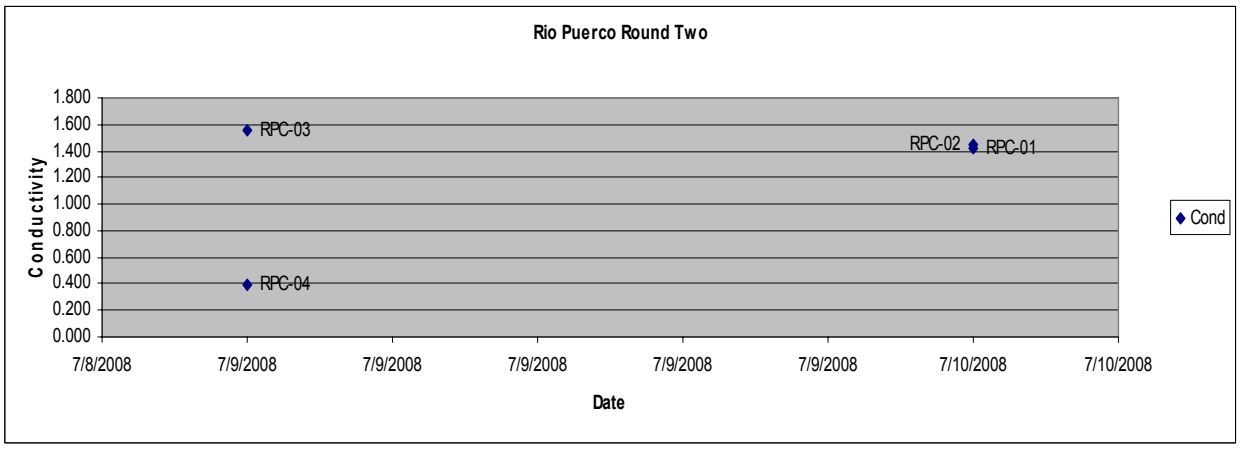

Rio Puerco Round One
Specific Conductance
2.50
2.00
1.50
1.00
0.50
0.00
2.25
1.75
0.96
0.76
SpCond
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

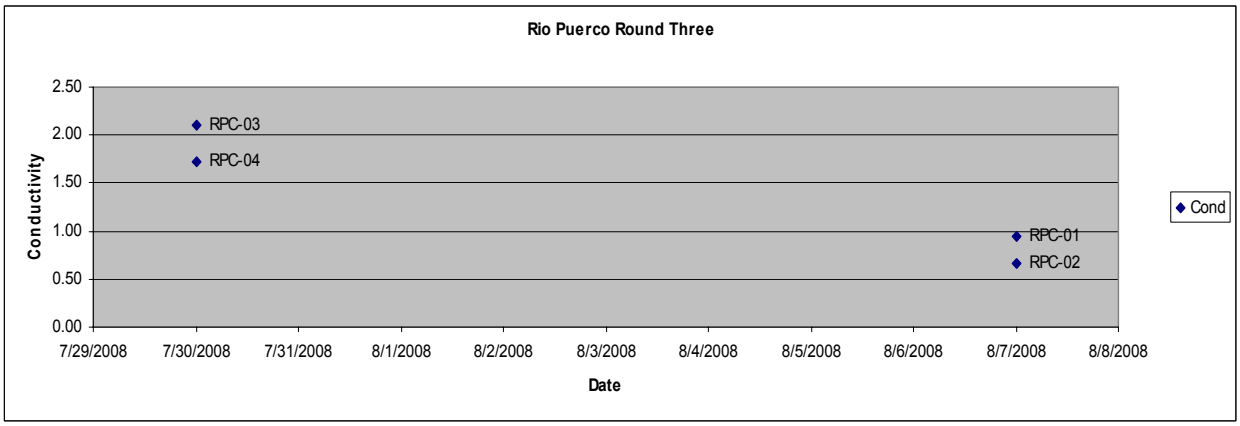

Rio Puerco Round Two
Specific Conductance
2.000
1.500
1.000
0.500
0.000
RPC-03
RPC-04
RPC-02
RPC-01
SpCond
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

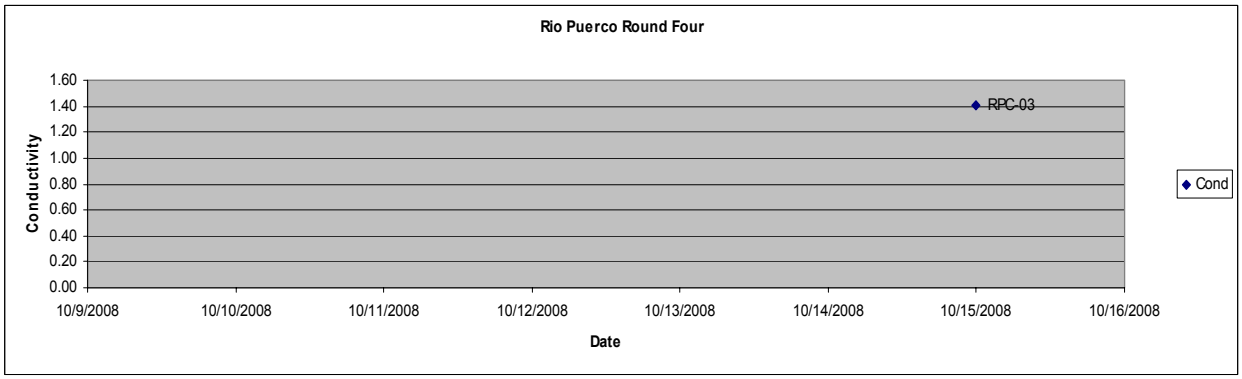

Rio Puerco Round Three
Specific Conductance
2.50
2.00
1.50
1.00
0.50
0.00
RPC-03
RPC-04
RPC-01
RPC-02
SpCond
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

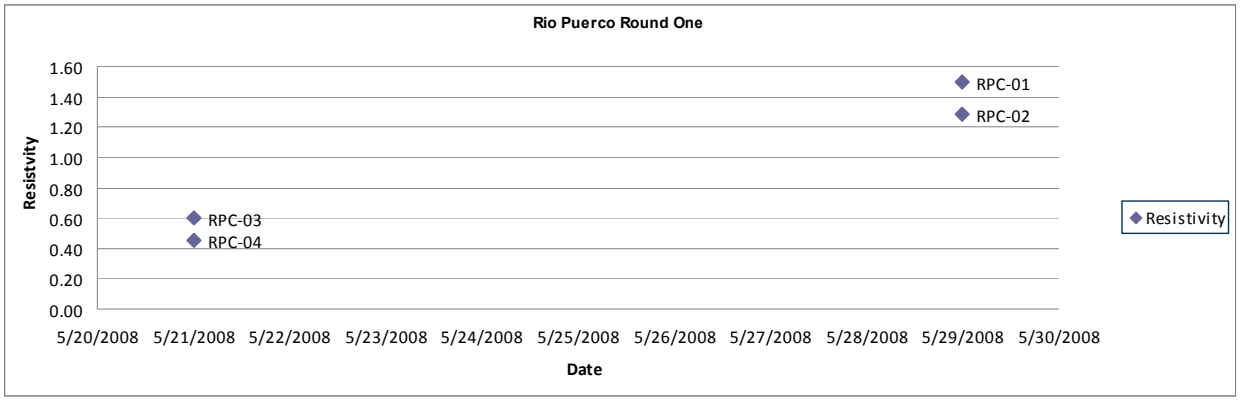

Rio Puerco Round Four
Specific Conductance
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
SpCond
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

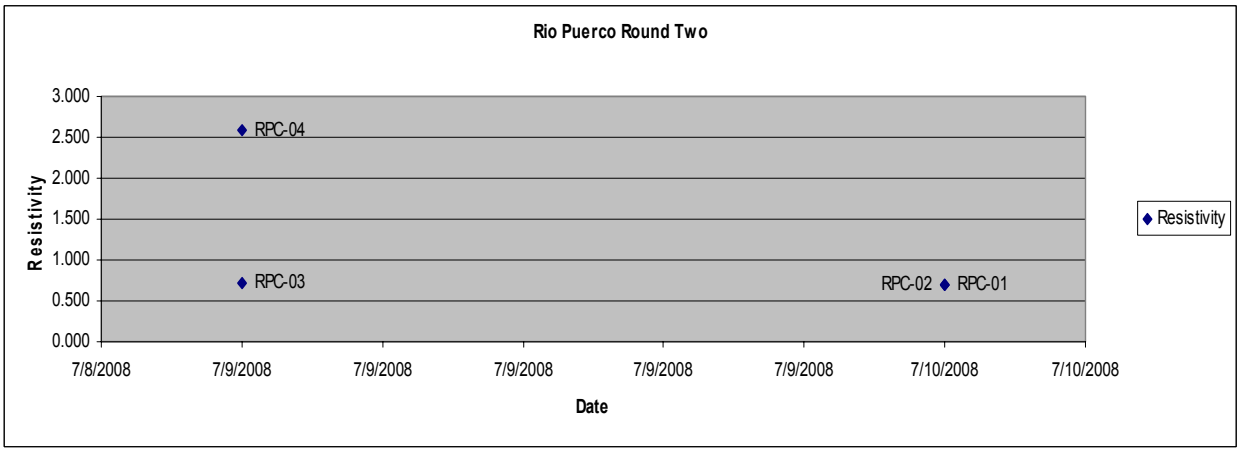

Rio Puerco Round One
Conductivity
2.50
2.00
1.50
1.00
0.50
0.00
RPC-04
RPC-03
RPC-02
RPC-01
Cond
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

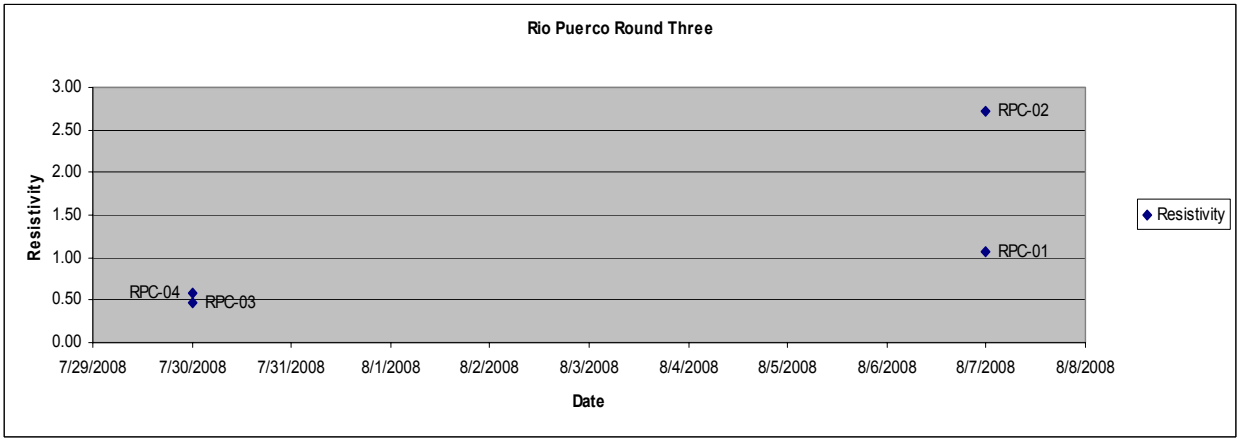

Rio Puerco Round Two
Conductivity
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
RPC-03
RPC-02
RPC-01
RPC-04
Cond
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

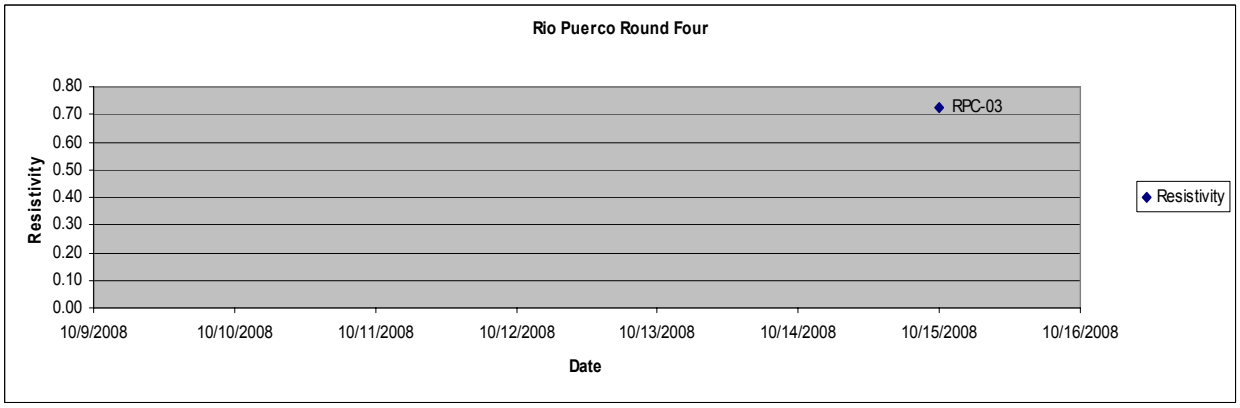

Rio Puerco Round Three
Conductivity
2.50
2.00
1.50
1.00
0.50
0.00
RPC-03
RPC-04
RPC-01
RPC-02
Cond
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

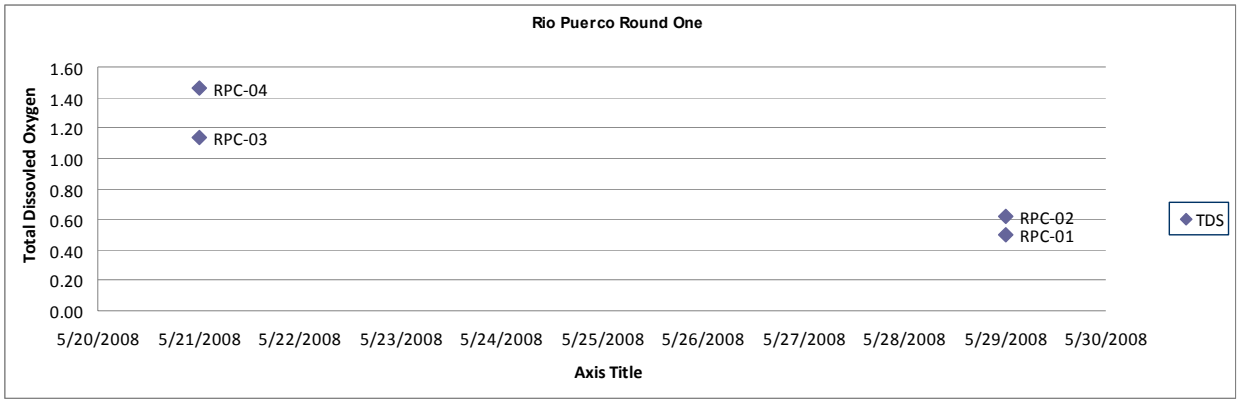

Rio Puerco Round Four
Conductivity
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
Cond
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

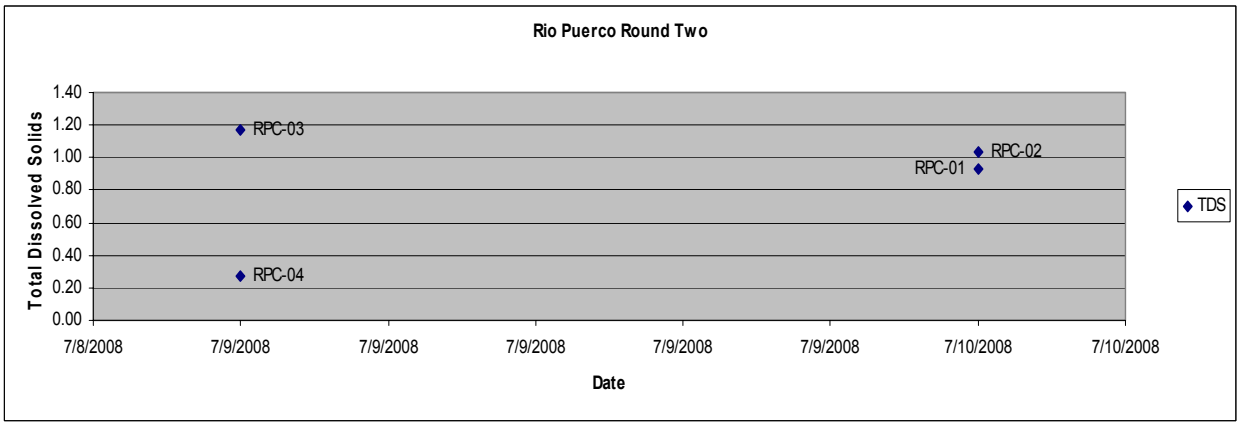

Rio Puerco Round One
Resistvity
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-01
RPC-02
RPC-03
RPC-04
Resistivity
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

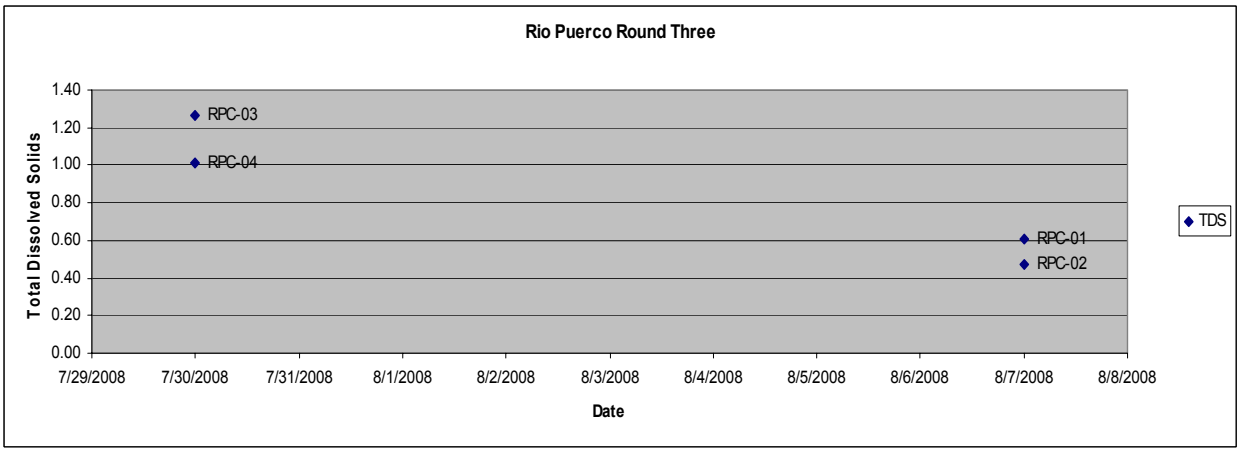

Rio Puerco Round Two
Resistivity
3.000
2.500
2.000
1.500
1.000
0.500
0.000
RPC-04
RPC-03
RPC-02
RPC-01
Resistivity
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

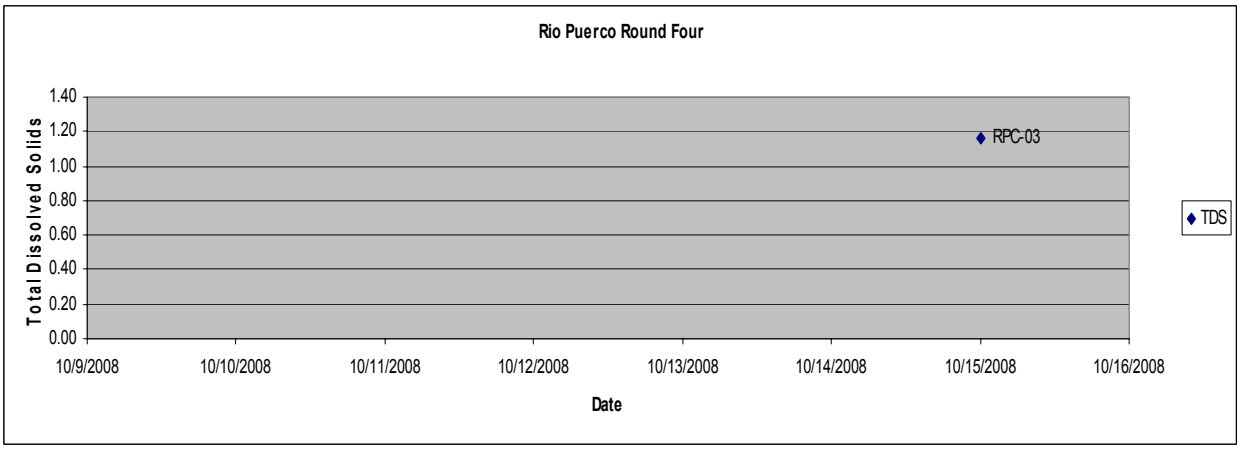

Rio Puerco Round Three
Resistivity
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPC-02
RPC-01
RPC-04
RPC-03
Resistivity
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

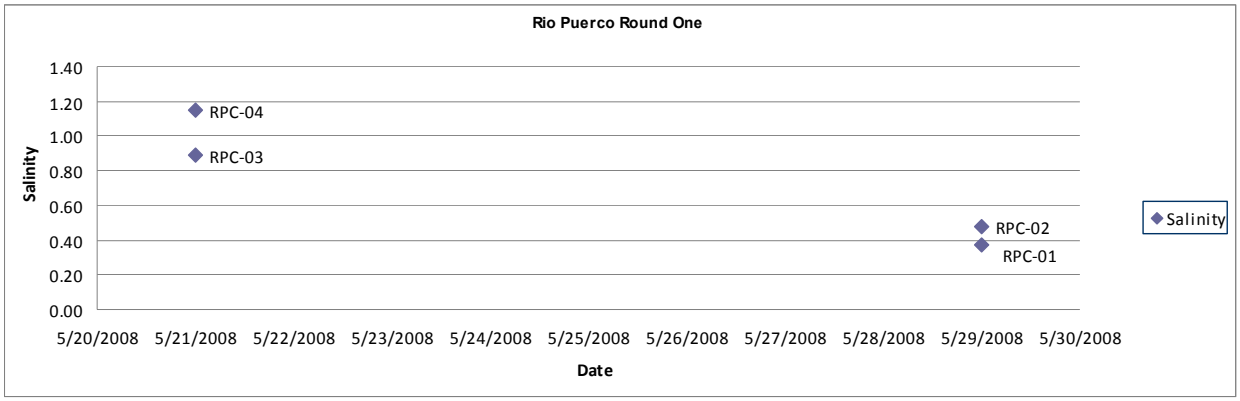

Rio Puerco Round Four
Resistivity
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
RPC-03
Resistivity
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

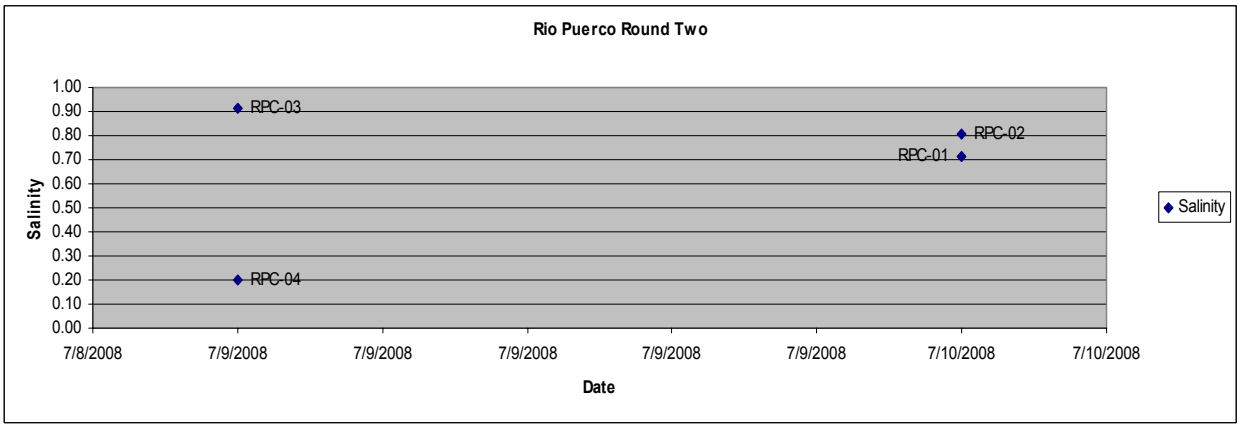

Rio Puerco Round One
Total Dissovled Oxygen
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-04
RPC-03
RPC-02
RPC-01
TDS
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Axis Title

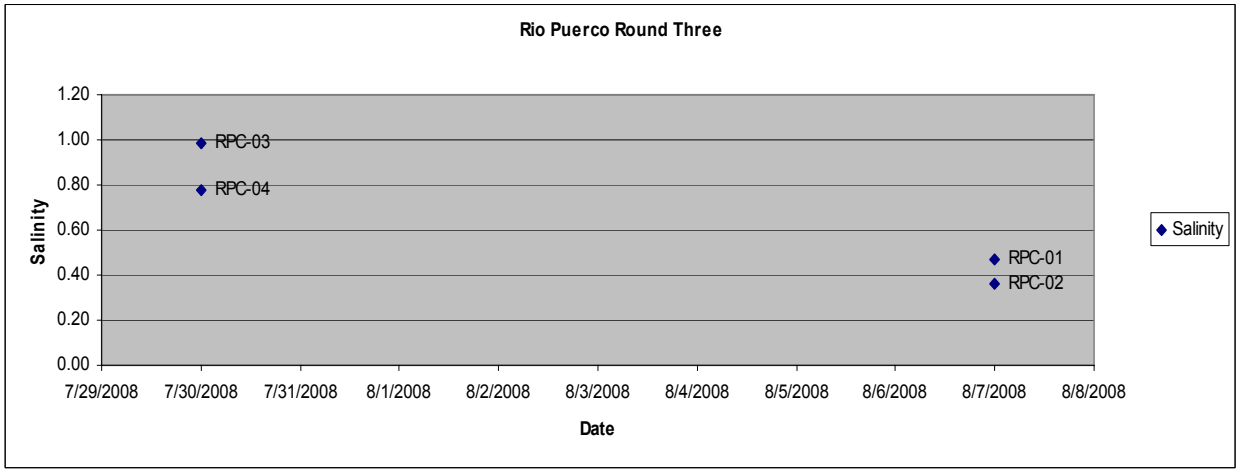

Rio Puerco Round Two
Total Dissolved Solids
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
RPC-02
RPC-01
RPC-04
TDS
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

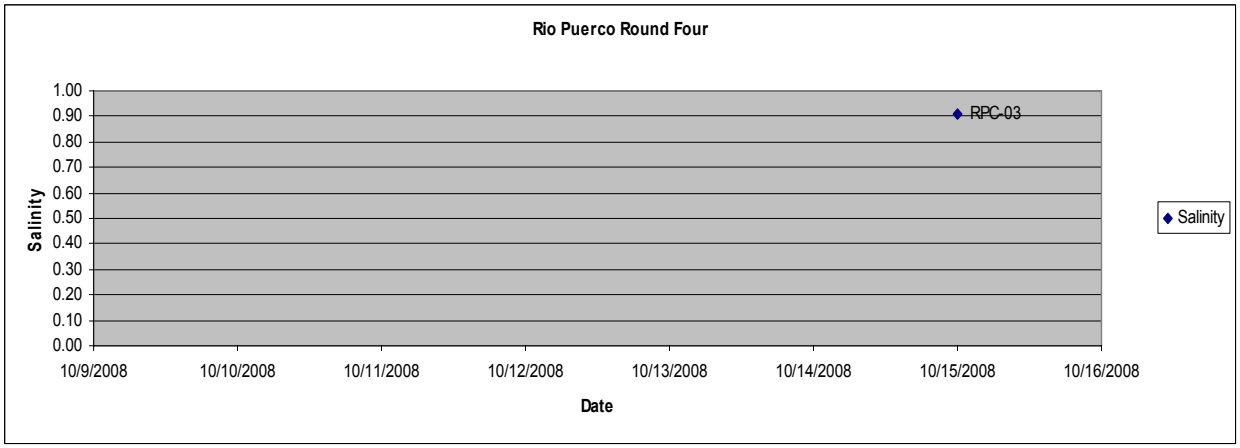

Rio Puerco Round Three
Total Dissolved Solids
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
RPC-04
RPC-01
RPC-02
TDS
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

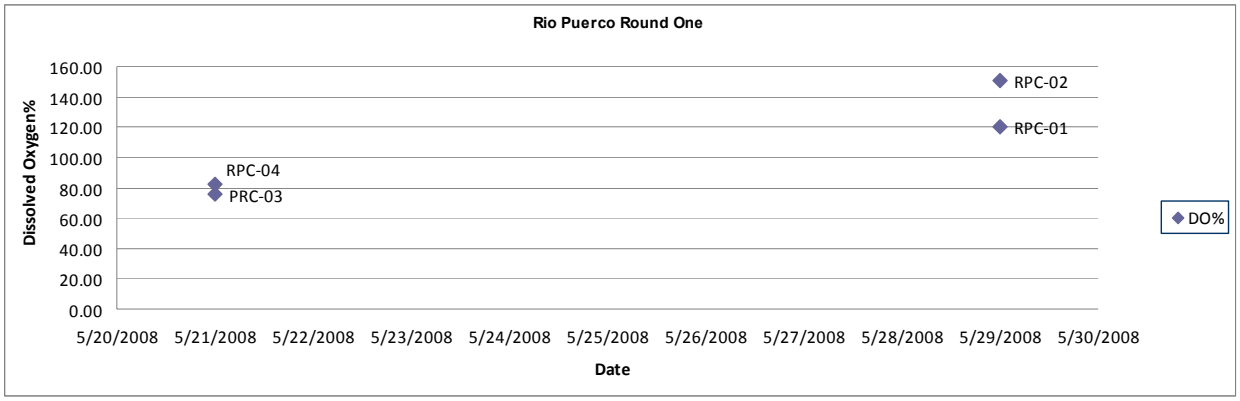

Rio Puerco Round Four
Total Dissolved Solids
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
TDS
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

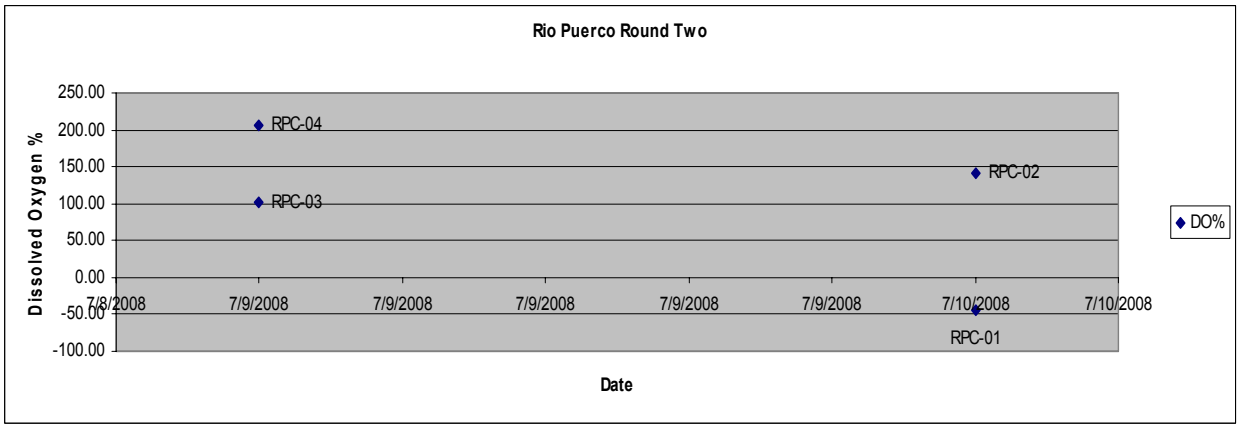

Rio Puerco Round One
Salinity
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-04
RPC-03
RPC-02
RPC-01
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date
Salinity

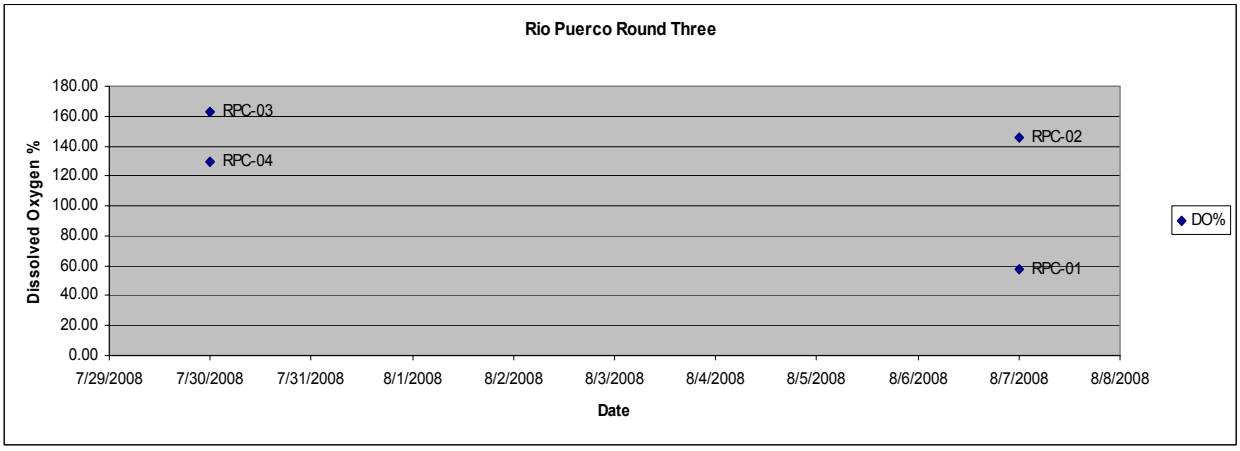

Rio Puerco Round Two
Salinity
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
RPC-03
RPC-02
RPC-01
RPC-04
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date
Salinity

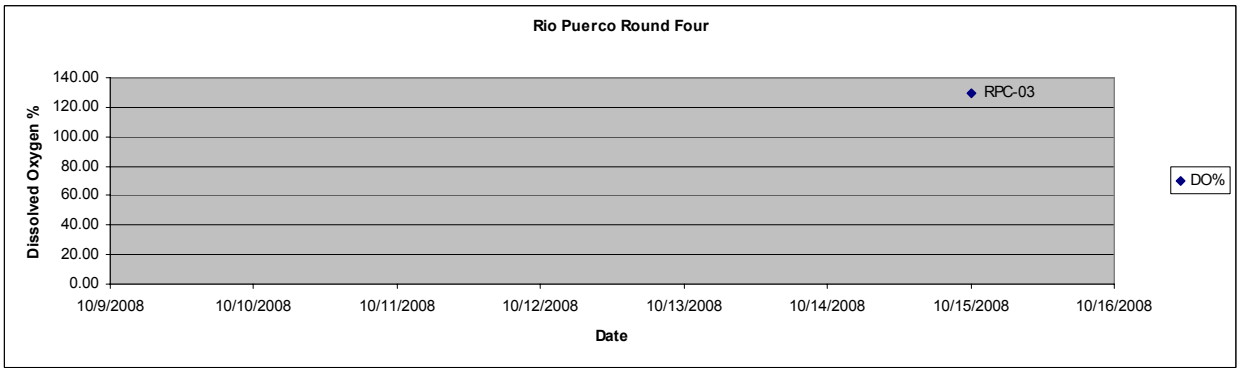

Rio Puerco Round Three
Salinity
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
RPC-04
RPC-01
RPC-02
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date
Salinity

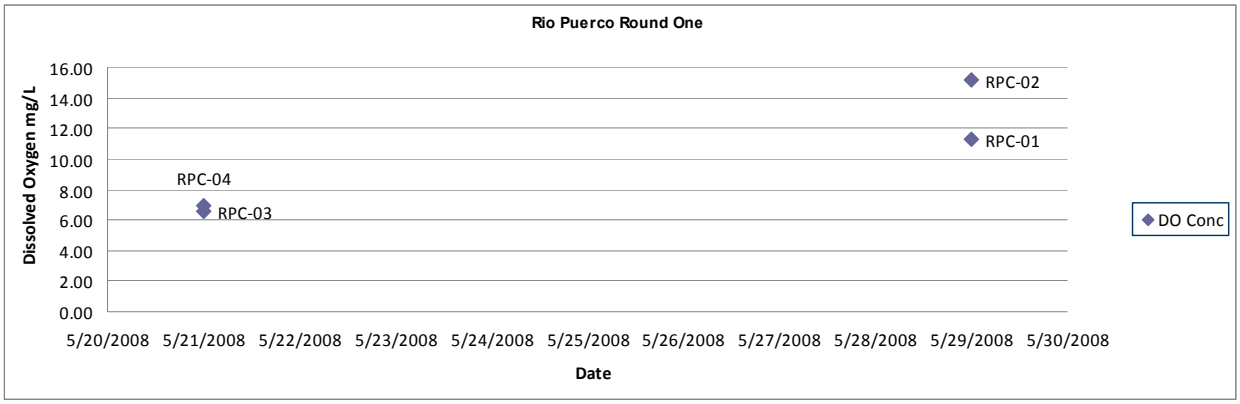

Rio Puerco Round Four
Salinity
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
RPC-03
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date
Salinity

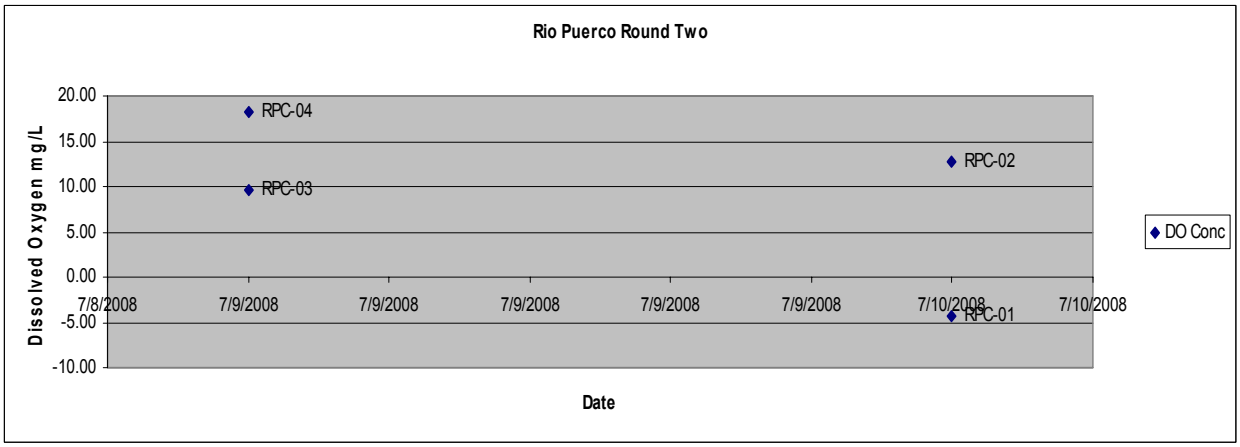

Rio Puerco Round One
Dissolved Oxygen%
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-02
RPC-01
RPC-04
PRC-03
DO%
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

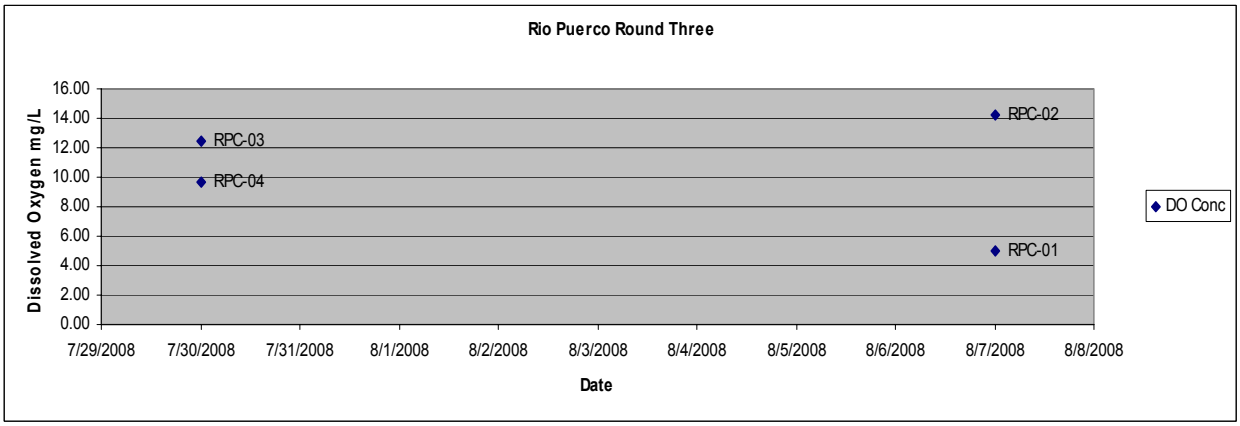

Rio Puerco Round Two
Dissolved Oxygen %
250.00
200.00
150.00
100.00
50.00
0.00
-50.00
-100.00
RPC-04
RPC-03
RPC-02
RPC-01
DO%
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

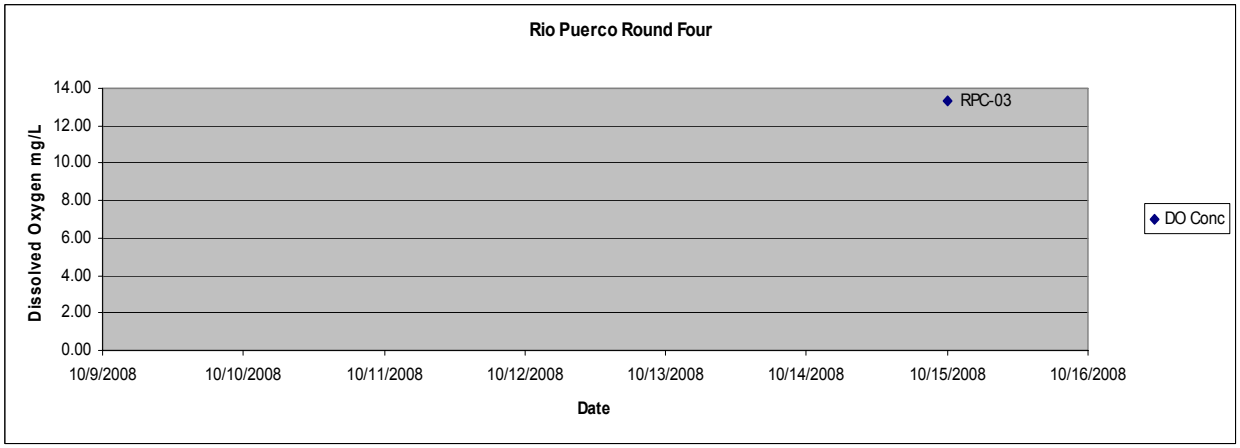

Rio Puerco Round Three
Dissolved Oxygen %
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-03
RPC-04
RPC-02
RPC-01
DO%
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

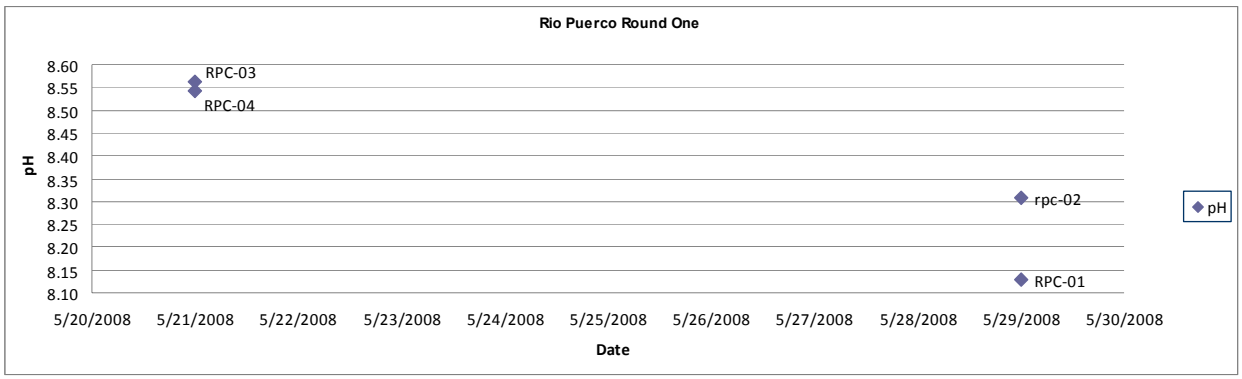

Rio Puerco Round Four
Dissolved Oxygen %
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-03
DO%
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

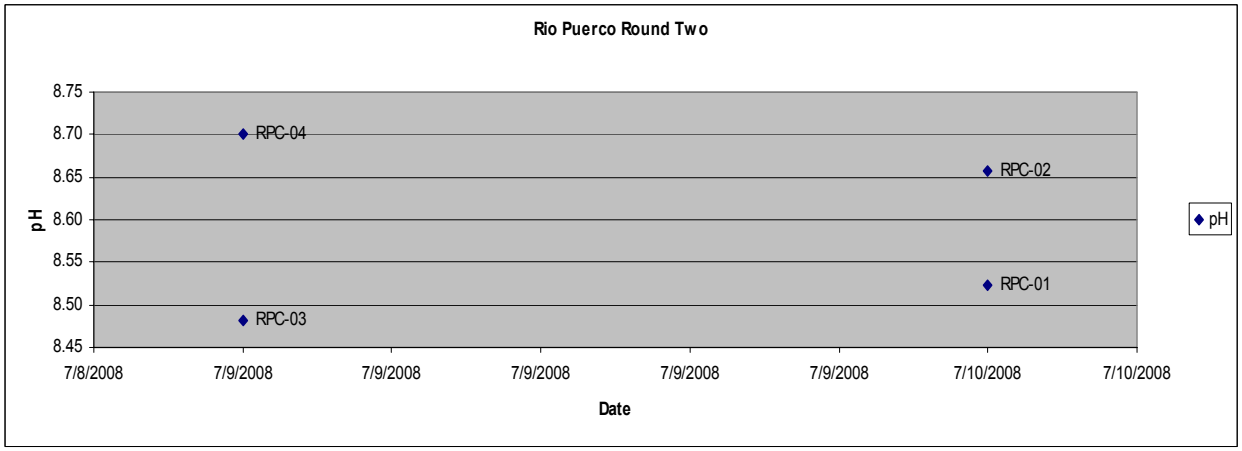

Rio Puerco Round One
Dissolved Oxygen mg/L
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPC-02
RPC-01
RPC-04
RPC-03
DO Conc
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

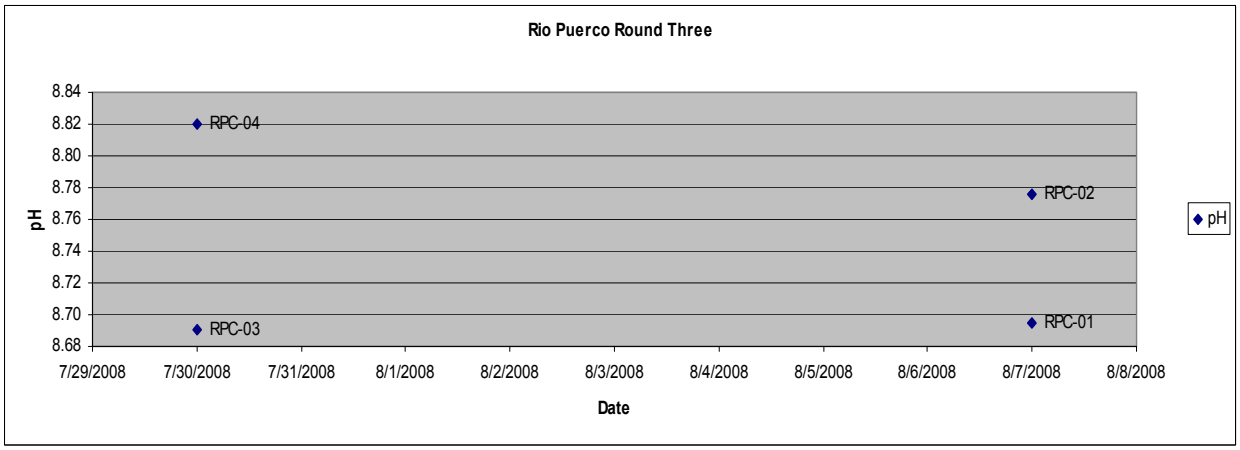

Rio Puerco Round Two
Dissolved Oxygen mg/L
20.00
15.00
10.00
5.00
0.00
-5.00
-10.00
RPC-04
RPC-03
RPC-02
RPC-01
DO Conc
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

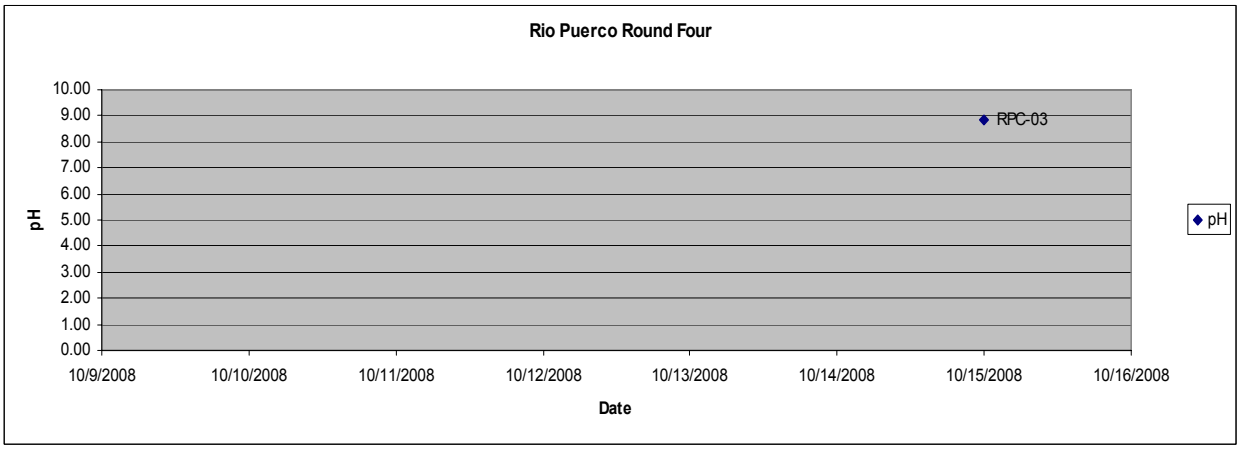

Rio Puerco Round Three
Dissolved Oxygen mg/L
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPC-03
RPC-04
RPC-02
RPC-01
DO Conc
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

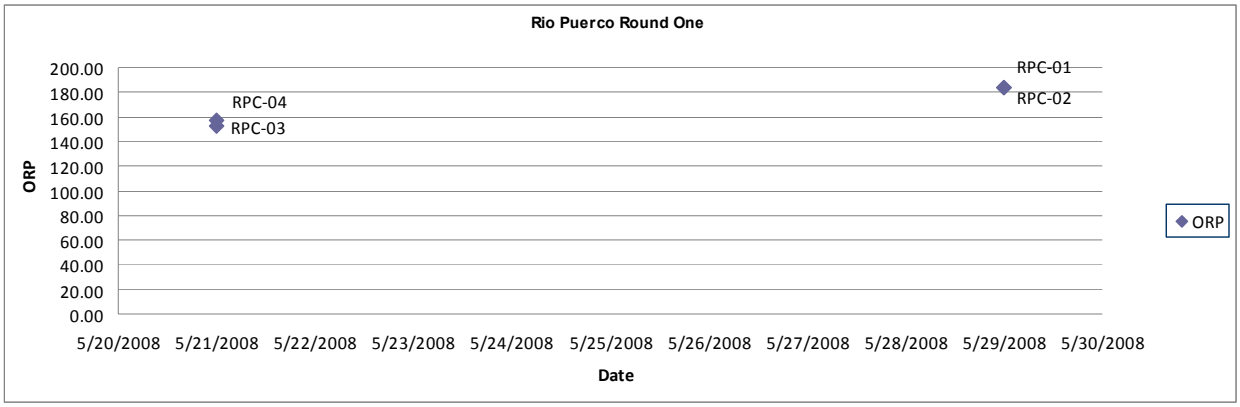

Rio Puerco Round Four
Dissolved Oxygen mg/L
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPC-03
DO Conc
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

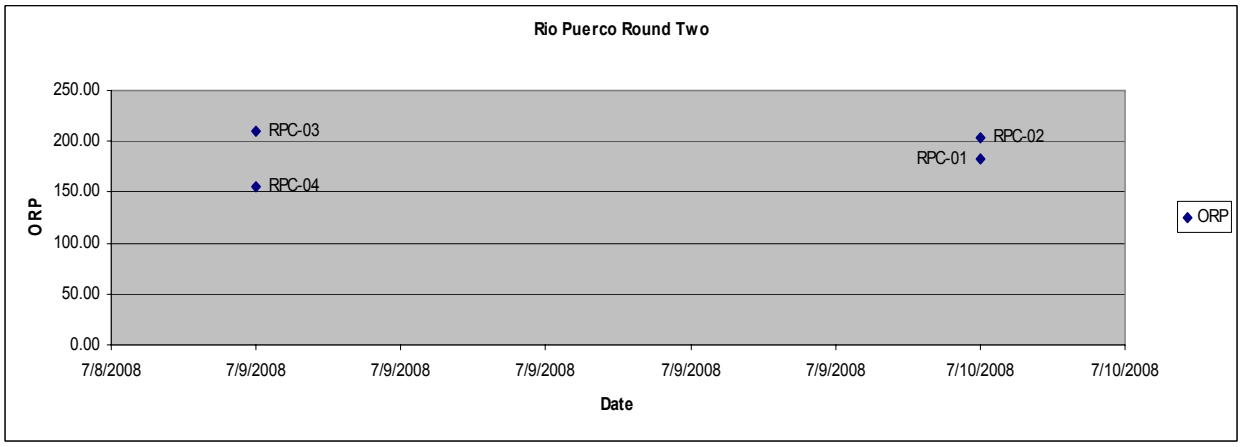

Rio Puerco Round One
8.60
8.55
8.50
8.45
8.40
8.35
8.30
8.25
8.20
8.15
8.10
pH
RPC-03
RPC-04
rpc-02
RPC-01
pH
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date

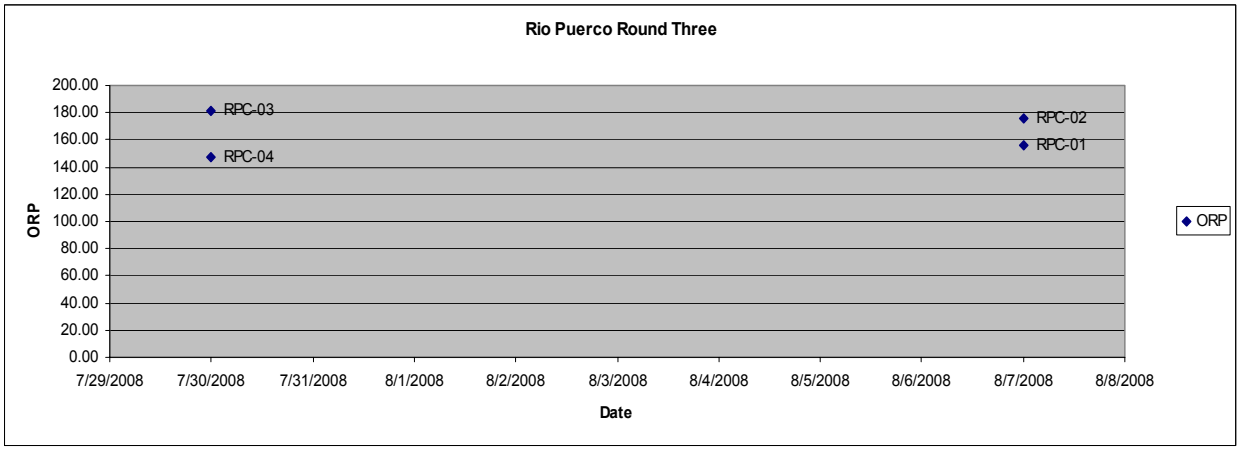

Rio Puerco Round Two
8.75
8.70
8.65
8.60
8.55
8.50
8.45
pH
RPC-04
RPC-02
RPC-01
RPC-03
pH
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date

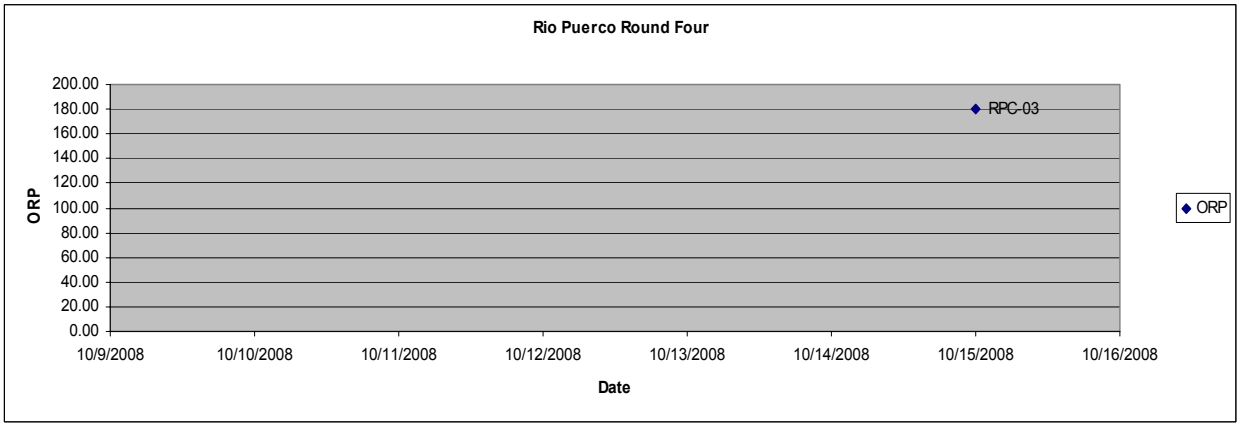

Rio Puerco Round Three
8.84
8.82
8.80
8.78
8.76
8.74
8.72
8.70
8.68
pH
RPC-04
RPC-02
RPC-03
RPC-01
pH
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date

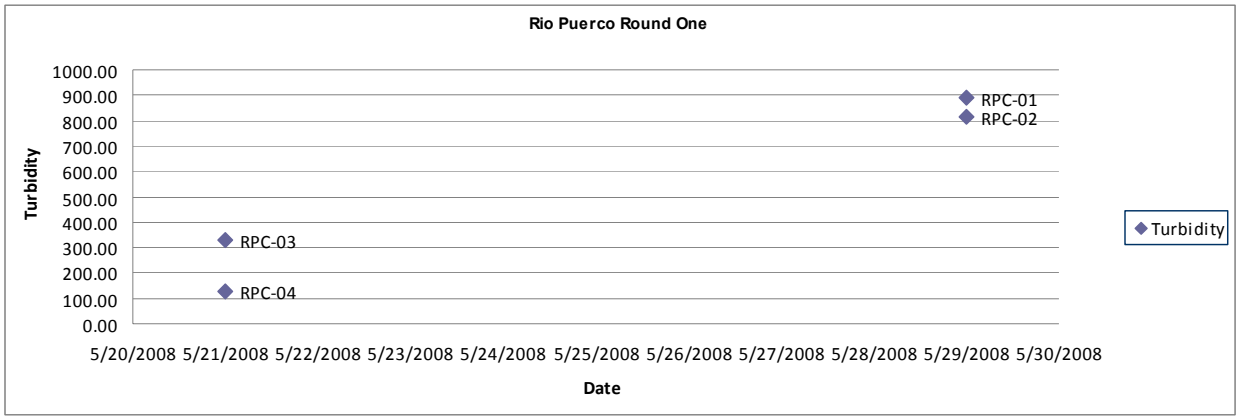

Rio Puerco Round Four
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
RPC-03
pH
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date

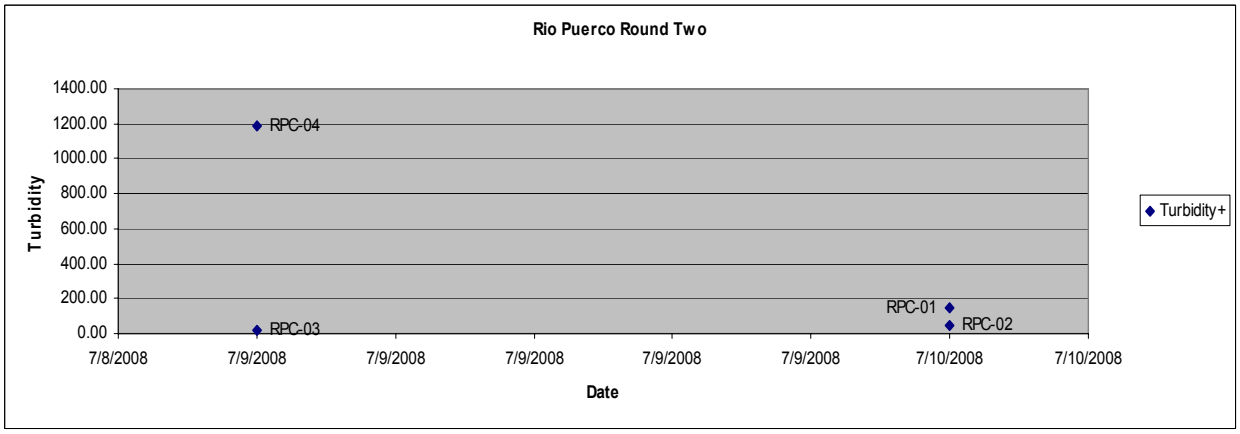

Rio Puerco Round One
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-04
RPC-03
RPC-01
RPC-02
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date
ORP

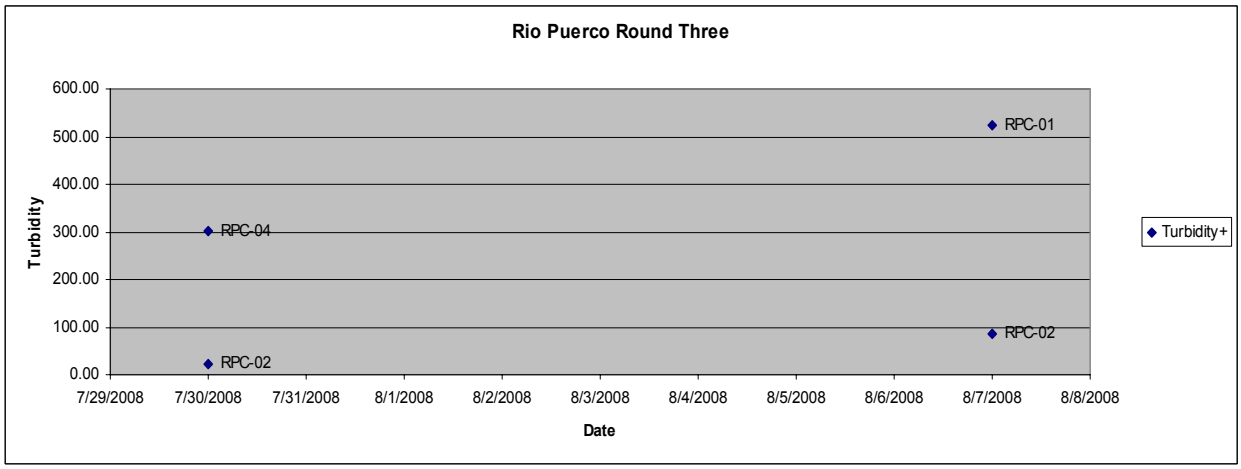

Rio Puerco Round Two
ORP
250.00
200.00
150.00
100.00
50.00
0.00
RPC-03
RPC-04
RPC-02
RPC-01
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date
ORP

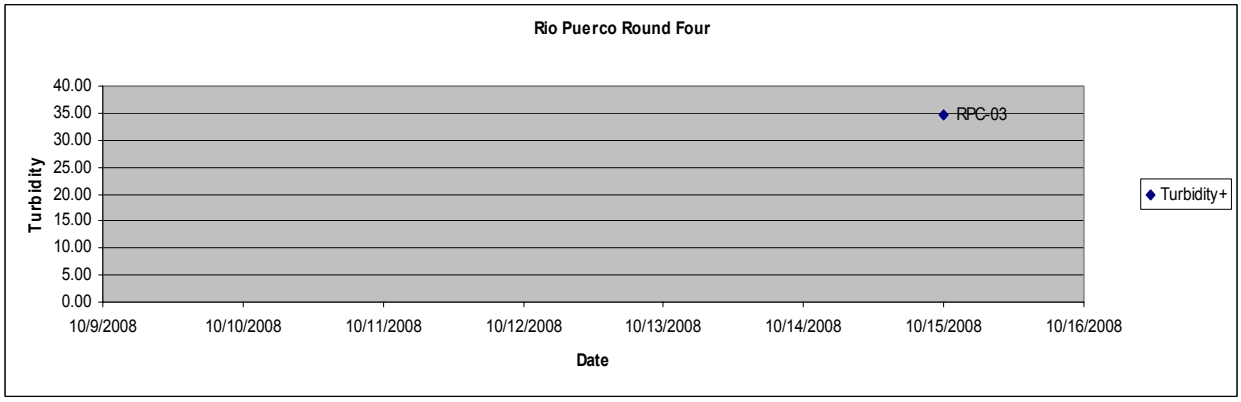

Rio Puerco Round Three
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-03
RPC-04
RPC-02
RPC-01
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date
ORP

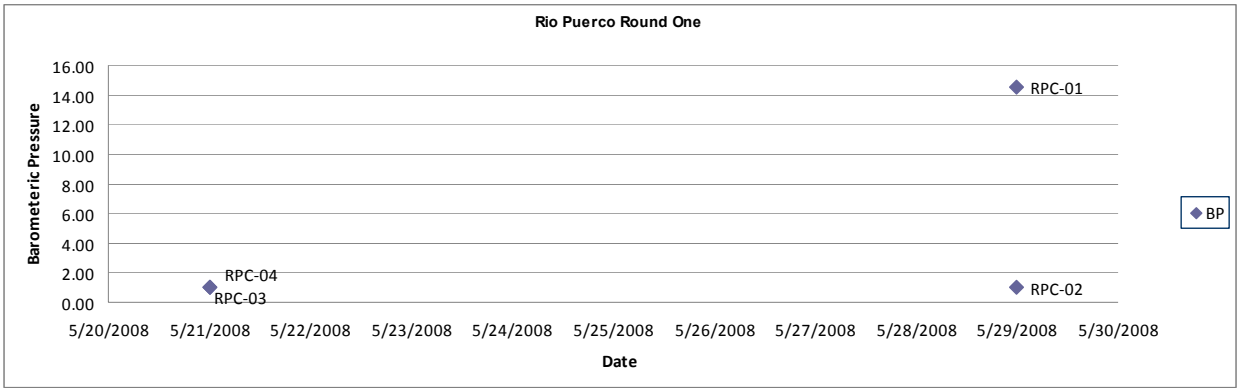

Rio Puerco Round Four
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RPC-03
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date
ORP

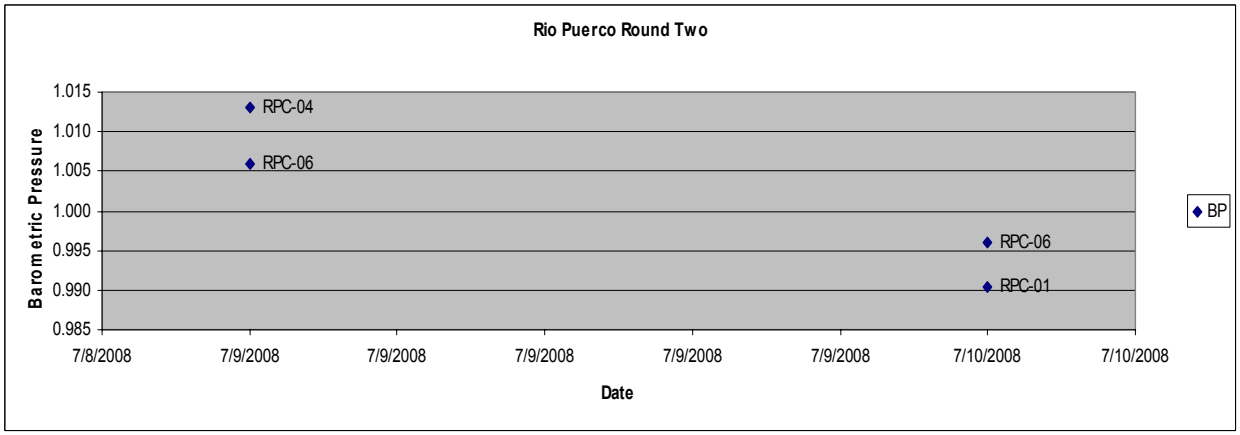

Rio Puerco Round One
Turbidity
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
RPC-01
RPC-02
RPC-03
RPC-04
5/20/2008 5/21/2008 5/22/2008 5/23/2008 5/24/2008 5/25/2008 5/26/2008 5/27/2008 5/28/2008 5/29/2008 5/30/2008
Date
Turbidity

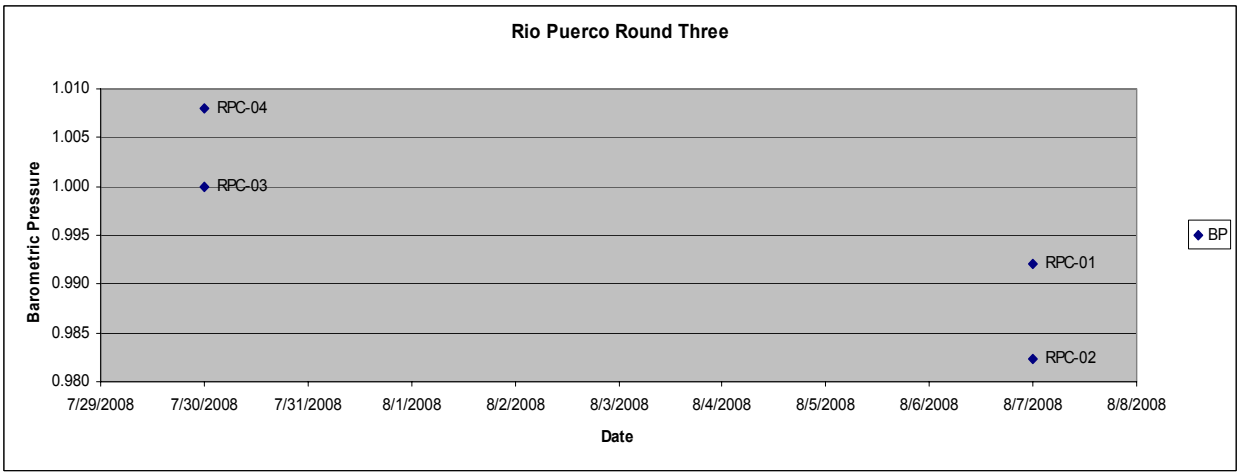

Rio Puerco Round Two
Turbidity
1400.00
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
RPC-04
RPC-01
RPC-02
RPC-03
7/8/2008 7/9/2008 7/9/2008 7/9/2008 7/9/2008 7/9/2008 7/10/2008 7/10/2008
Date
Turbidity+

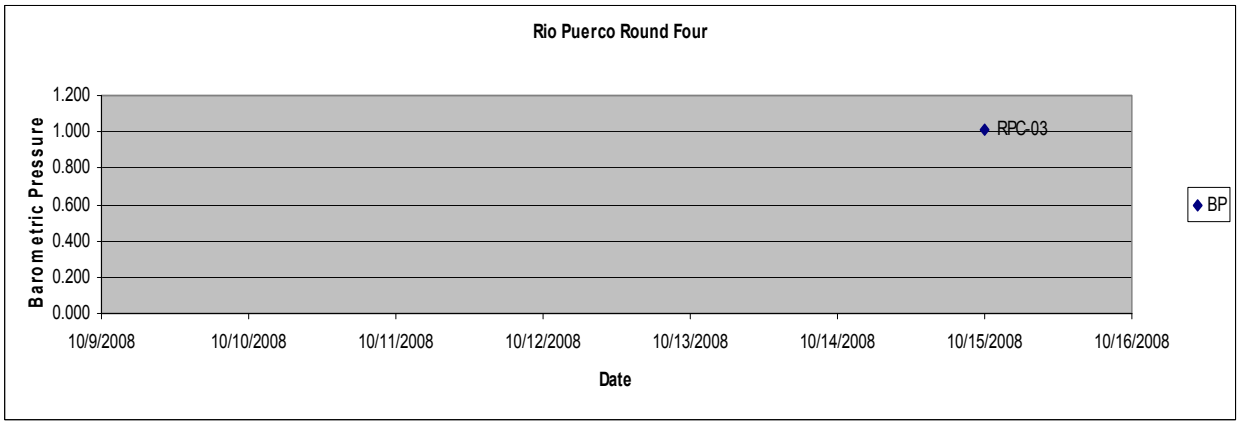

Rio Puerco Round Three
Turbidity
600.00
500.00
400.00
300.00
200.00
100.00
0.00
RPC-01
RPC-04
RPC-02
RPC-02
7/29/2008 7/30/2008 7/31/2008 8/1/2008 8/2/2008 8/3/2008 8/4/2008 8/5/2008 8/6/2008 8/7/2008 8/8/2008
Date
Turbidity+


Rio Puerco Round Four
Turbidity
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RPC-03
10/9/2008 10/10/2008 10/11/2008 10/12/2008 10/13/2008 10/14/2008 10/15/2008 10/16/2008
Date
Turbidity+

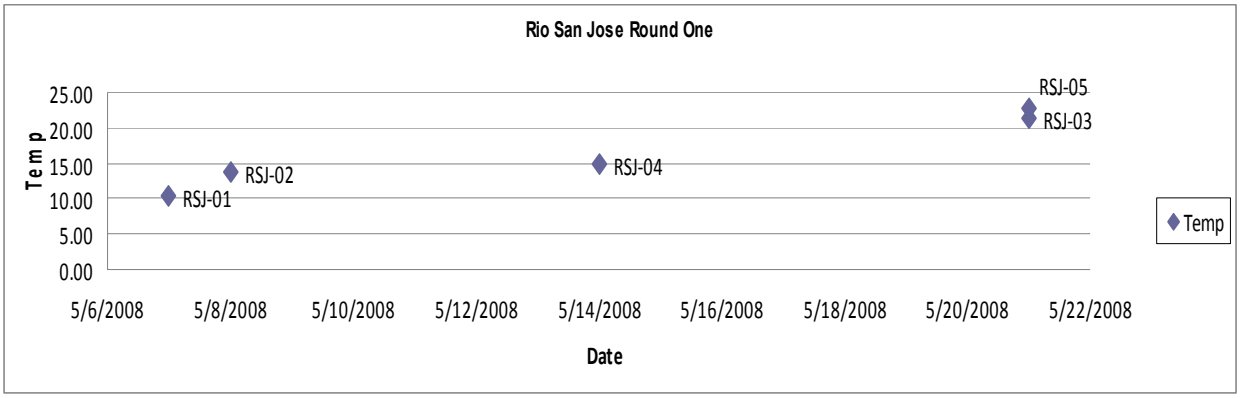

Rio Puerco Round One
Barometeric Pressure
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RPC-01
RPC-04
RPC-03
RPC-02
5/20/2008
5/21/2008
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
5/30/2008
Date
BP

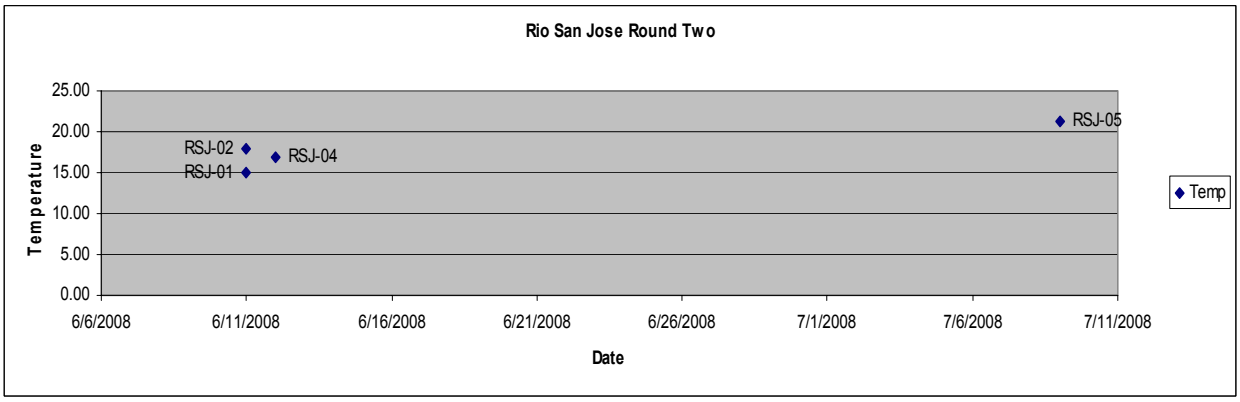

Rio Puerco Round Two
Barometric Pressure
1.015
1.010
1.005
1.000
0.995
0.990
0.985
RPC-04
RPC-06
RPC-06
RPC-01
7/8/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/9/2008
7/10/2008
7/10/2008
Date
BP

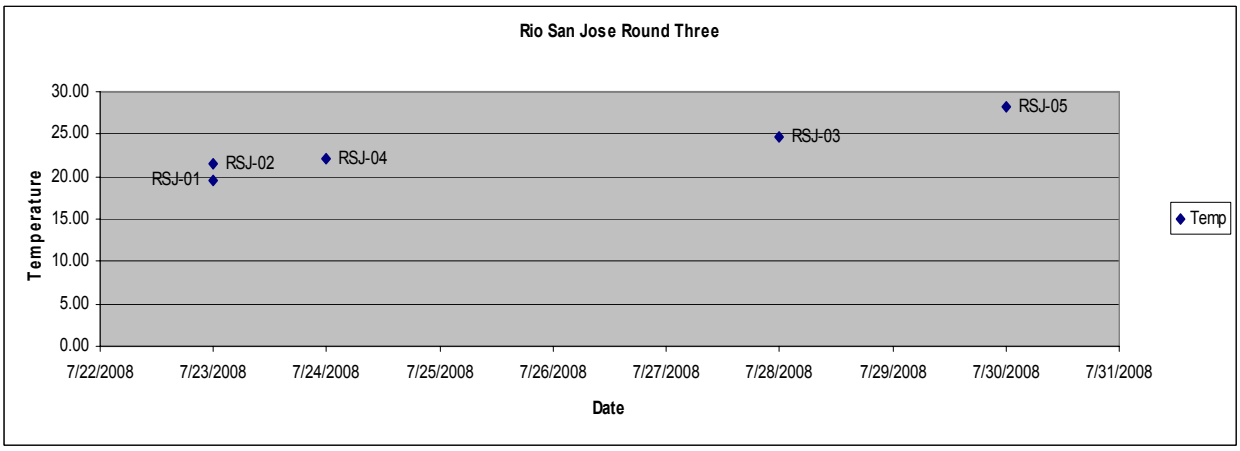

Rio Puerco Round Three
Barometric Pressure
1.010
1.005
1.000
0.995
0.990
0.985
0.980
RPC-04
RPC-03
RPC-01
RPC-02
7/29/2008
7/30/2008
7/31/2008
8/1/2008
8/2/2008
8/3/2008
8/4/2008
8/5/2008
8/6/2008
8/7/2008
8/8/2008
Date
BP

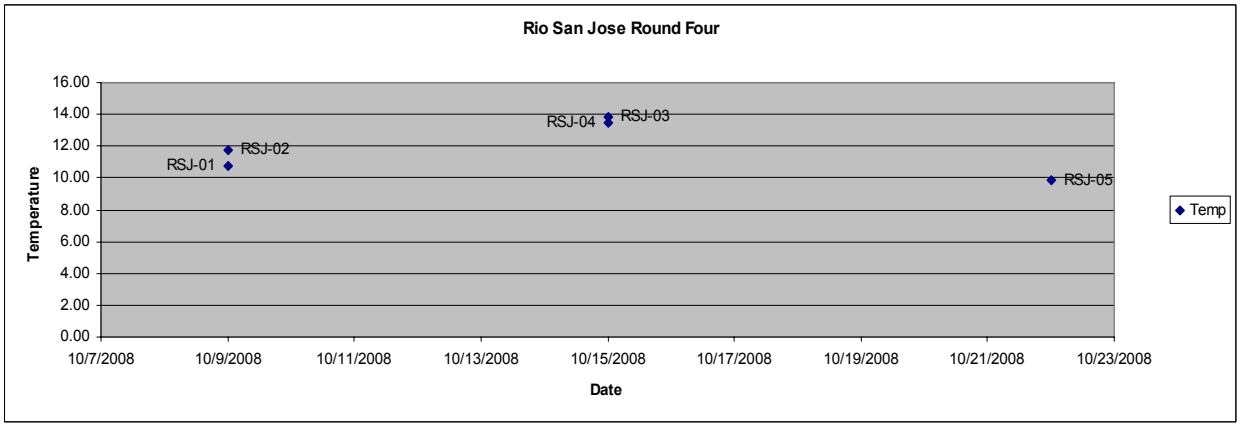

Rio Puerco Round Four
Barometric Pressure
1.200
1.000
0.800
0.600
0.400
0.200
0.000
RPC-03
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
Date
BP

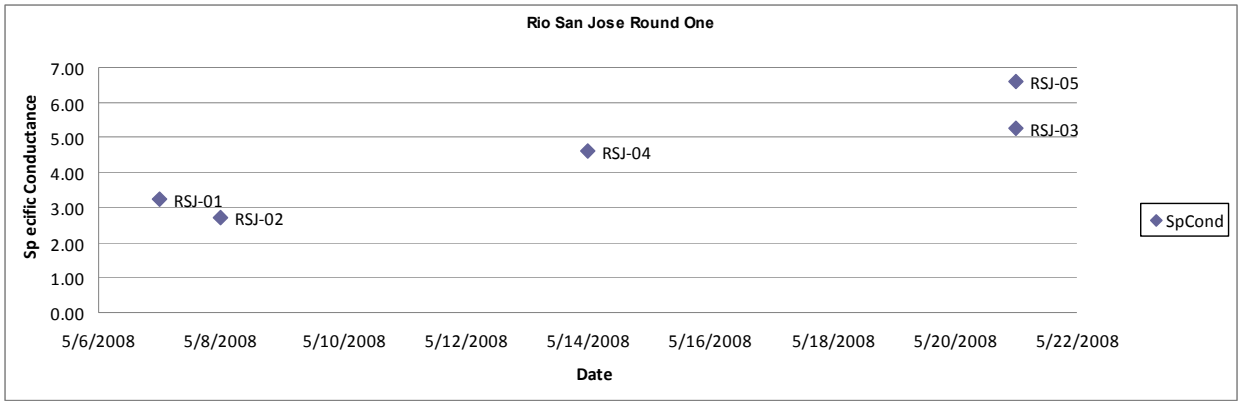
Rio San Jose

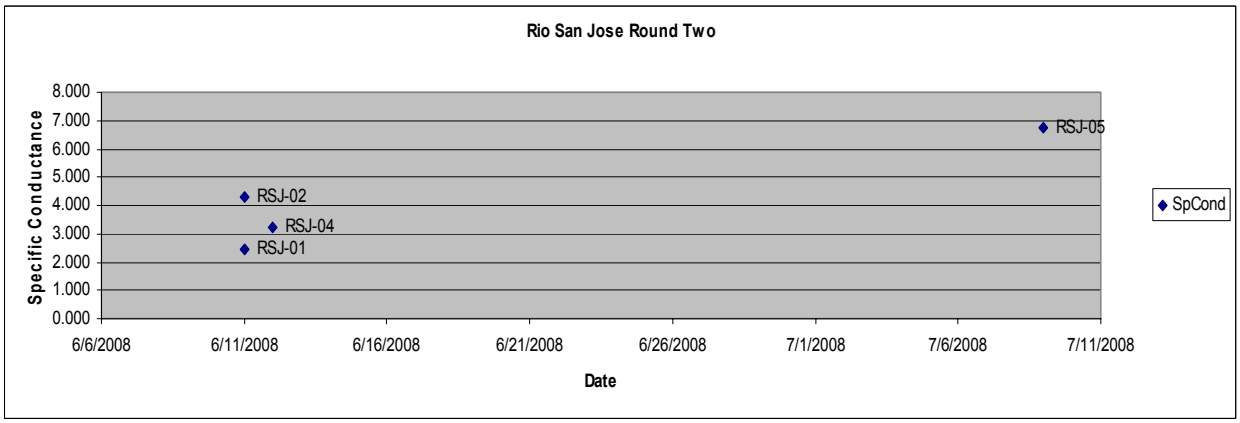

Rio San Jose Round One
Temp
25.00
20.00
15.00
10.00
5.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
Temp

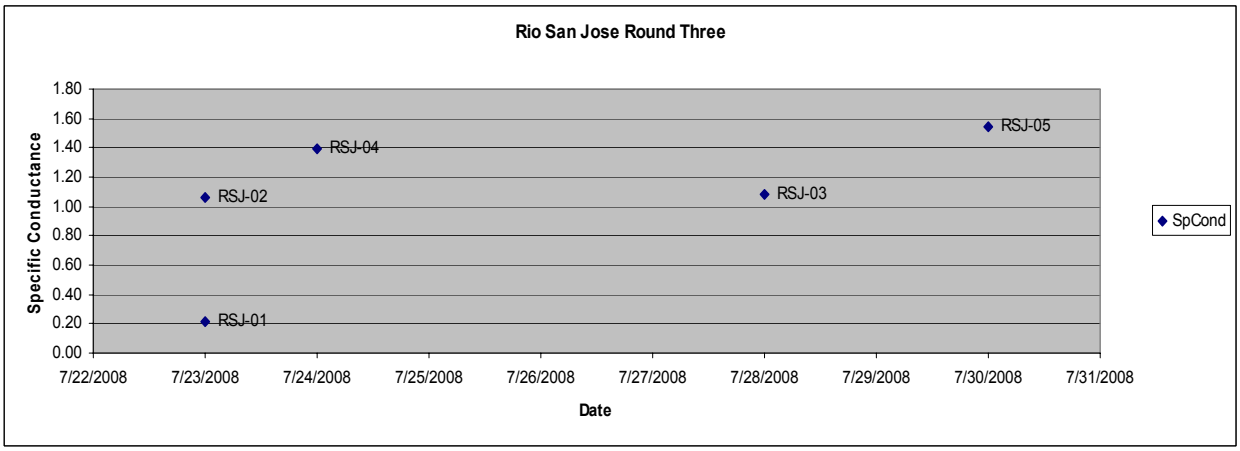

Rio San Jose Round Two
Temperature
25.00
20.00
15.00
10.00
5.00
0.00
RSJ-02
RSJ-01
RSJ-04
RSJ-05
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
Temp

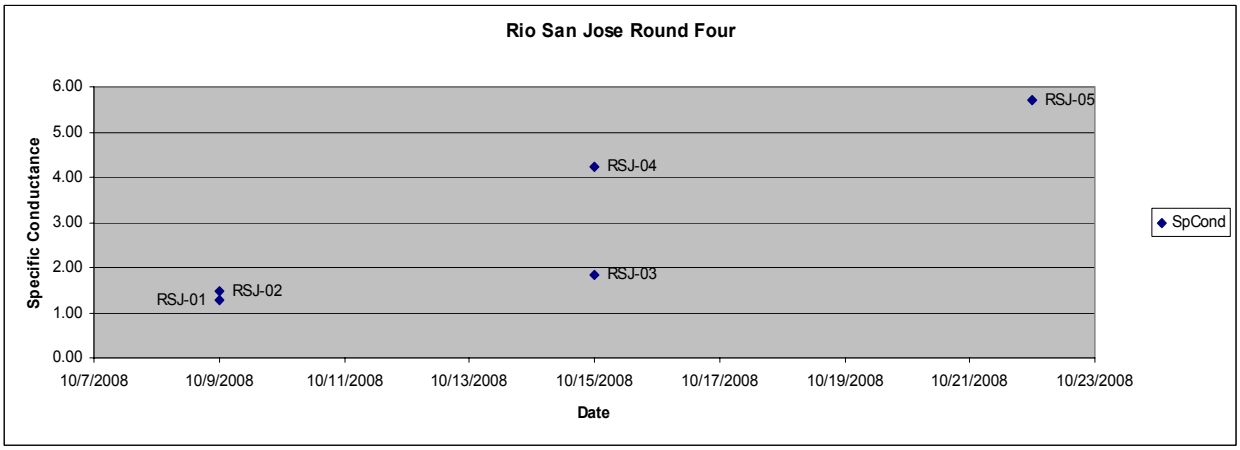

Rio San Jose Round Three
Temperature
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
Temp

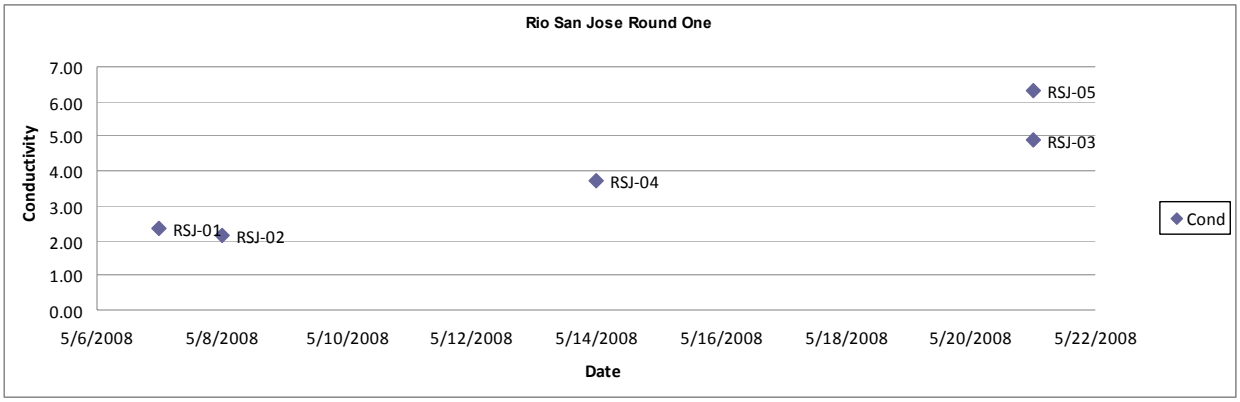

Rio San Jose Round Four
Temperature
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
Temp

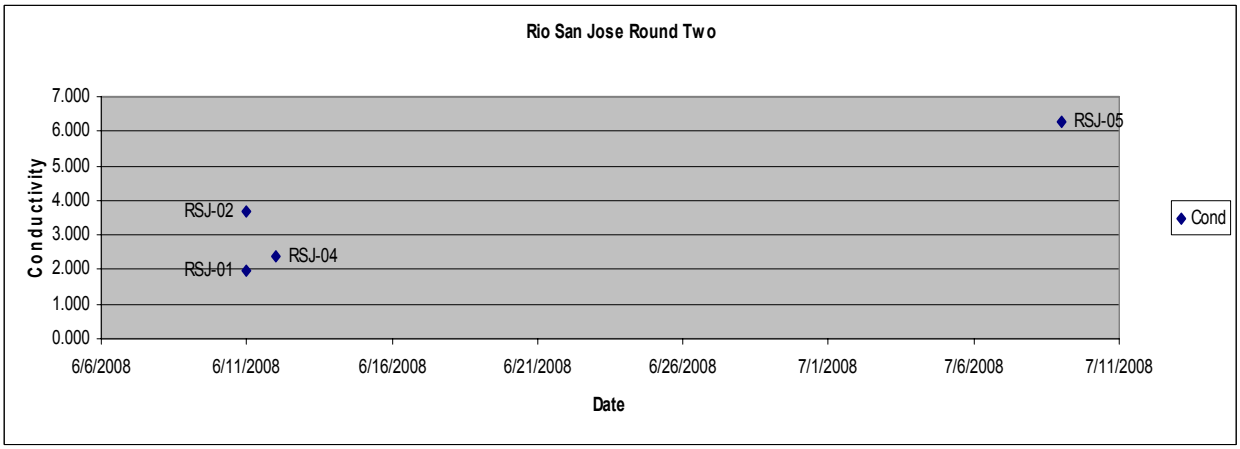

Rio San Jose Round One
Sp ecific Conductance
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
SpCond

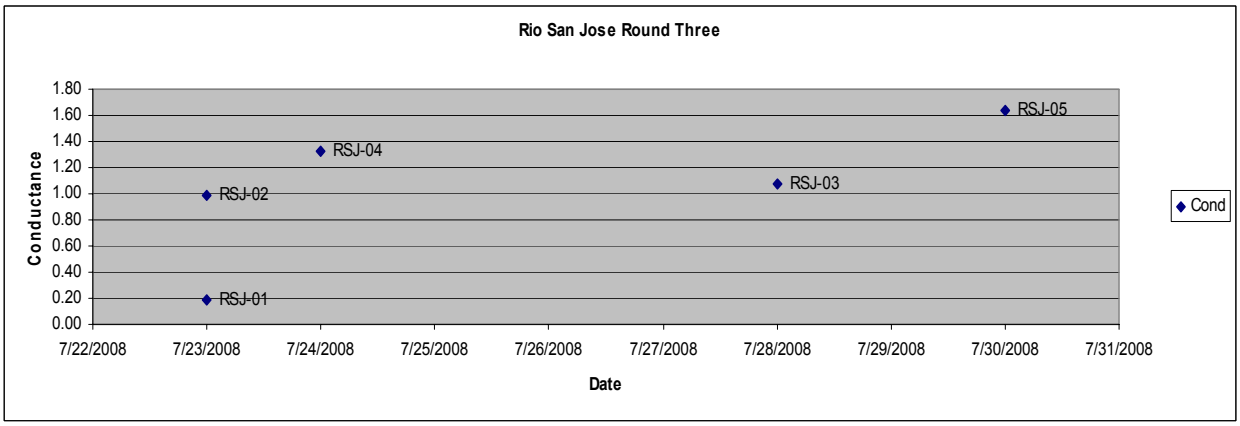

Rio San Jose Round Two
Specific Conductance
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
RSJ-05
RSJ-02
RSJ-04
RSJ-01
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
SpCond

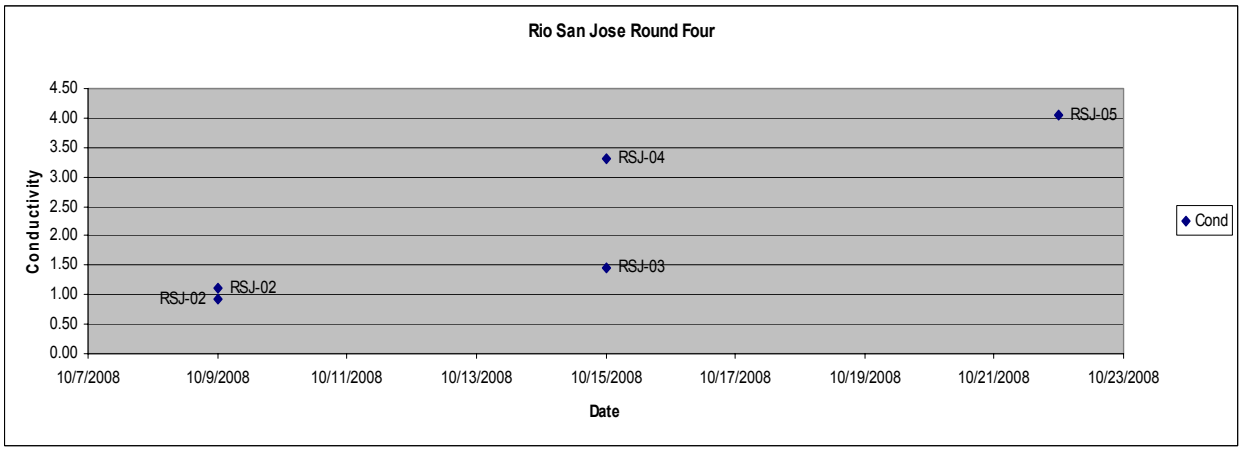

Rio San Jose Round Three
Specific Conductance
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RSJ-05
RSJ-04
RSJ-02
RSJ-03
RSJ-01
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
SpCond

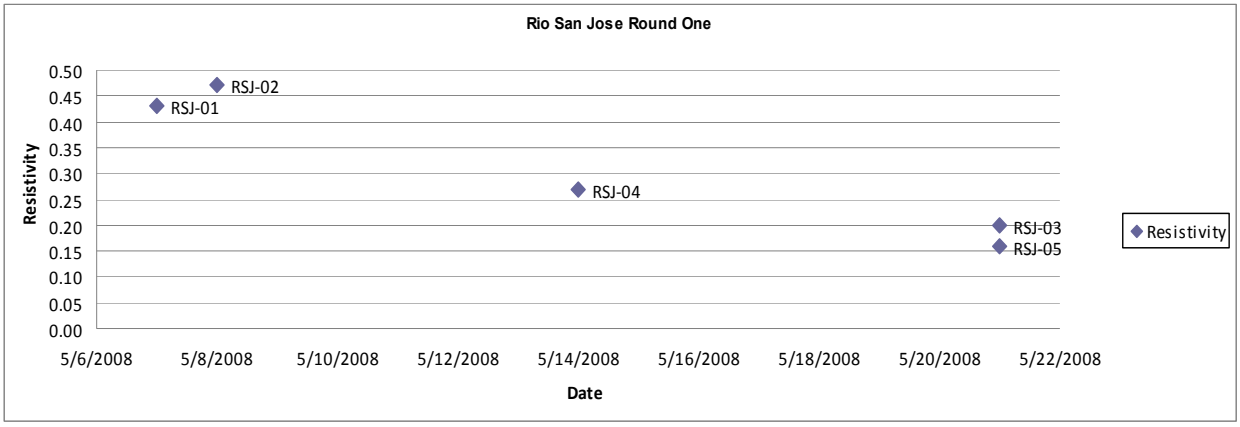

Rio San Jose Round Four
Specific Conductance
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RSJ-05
RSJ-04
RSJ-03
RSJ-01
RSJ-02
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
SpCond

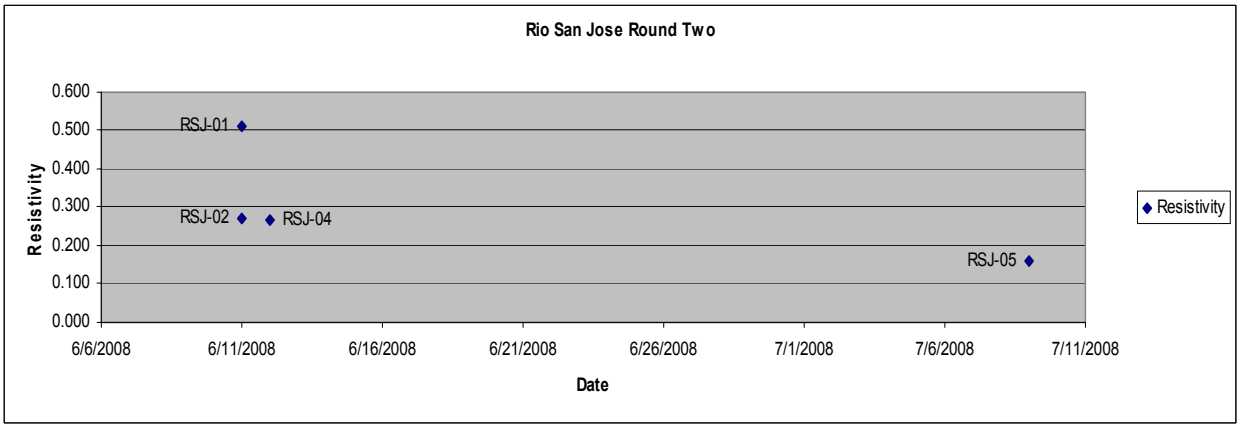

Rio San Jose Round One
Conductivity
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RSJ-05
RSJ-03
RSJ-04
RSJ-01
RSJ-02
Cond
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date

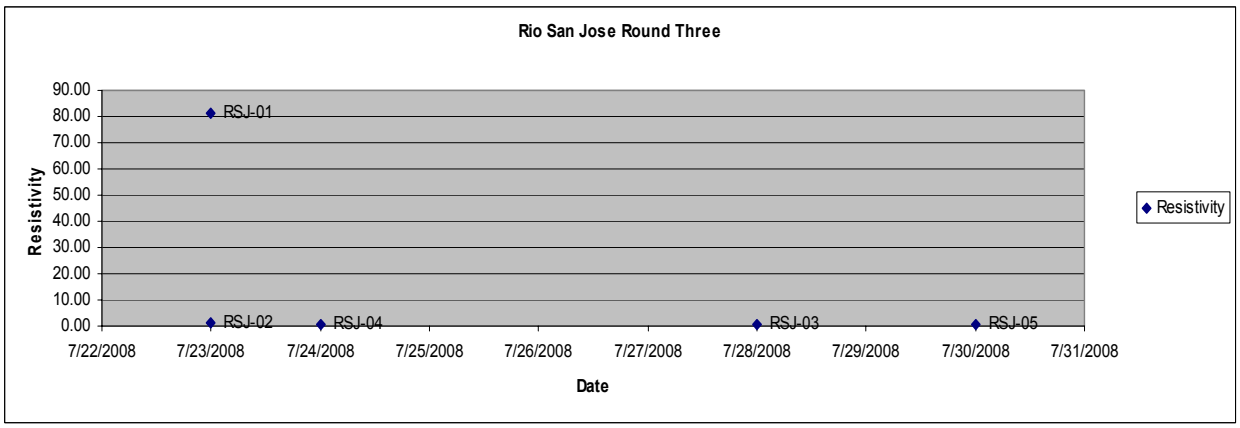

Rio San Jose Round Two
Conductivity
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
RSJ-05
RSJ-02
RSJ-04
RSJ-01
Cond
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date

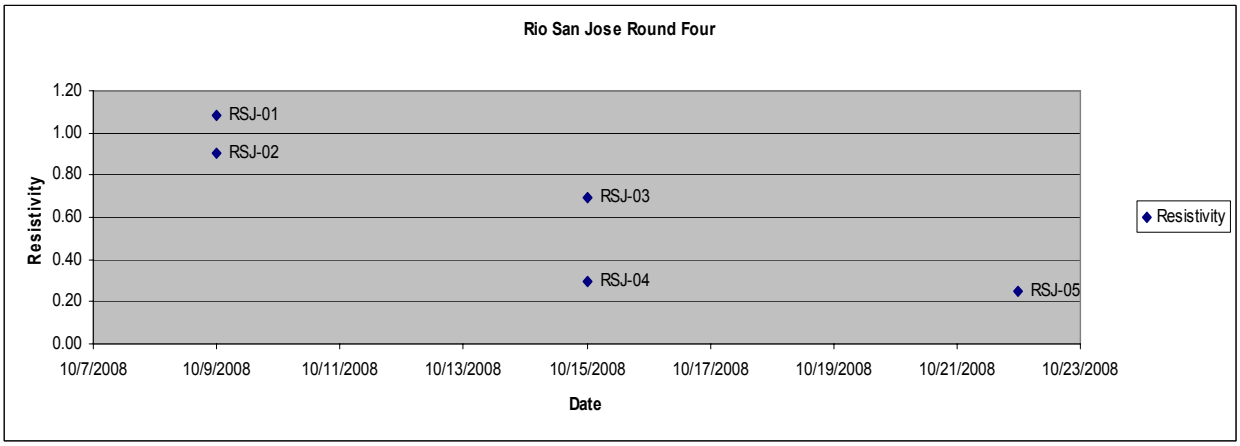

Rio San Jose Round Three
Conductance
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RSJ-05
RSJ-04
RSJ-03
RSJ-02
RSJ-01
Cond
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date

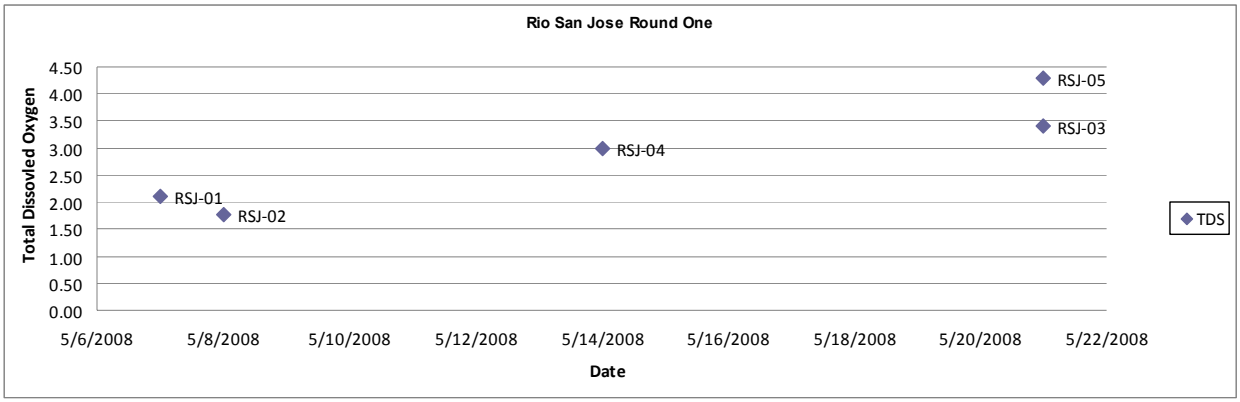

Rio San Jose Round Four
Conductivity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RSJ-05
RSJ-04
RSJ-03
RSJ-02
RSJ-02
Cond
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date

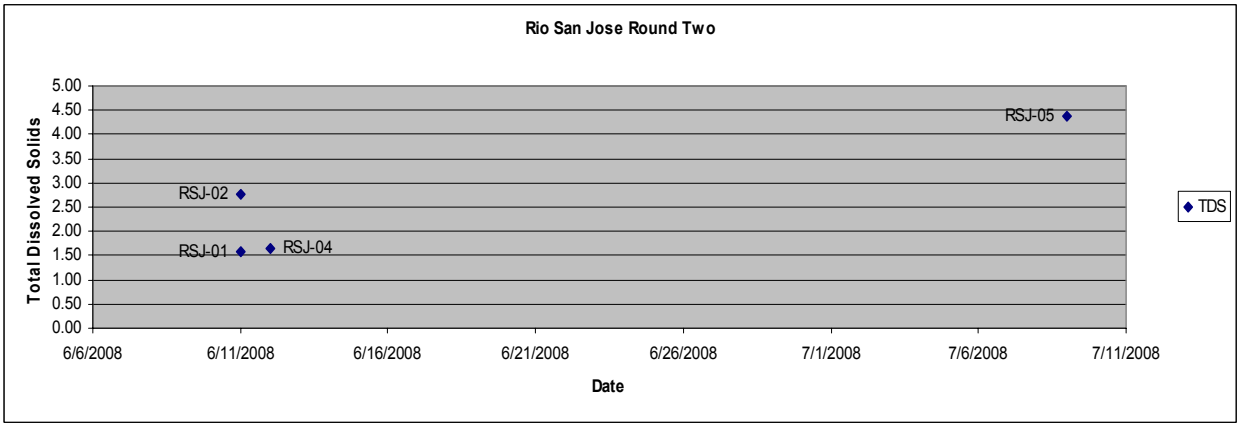

Rio San Jose Round One
Resistivity
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
Resistivity

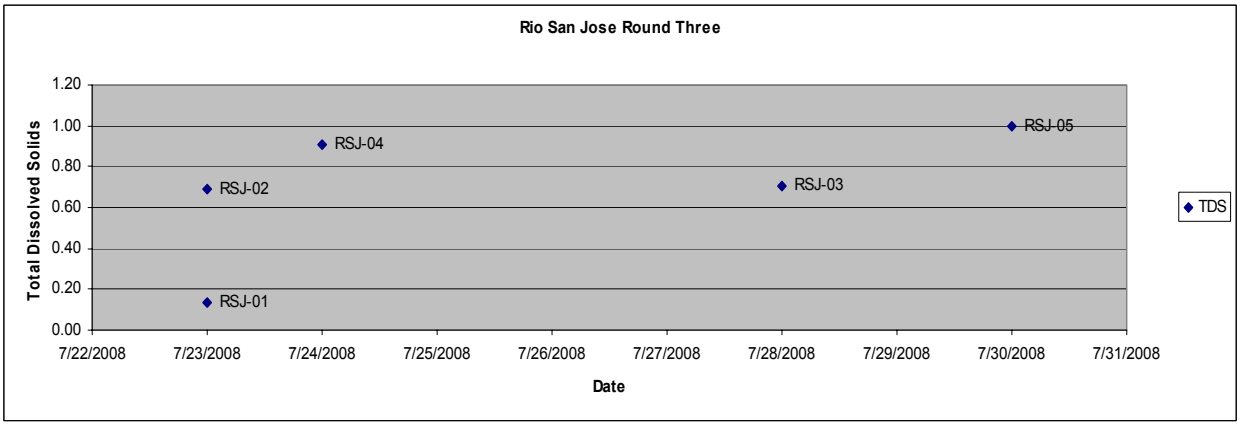

Rio San Jose Round Two
Resistivity
0.600
0.500
0.400
0.300
0.200
0.100
0.000
RSJ-01
RSJ-02
RSJ-04
RSJ-05
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
Resistivity

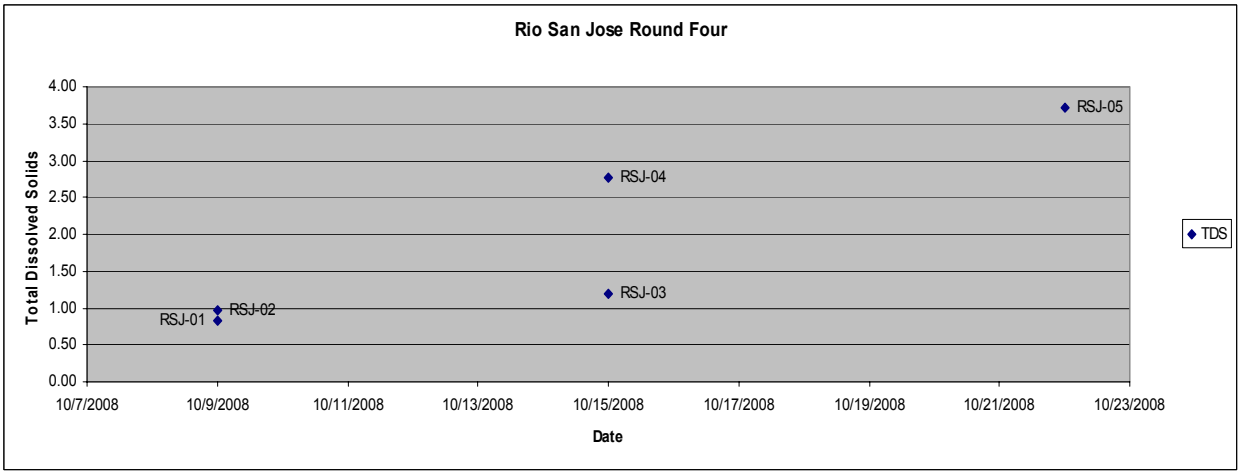

Rio San Jose Round Three
Resistivity
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
Resistivity

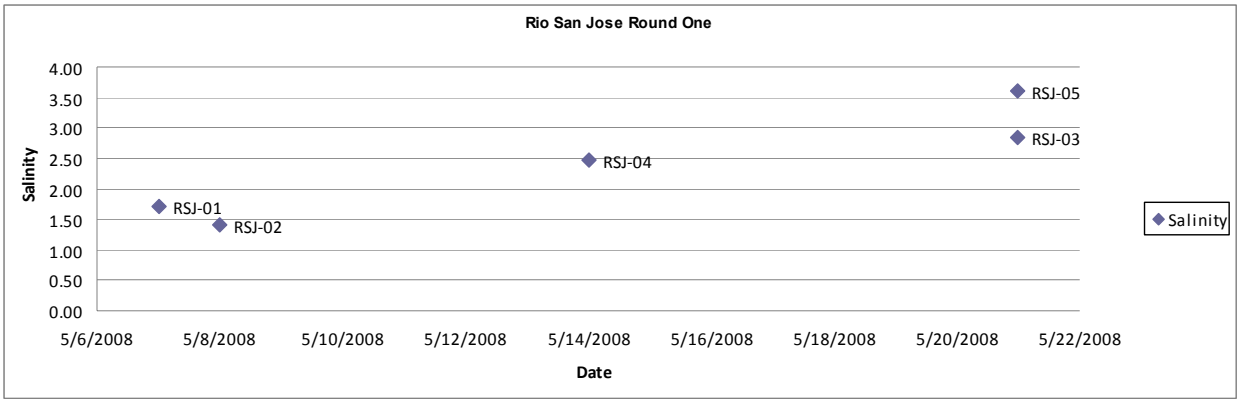

Rio San Jose Round Four
Resistivity
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RSJ-01
RSJ-02
RSJ-03
RSJ-04
RSJ-05
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
Resistivity

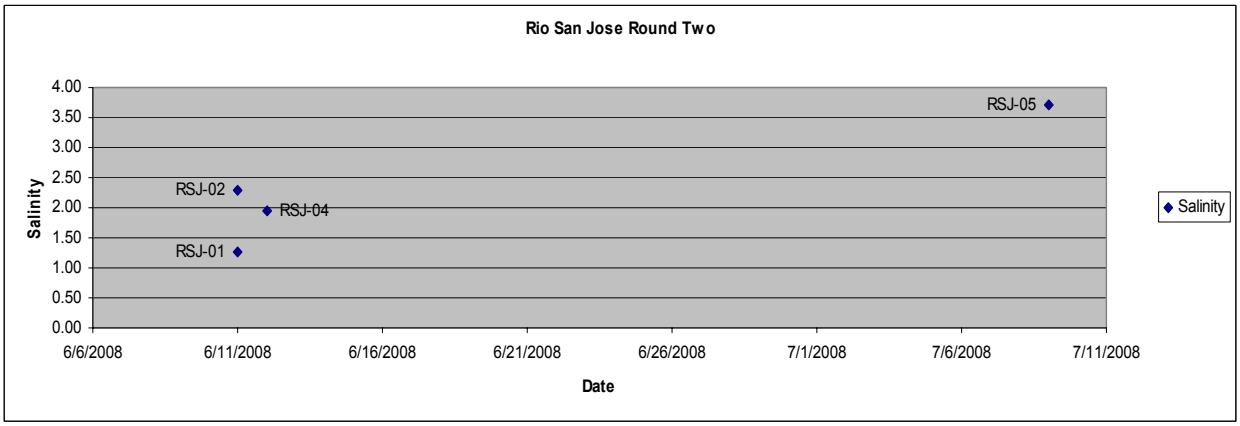

Rio San Jose Round One
Total Dissovled Oxygen
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
TDS

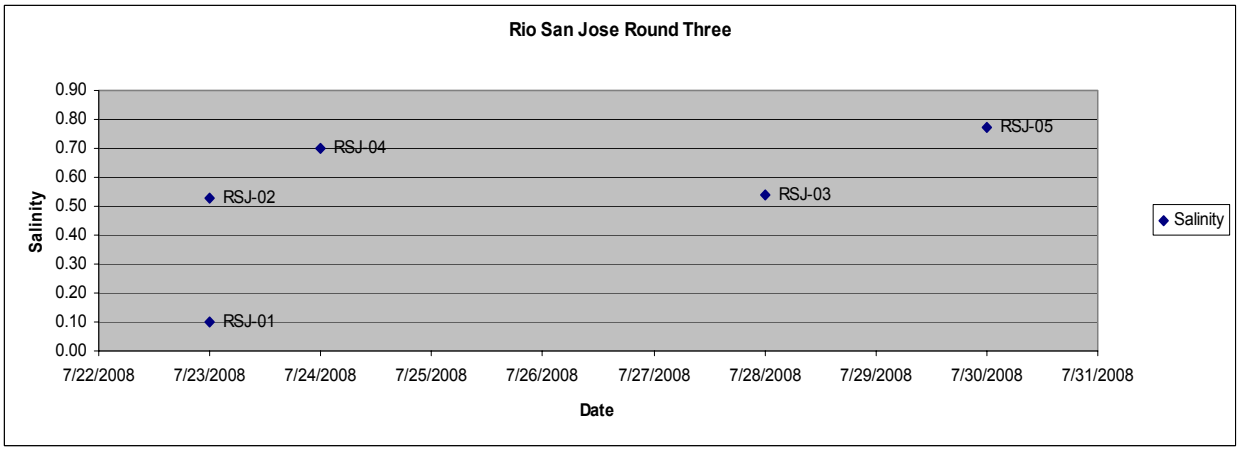

Rio San Jose Round Two
Total Dissolved Solids
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RSJ-05
RSJ-02
RSJ-01
RSJ-04
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
TDS

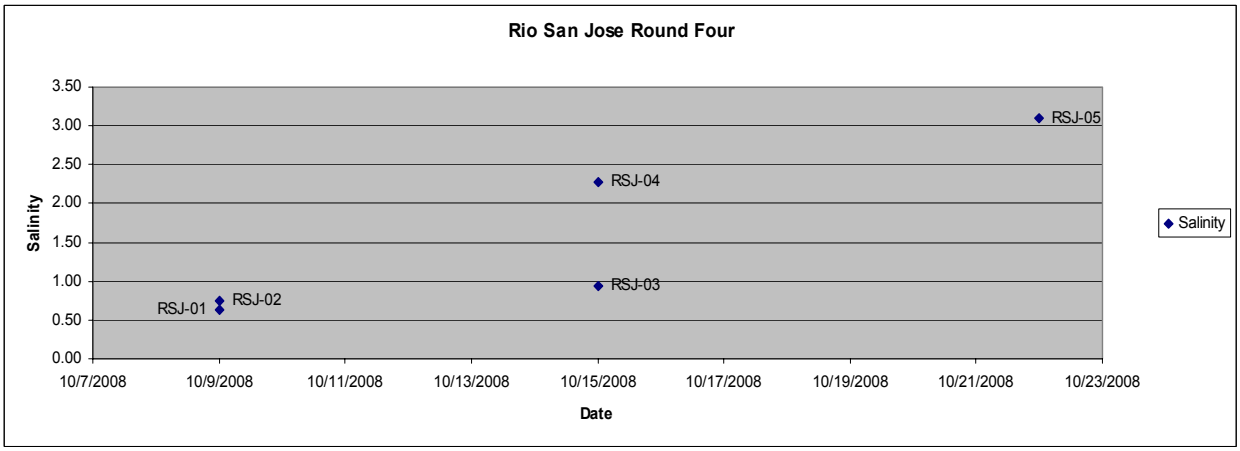

Rio San Jose Round Three
Total Dissolved Solids
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RSJ-04
RSJ-05
RSJ-02
RSJ-03
RSJ-01
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
TDS

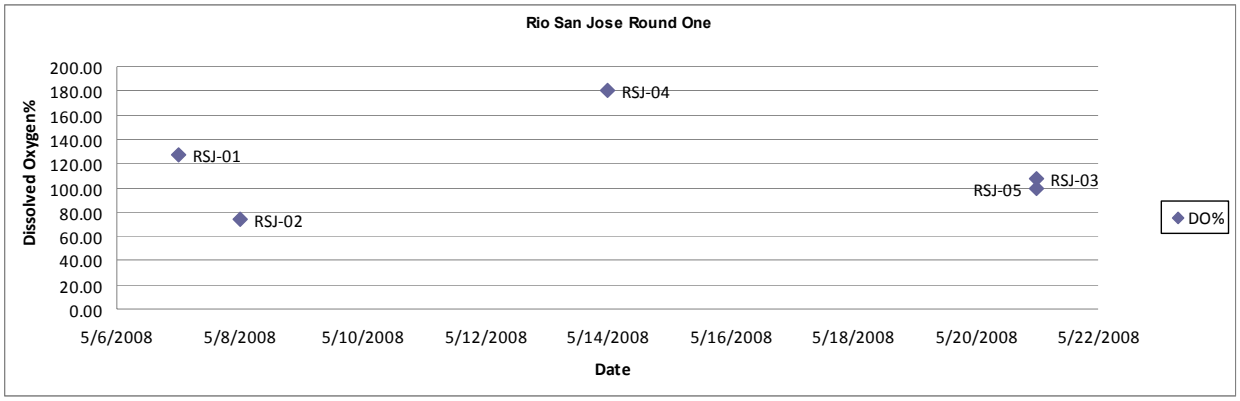

Rio San Jose Round Four
Total Dissolved Solids
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RSJ-05
RSJ-04
RSJ-03
RSJ-02
RSJ-01
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
TDS

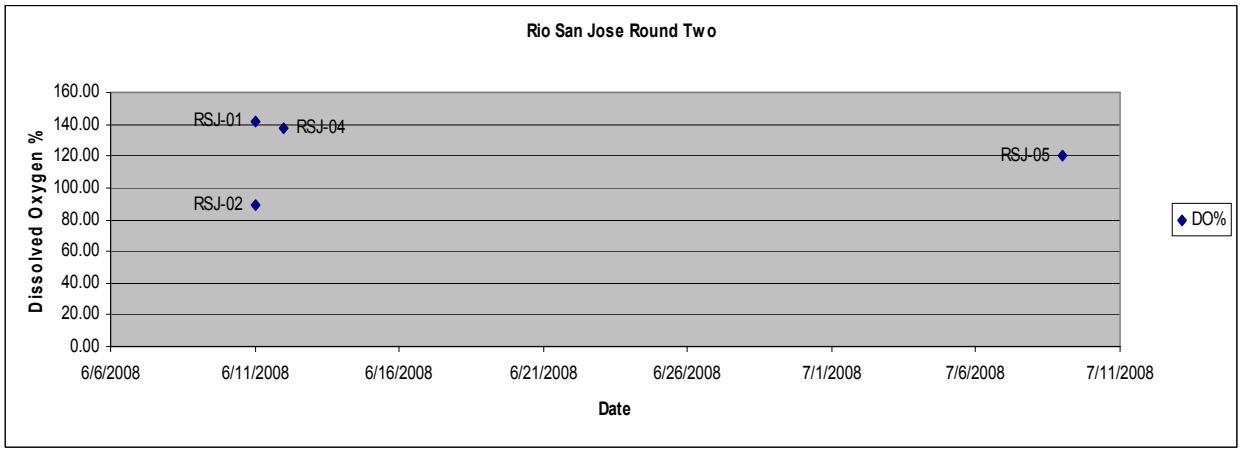

Rio San Jose Round One
Salinity
Date
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
Salinity

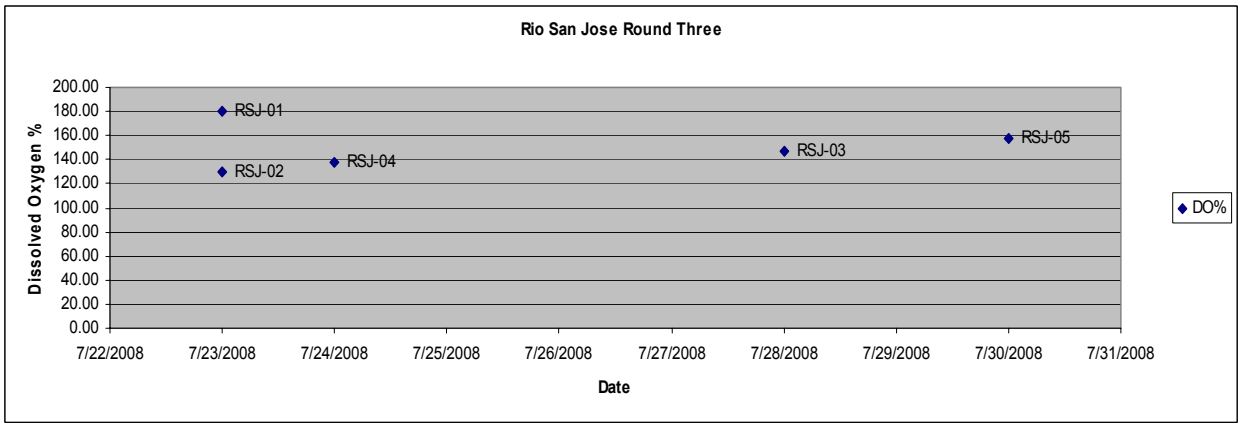

Rio San Jose Round Two
Salinity
Date
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
RSJ-05
RSJ-02
RSJ-04
RSJ-01
Salinity

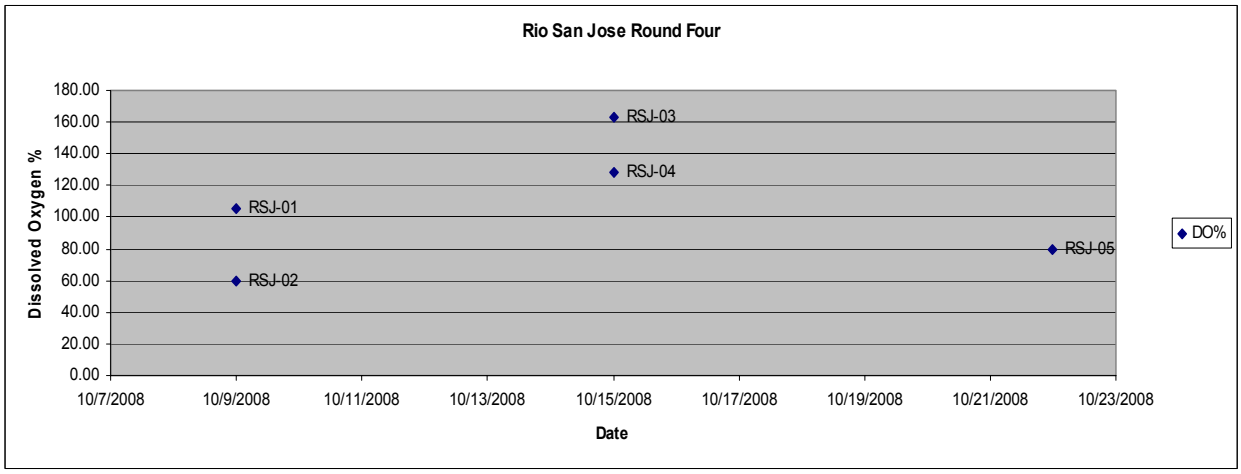

Rio San Jose Round Three
Salinity
Date
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
RSJ-05
RSJ-04
RSJ-02
RSJ-03
RSJ-01
Salinity

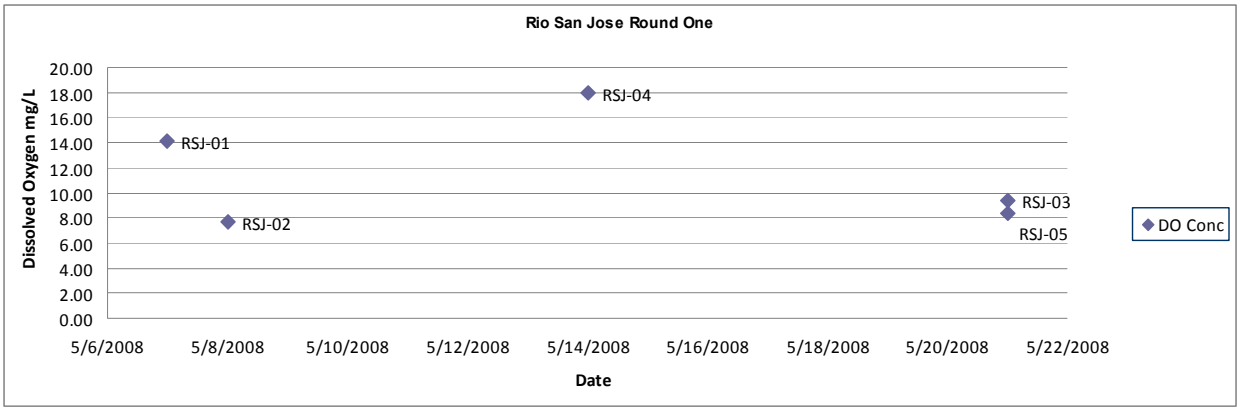

Rio San Jose Round Four
Salinity
Date
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
RSJ-05
RSJ-04
RSJ-03
RSJ-01
RSJ-02
Salinity

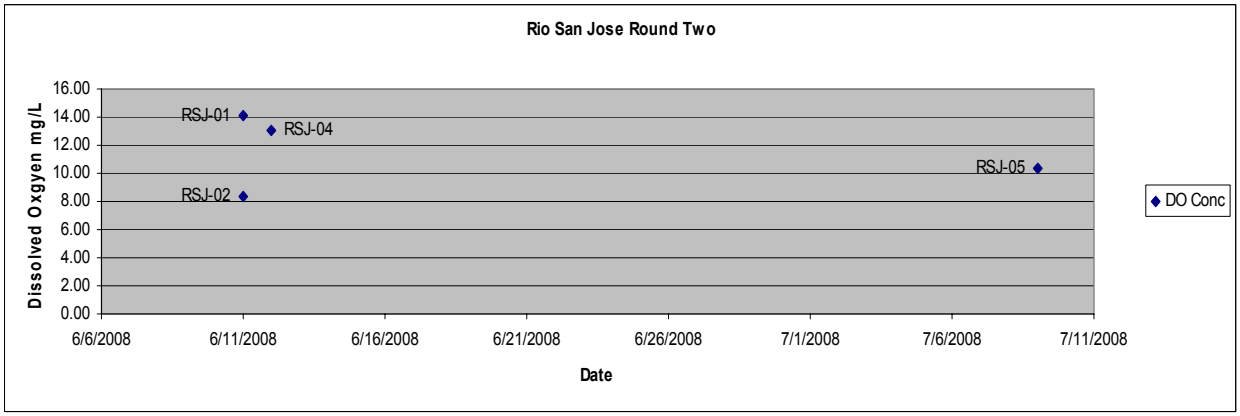

Rio San Jose Round One
Dissolved Oxygen%
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
DO%

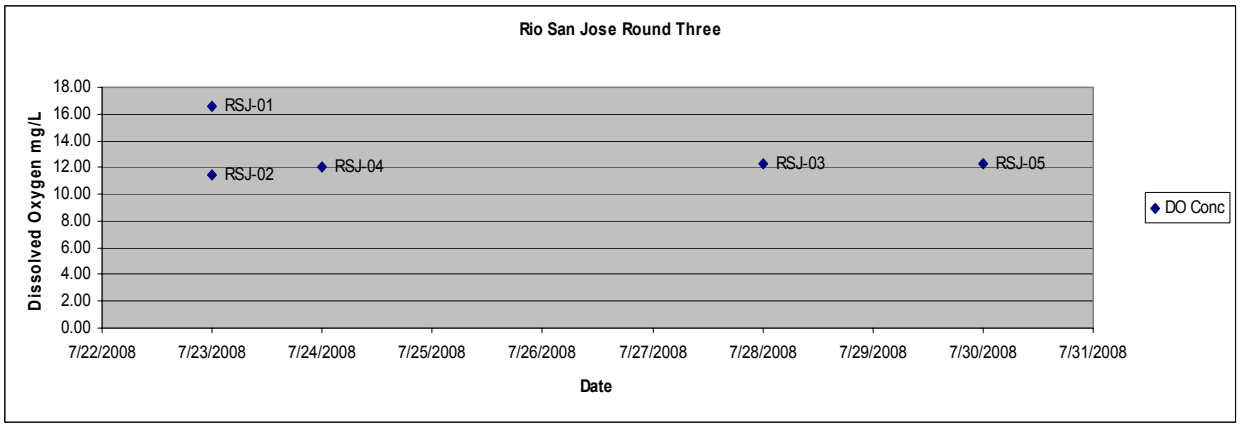

Rio San Jose Round Two
Dissolved Oxygen %
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RSJ-01
RSJ-04
RSJ-05
RSJ-02
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
DO%

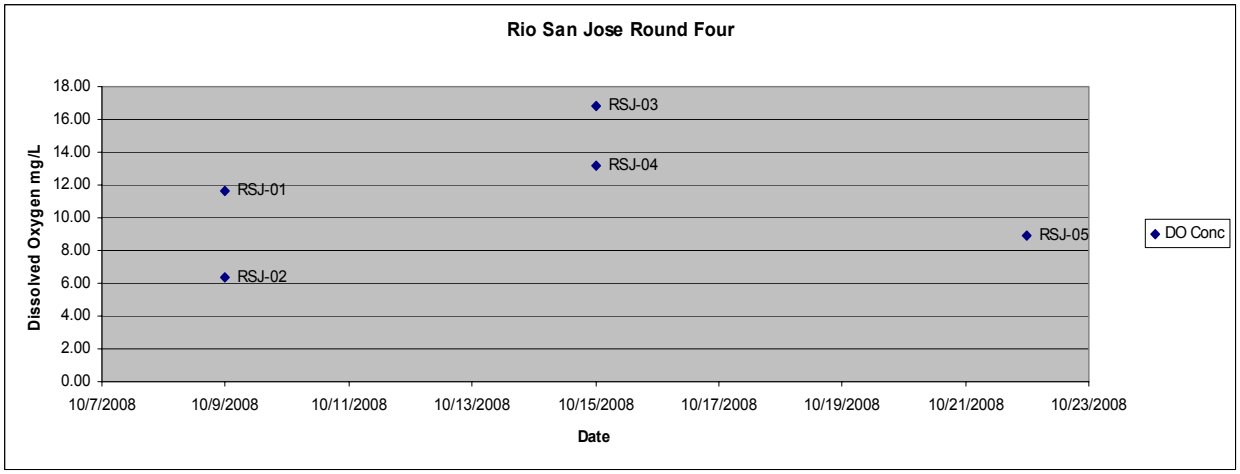

Rio San Jose Round Three
Dissolved Oxygen %
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
DO%

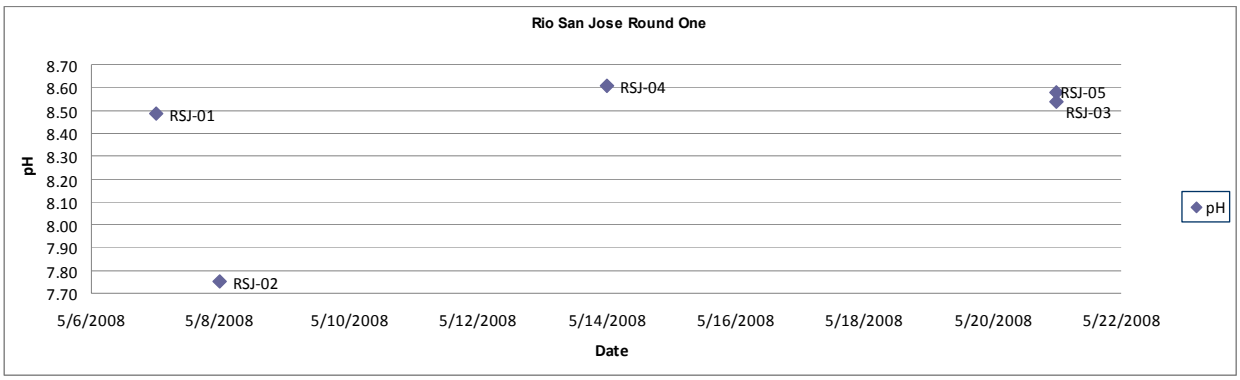

Rio San Jose Round Four
Dissolved Oxygen %
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
RSJ-03
RSJ-04
RSJ-01
RSJ-05
RSJ-02
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
DO%

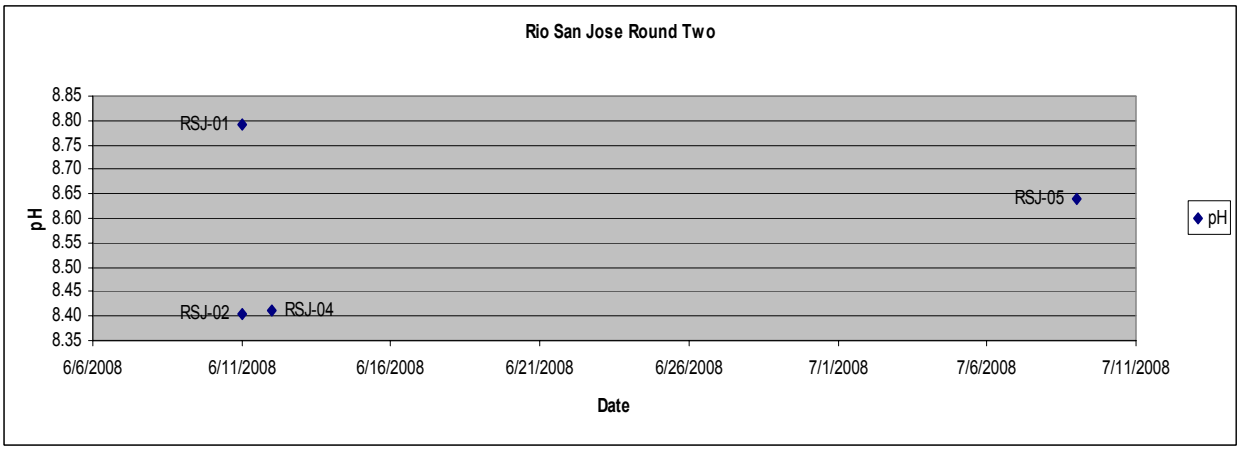

Rio San Jose Round One
Dissolved Oxygen mg/L
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
DO Conc

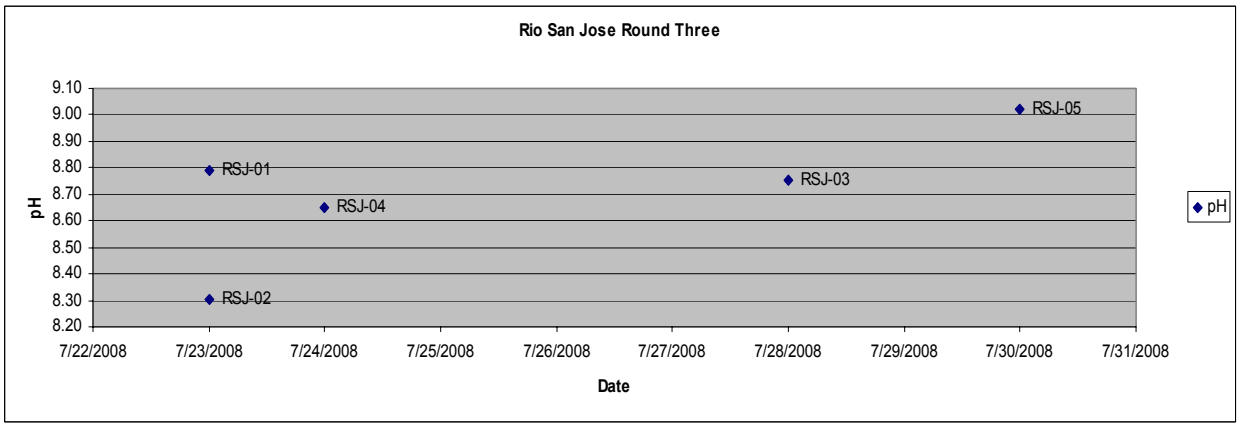

Rio San Jose Round Two
Dissolved Oxgyen mg/L
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RSJ-01
RSJ-04
RSJ-02
RSJ-05
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
DO Conc

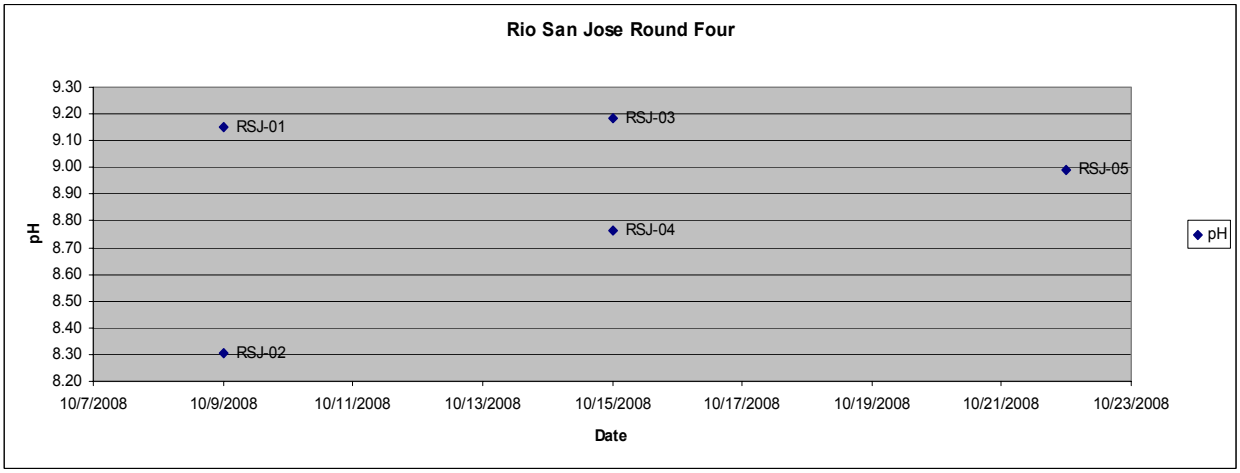

Rio San Jose Round Three
Dissolved Oxygen mg/L
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
DO Conc

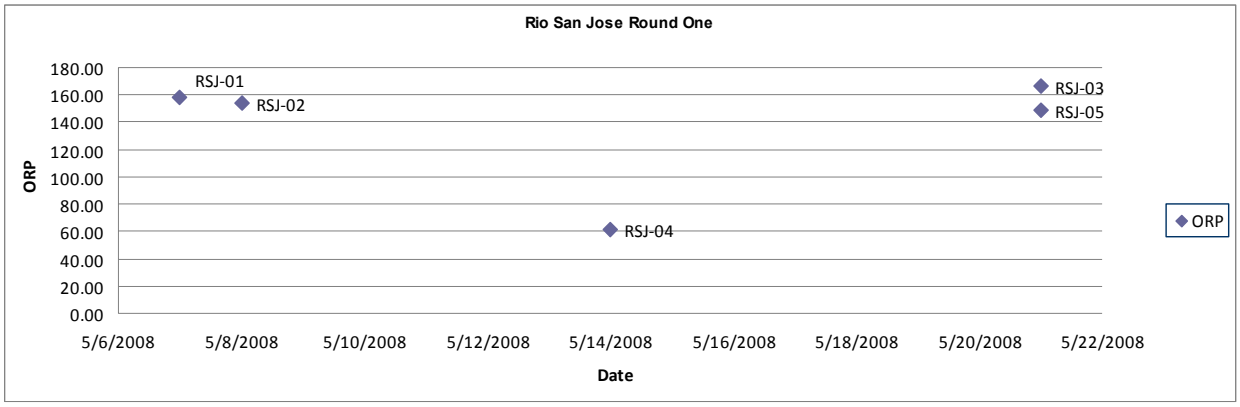

Rio San Jose Round Four
Dissolved Oxygen mg/L
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
RSJ-03
RSJ-04
RSJ-01
RSJ-05
RSJ-02
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
DO Conc

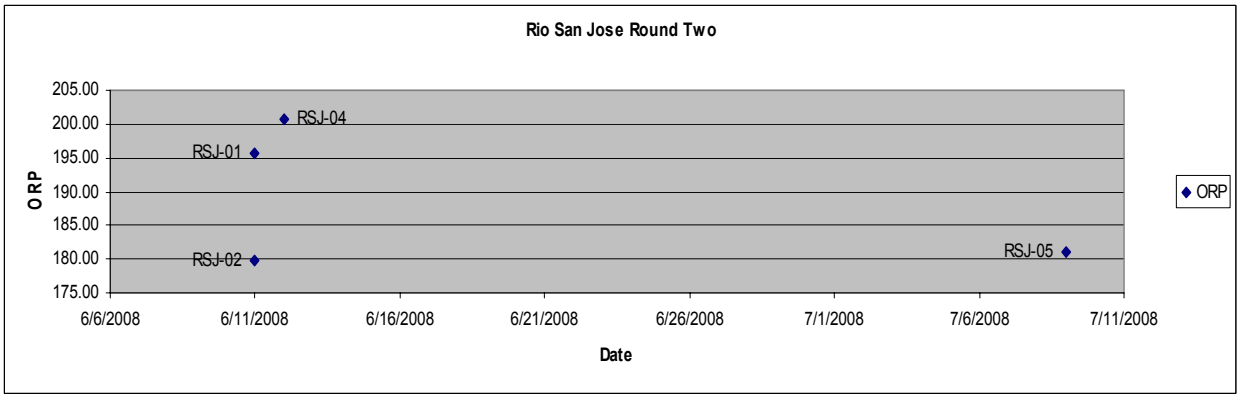

Rio San Jose Round One
pH
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
7.80
7.70
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
pH

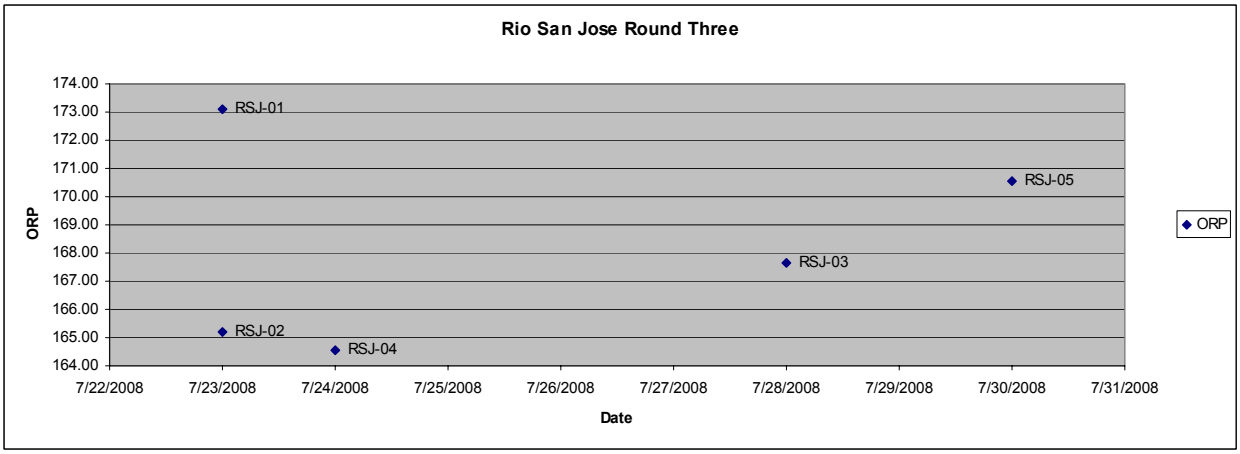

Rio San Jose Round Two
pH
8.85
8.80
8.75
8.70
8.65
8.60
8.55
8.50
8.45
8.40
8.35
RSJ-01
RSJ-05
RSJ-02
RSJ-04
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
pH

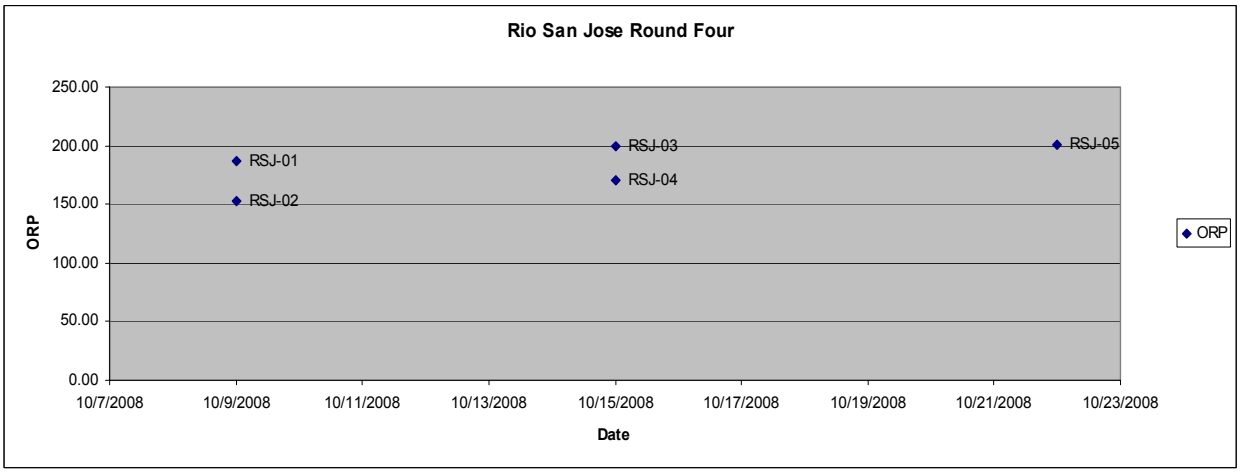

Rio San Jose Round Three
pH
9.10
9.00
8.90
8.80
8.70
8.60
8.50
8.40
8.30
8.20
RSJ-05
RSJ-01
RSJ-03
RSJ-04
RSJ-02
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
pH

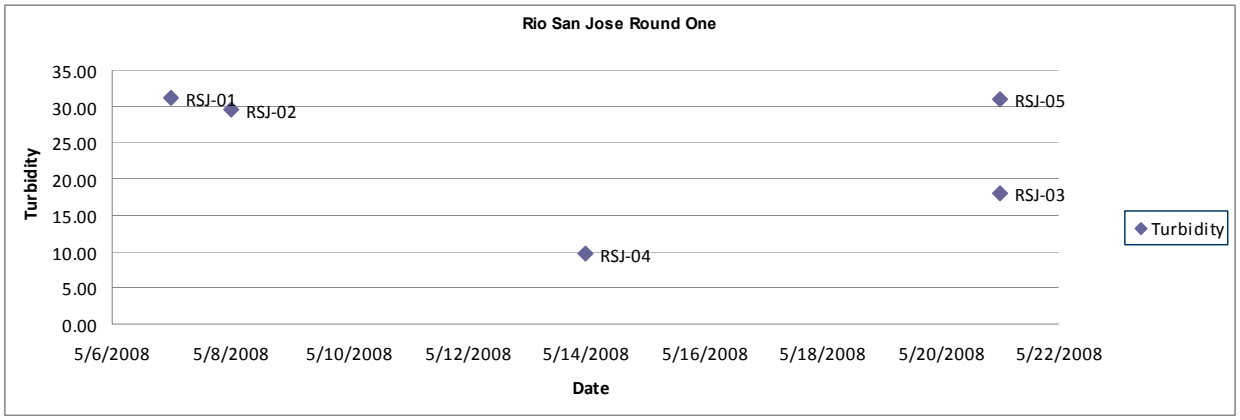

Rio San Jose Round Four
pH
9.30
9.20
9.10
9.00
8.90
8.80
8.70
8.60
8.50
8.40
8.30
8.20
RSJ-01
RSJ-03
RSJ-05
RSJ-04
RSJ-02
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
pH

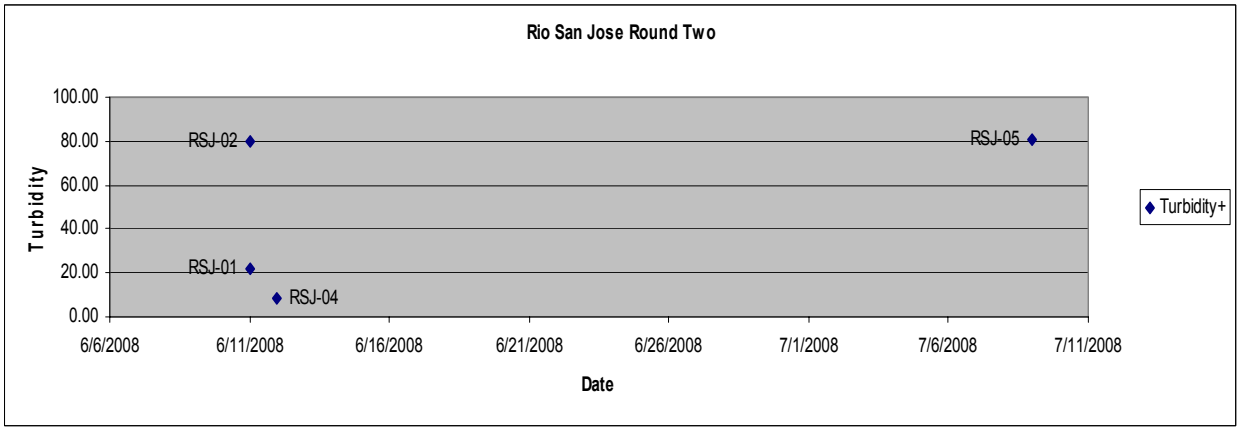

Rio San Jose Round One
ORP
Date
RSJ-01
RSJ-02
RSJ-03
RSJ-05
RSJ-04
ORP
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008

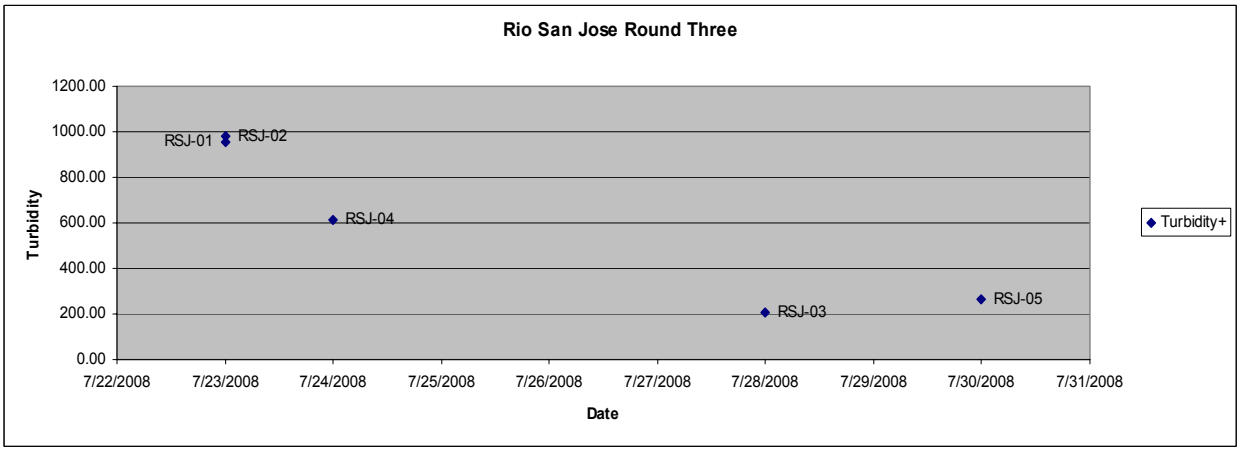

Rio San Jose Round Two
ORP
Date
RSJ-04
RSJ-01
RSJ-02
RSJ-05
ORP
205.00
200.00
195.00
190.00
185.00
180.00
175.00
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008

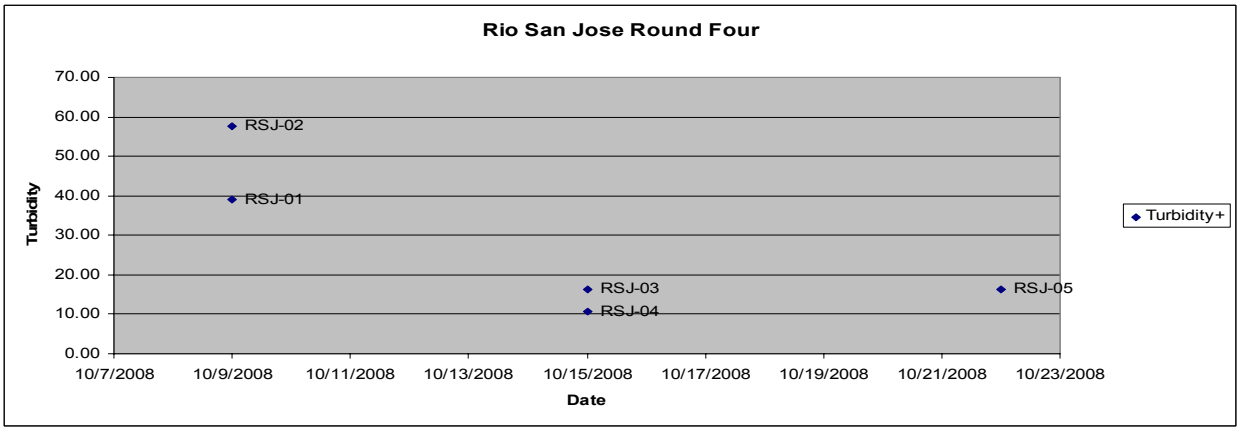

Rio San Jose Round Three
ORP
Date
RSJ-01
RSJ-05
RSJ-03
RSJ-02
RSJ-04
ORP
174.00
173.00
172.00
171.00
170.00
169.00
168.00
167.00
166.00
165.00
164.00
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008

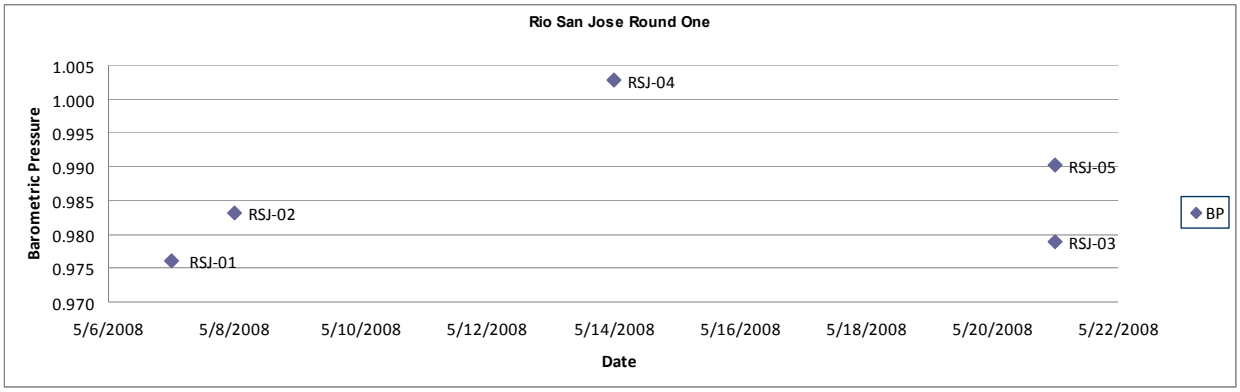

Rio San Jose Round Four
ORP
Date
RSJ-03
RSJ-05
RSJ-01
RSJ-04
RSJ-02
ORP
250.00
200.00
150.00
100.00
50.00
0.00
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008

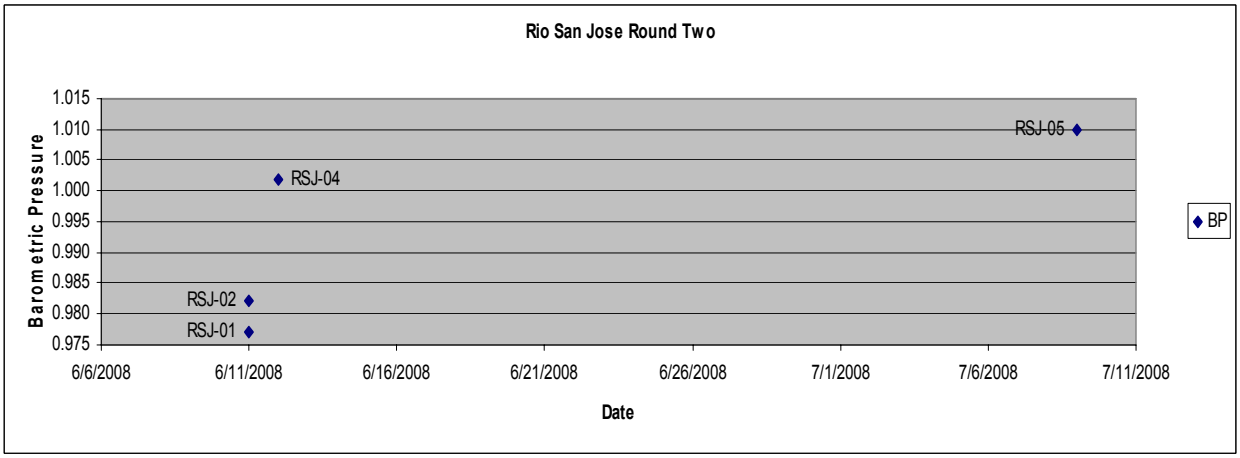

Rio San Jose Round One
Turbidity
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RSJ-01
RSJ-02
RSJ-05
RSJ-03
RSJ-04
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date
Turbidity

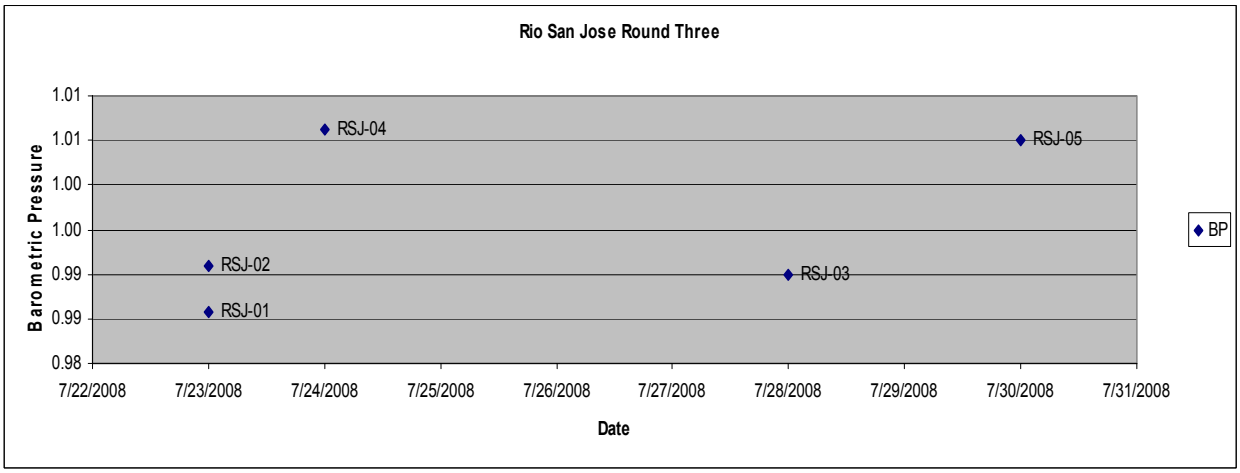

Rio San Jose Round Two
Turbidity
100.00
80.00
60.00
40.00
20.00
0.00
RSJ-02
RSJ-05
RSJ-01
RSJ-04
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date
Turbidity+

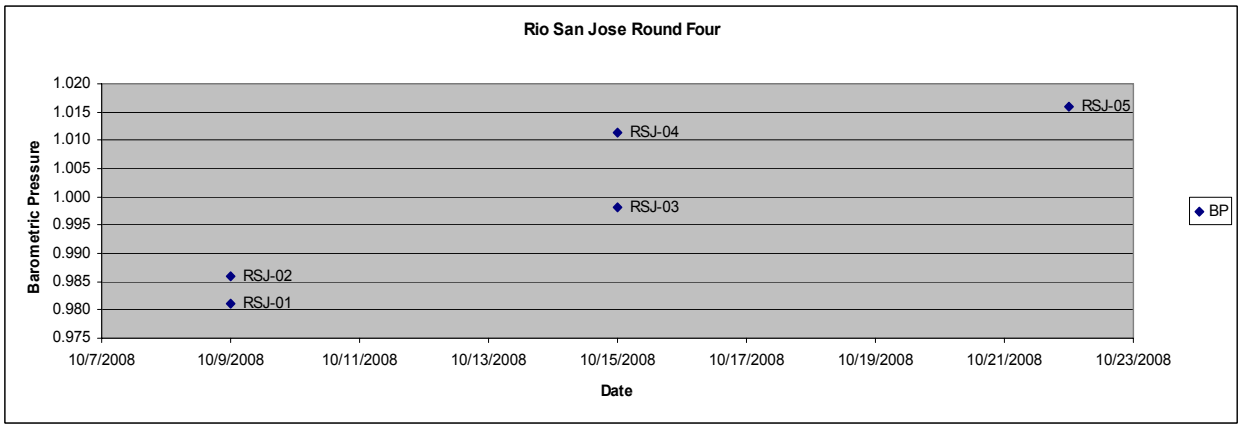

Rio San Jose Round Three
Turbidity
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date
Turbidity+


Rio San Jose Round Four
Turbidity
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
RSJ-02
RSJ-01
RSJ-03
RSJ-04
RSJ-05
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date
Turbidity+

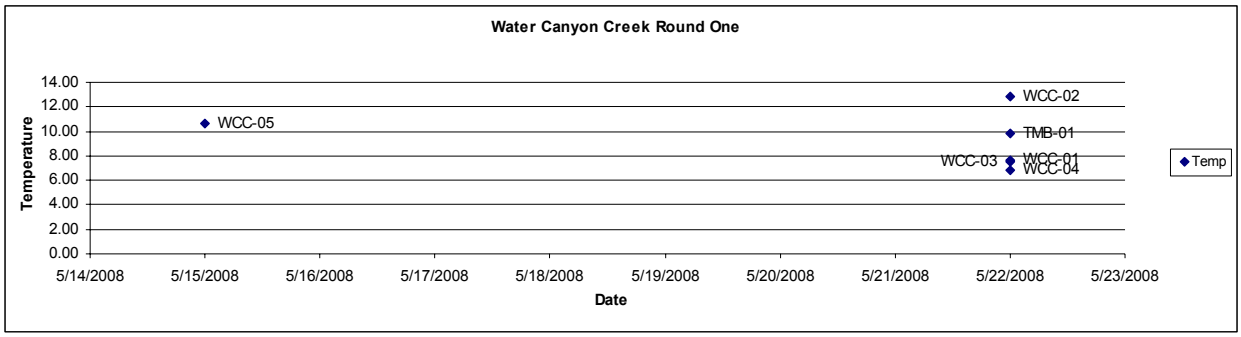

Rio San Jose Round One
Barometric Pressure
1.005
1.000
0.995
0.990
0.985
0.980
0.975
0.970
RSJ-04
RSJ-05
RSJ-02
RSJ-03
RSJ-01
BP
5/6/2008
5/8/2008
5/10/2008
5/12/2008
5/14/2008
5/16/2008
5/18/2008
5/20/2008
5/22/2008
Date

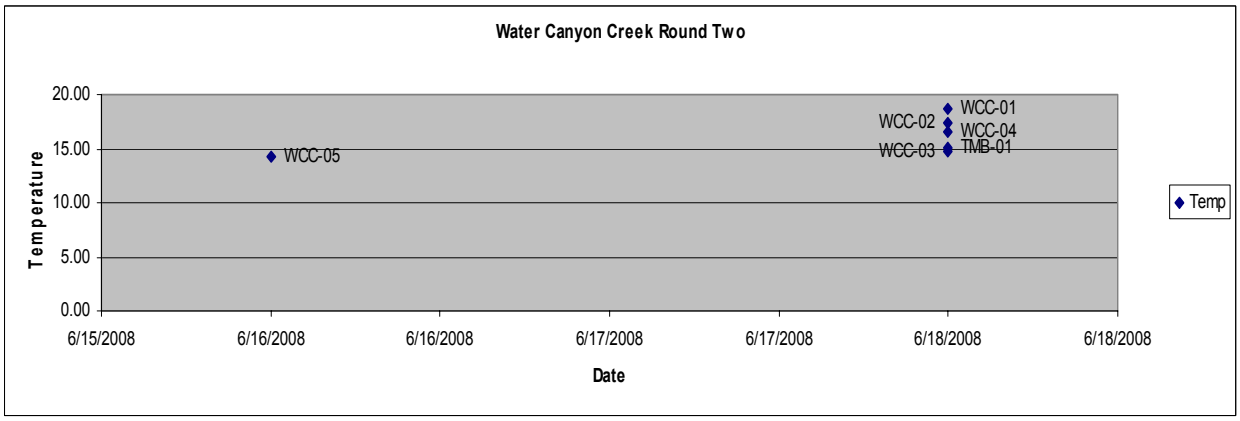

Rio San Jose Round Two
Barometric Pressure
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
RSJ-05
RSJ-04
RSJ-02
RSJ-01
BP
6/6/2008
6/11/2008
6/16/2008
6/21/2008
6/26/2008
7/1/2008
7/6/2008
7/11/2008
Date

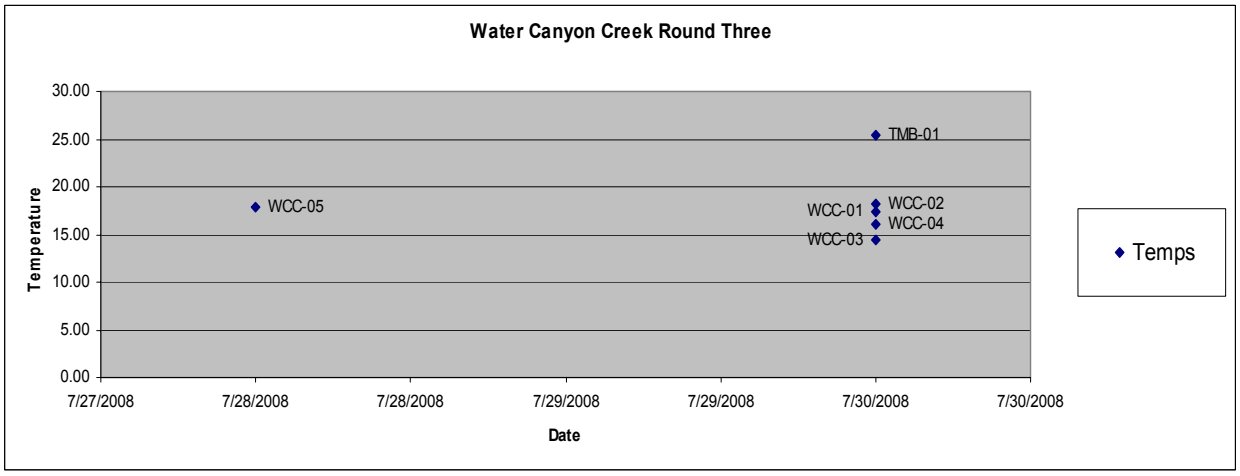

Rio San Jose Round Three
Barometric Pressure
1.01
1.01
1.00
1.00
0.99
0.99
0.98
RSJ-04
RSJ-05
RSJ-02
RSJ-03
RSJ-01
BP
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
7/30/2008
7/31/2008
Date

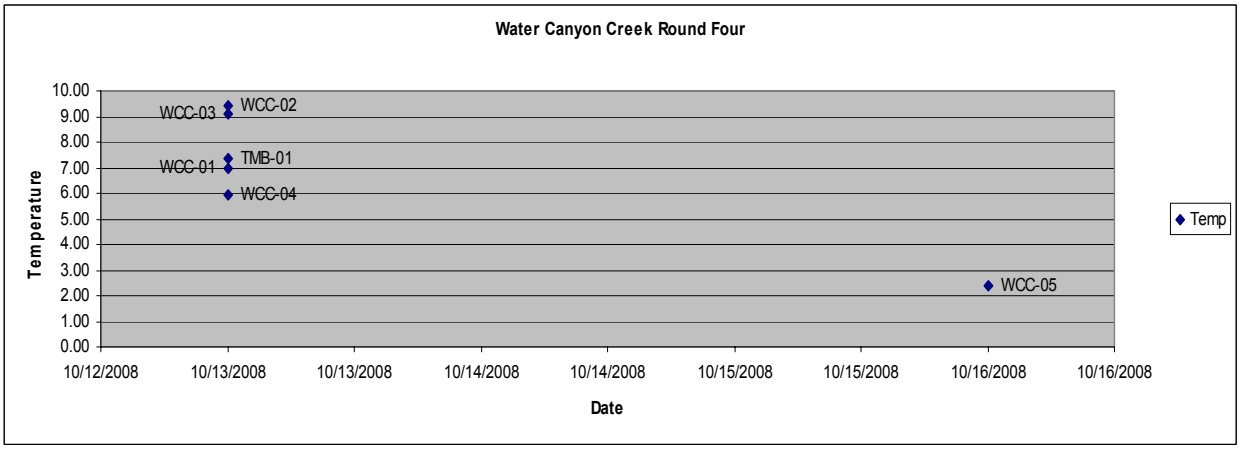

Rio San Jose Round Four
Barometric Pressure
1.020
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
RSJ-05
RSJ-04
RSJ-03
RSJ-02
RSJ-01
BP
10/7/2008
10/9/2008
10/11/2008
10/13/2008
10/15/2008
10/17/2008
10/19/2008
10/21/2008
10/23/2008
Date

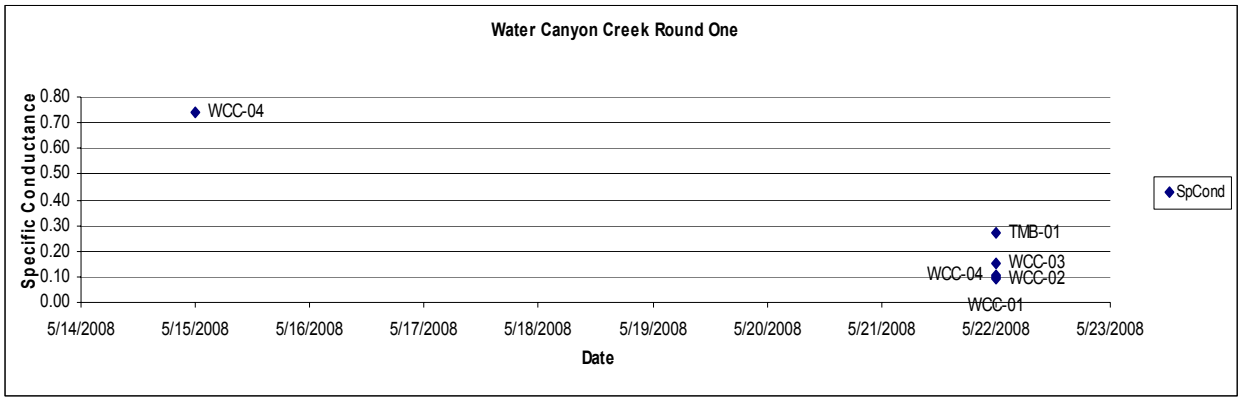
Water Canyon Creek

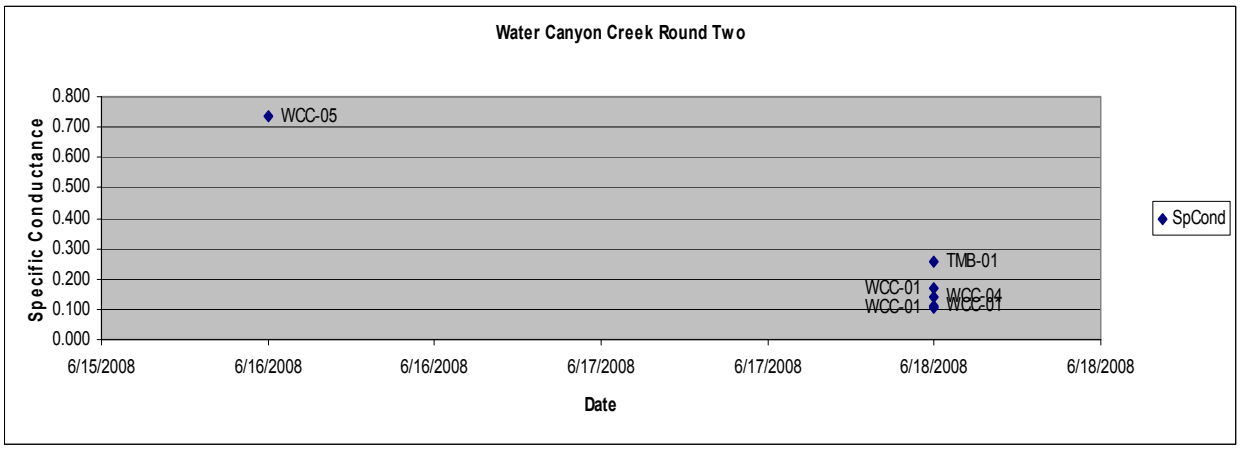


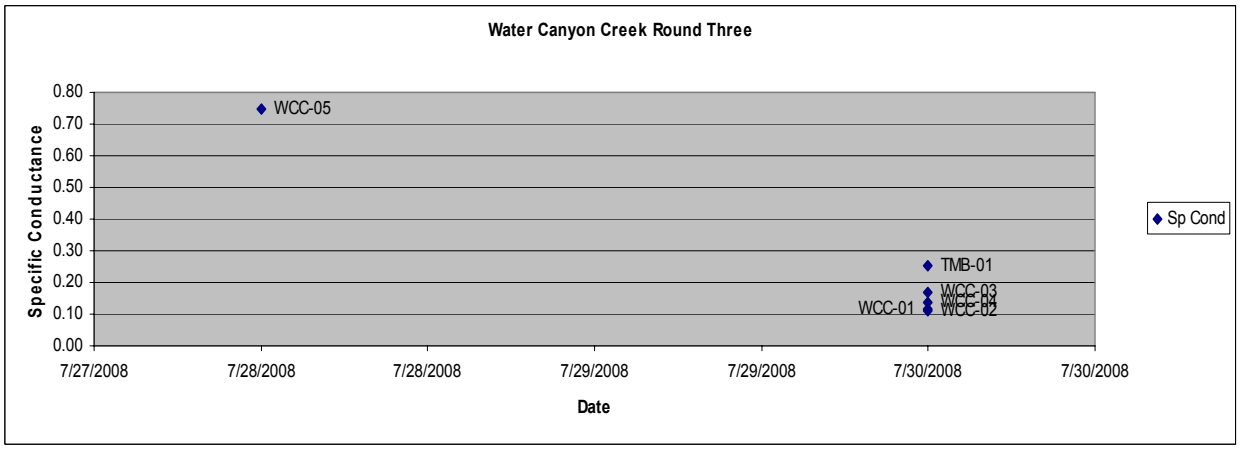


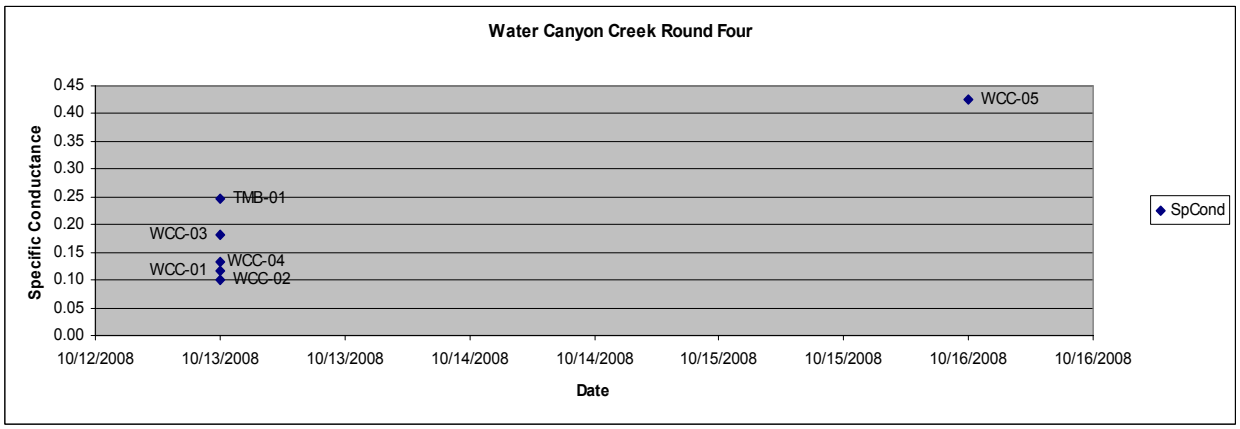


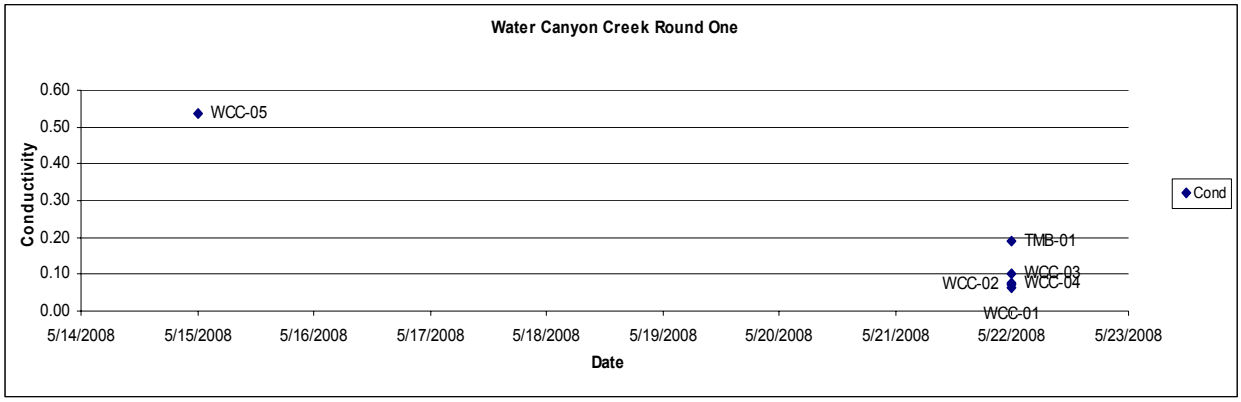


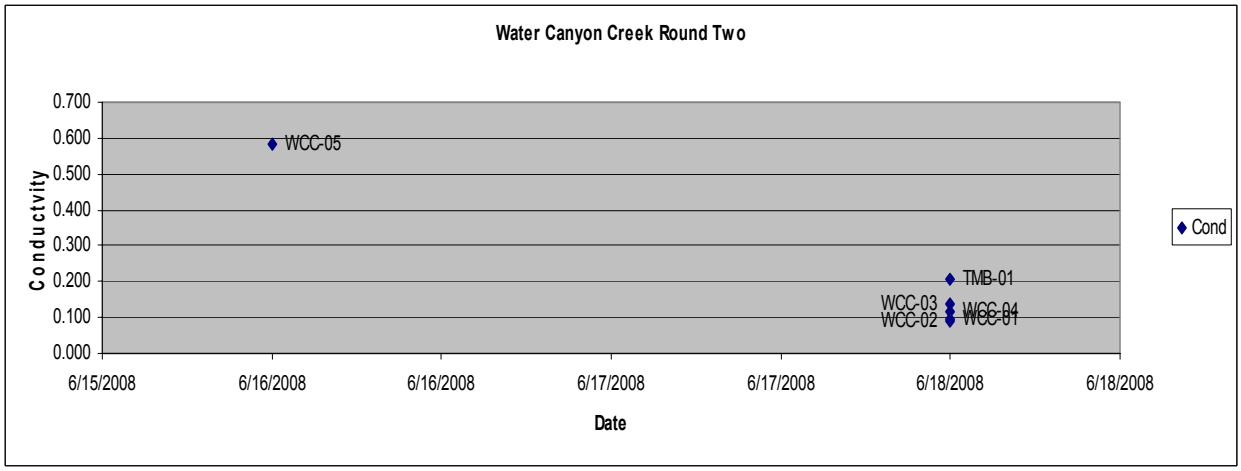

Water Canyon Creek Round One
Specific Conductance
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-04
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
SpCond

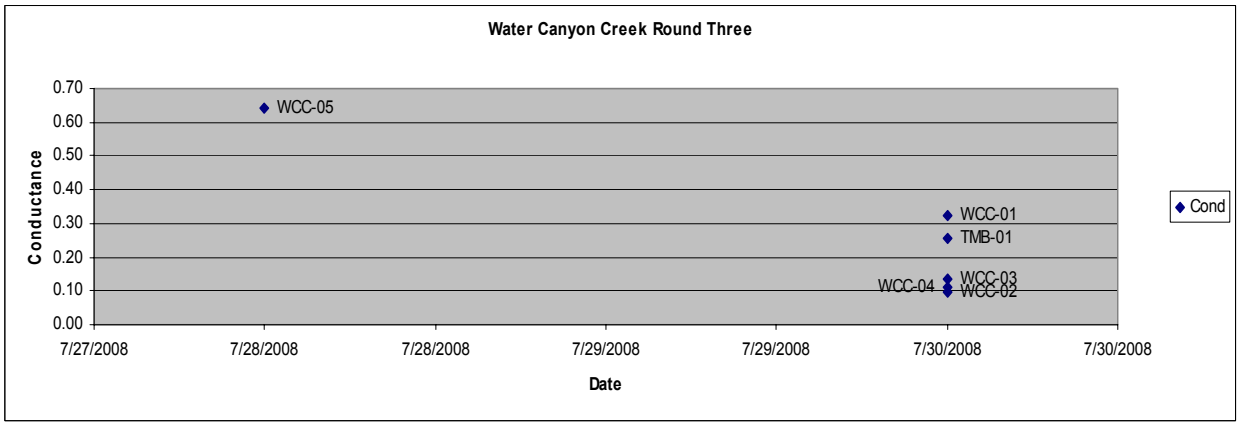

Water Canyon Creek Round Two
Specific Conductance
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
WCC-05
TMB-01
WCC-01
WCC-04
WCC-01
WCC-01
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
SpCond

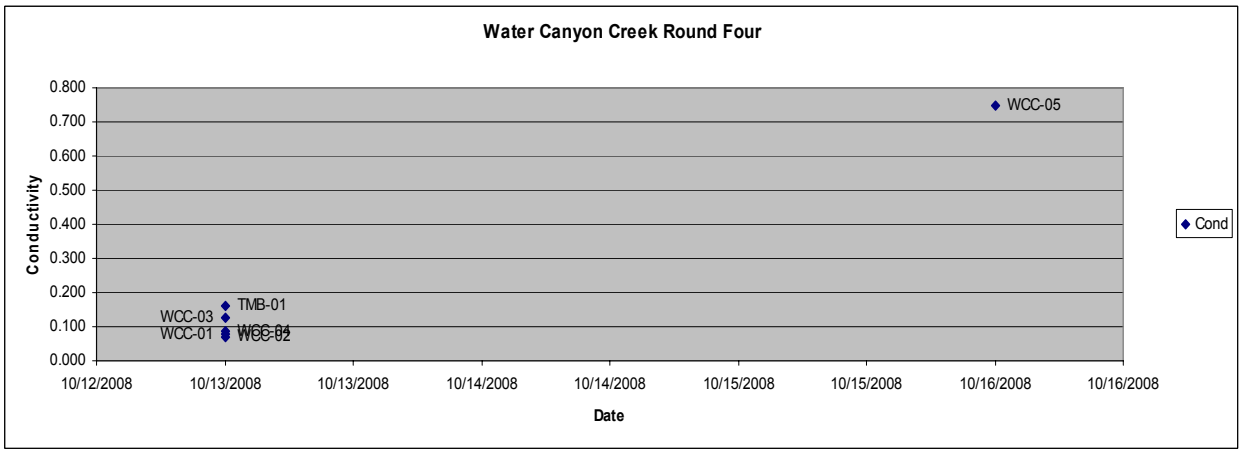

Water Canyon Creek Round Three
Specific Conductance
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-05
TMB-01
WCC-03
WCC-01
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
Sp Cond

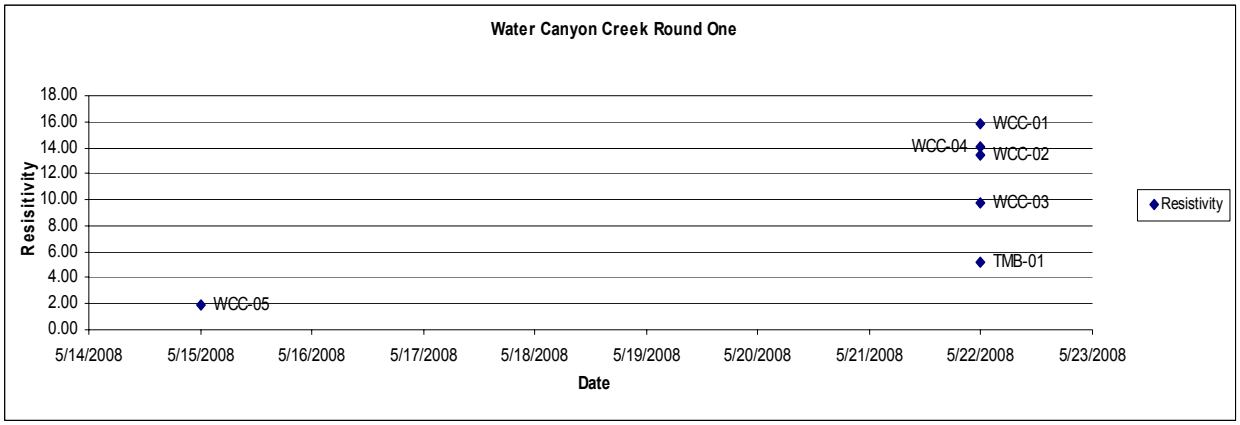

Water Canyon Creek Round Four
Specific Conductance
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
WCC-05
TMB-01
WCC-03
WCC-01
WCC-04
WCC-02
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
SpCond

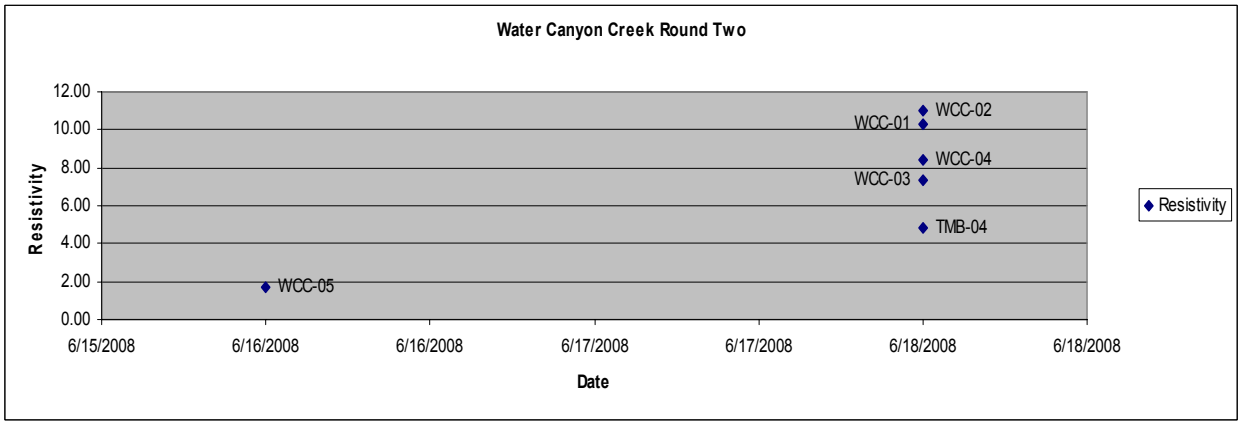

Water Canyon Creek Round One
Conductivity
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-05
TMB-01
WCC-03
WCC-02
WCC-04
WCC-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
Cond

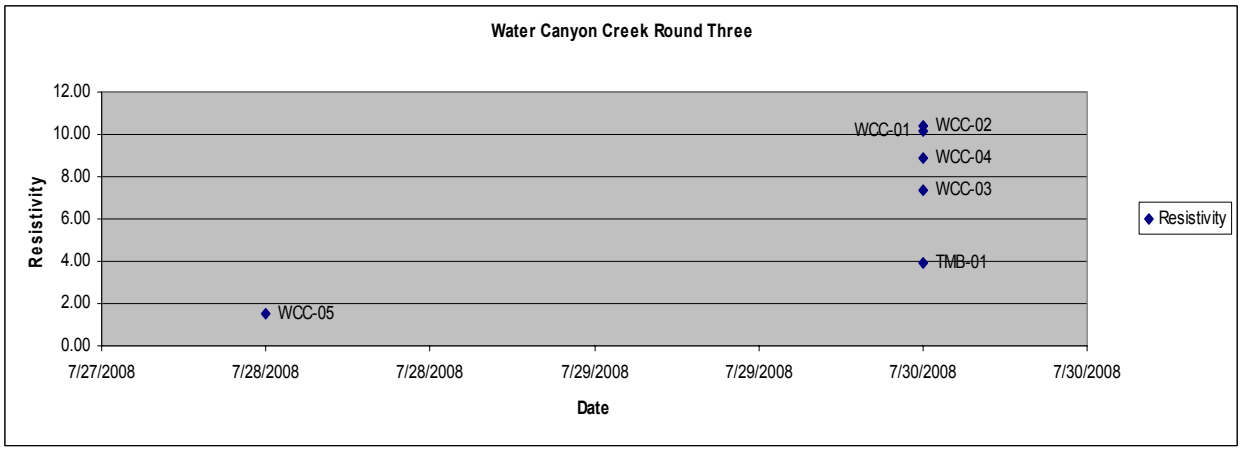

Water Canyon Creek Round Two
Conductvity
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
WCC-05
TMB-01
WCC-03
WCC-02
WCC-04
WCC-01
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
Cond

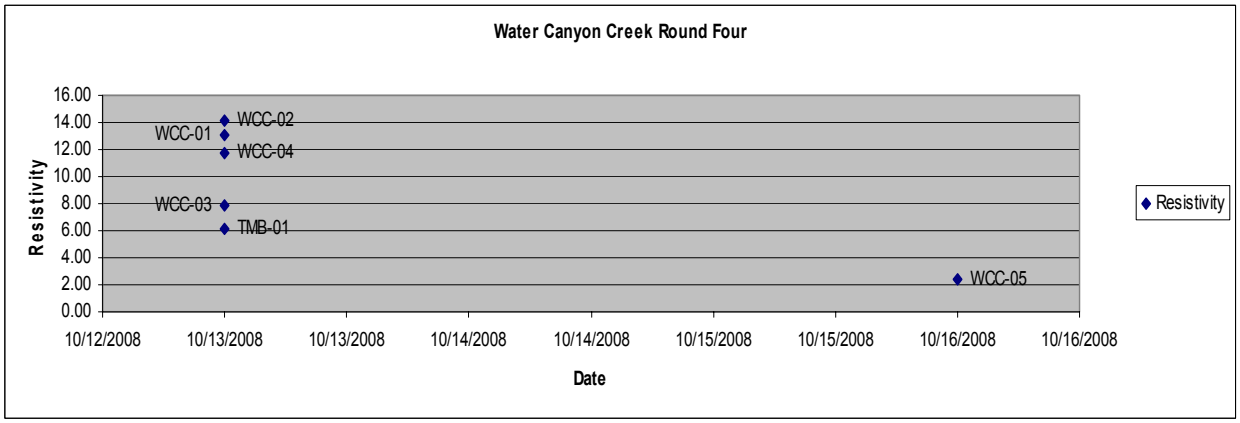

Water Canyon Creek Round Three
Conductance
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-05
WCC-01
TMB-01
WCC-03
WCC-04
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
Cond

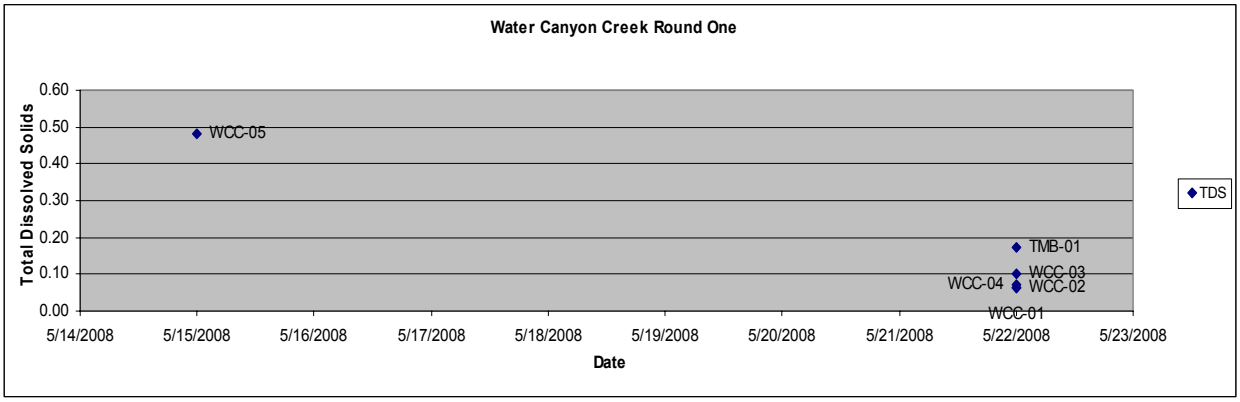

Water Canyon Creek Round Four
Conductivity
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
WCC-05
TMB-01
WCC-03
WCC-01
WCC-04
WCC-02
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
Cond

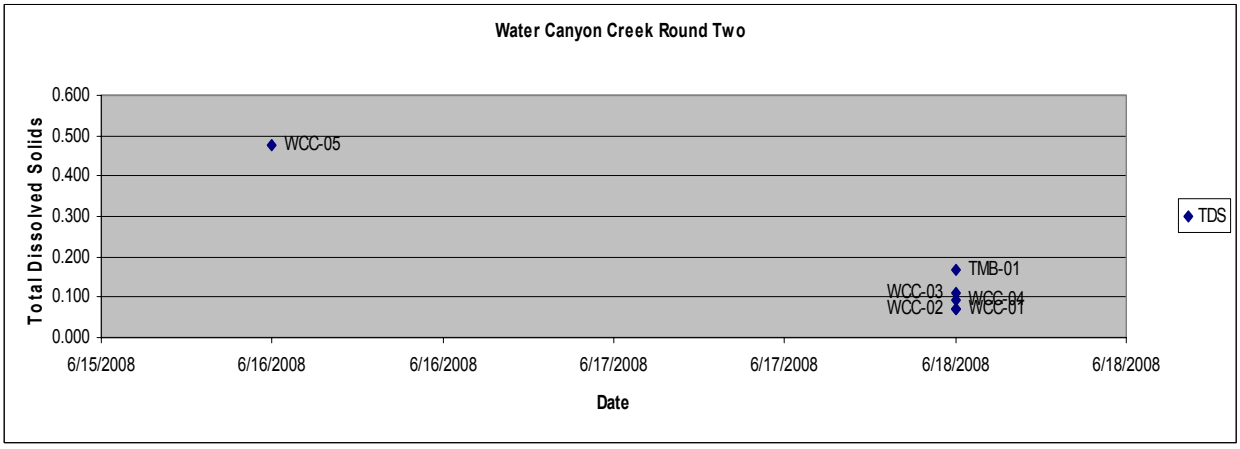

Water Canyon Creek Round One
Resistivity
Date
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
WCC-01
WCC-04
WCC-02
WCC-03
TMB-01
WCC-05
Resistivity

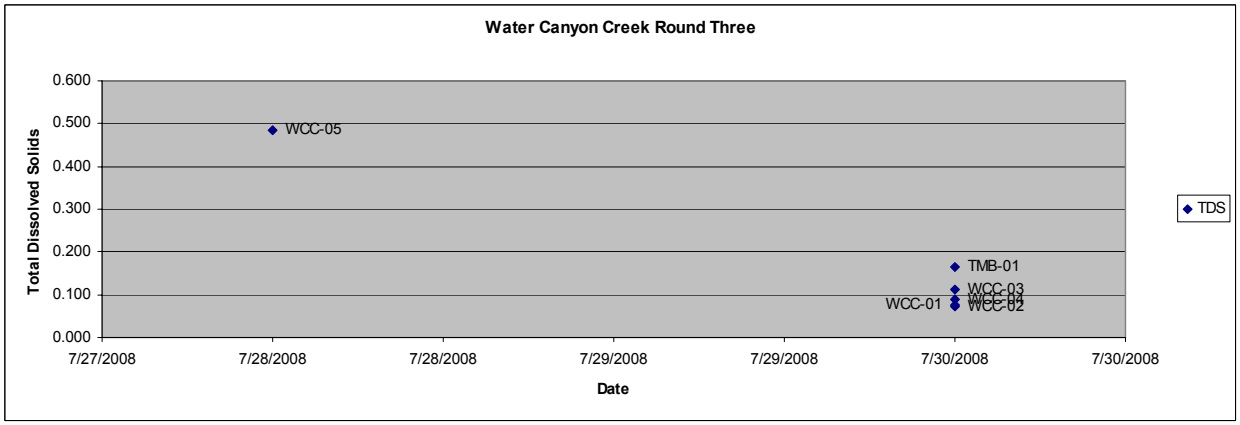

Water Canyon Creek Round Two
Resistivity
Date
12.00
10.00
8.00
6.00
4.00
2.00
0.00
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
WCC-02
WCC-01
WCC-04
WCC-03
TMB-04
WCC-05
Resistivity

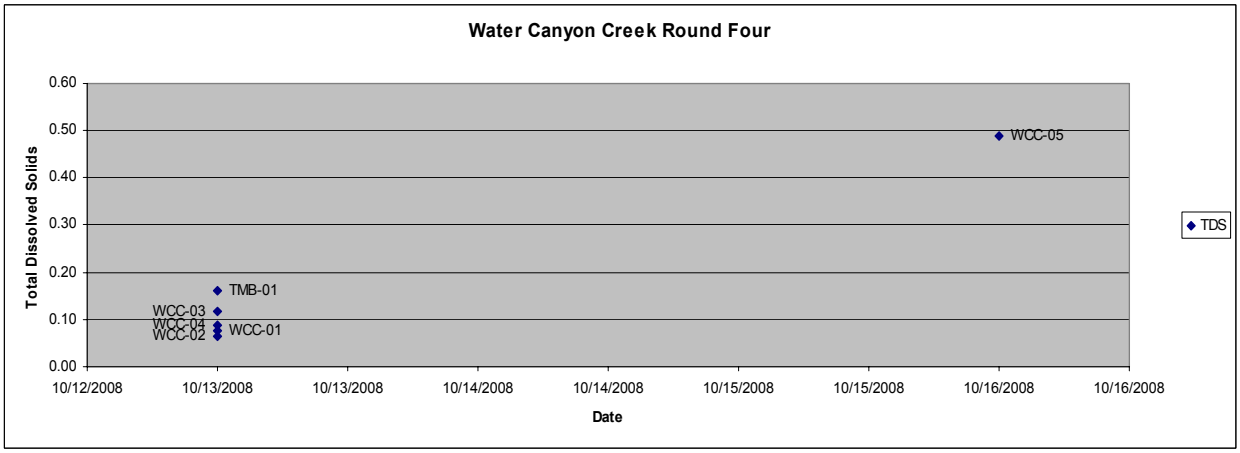

Water Canyon Creek Round Three
Resistivity
Date
12.00
10.00
8.00
6.00
4.00
2.00
0.00
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
WCC-01
WCC-02
WCC-04
WCC-03
TMB-01
WCC-05
Resistivity

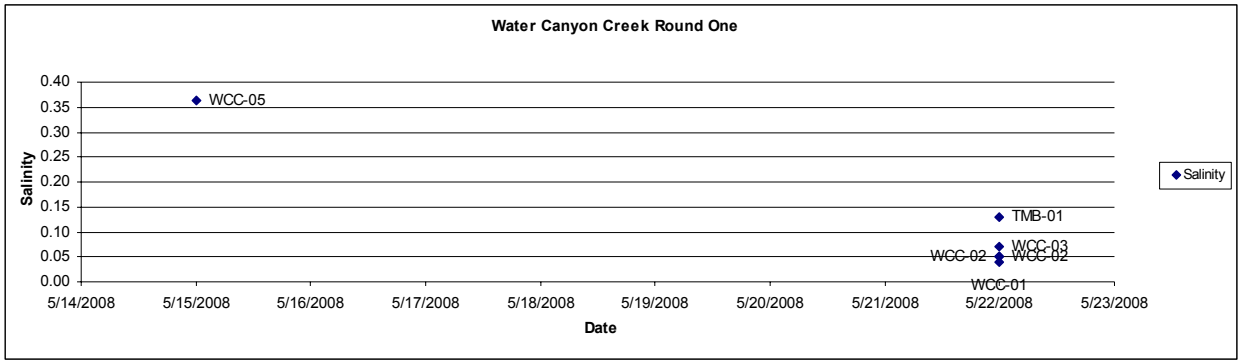

Water Canyon Creek Round Four
Resistivity
Date
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
WCC-02
WCC-01
WCC-04
WCC-03
TMB-01
WCC-05
Resistivity

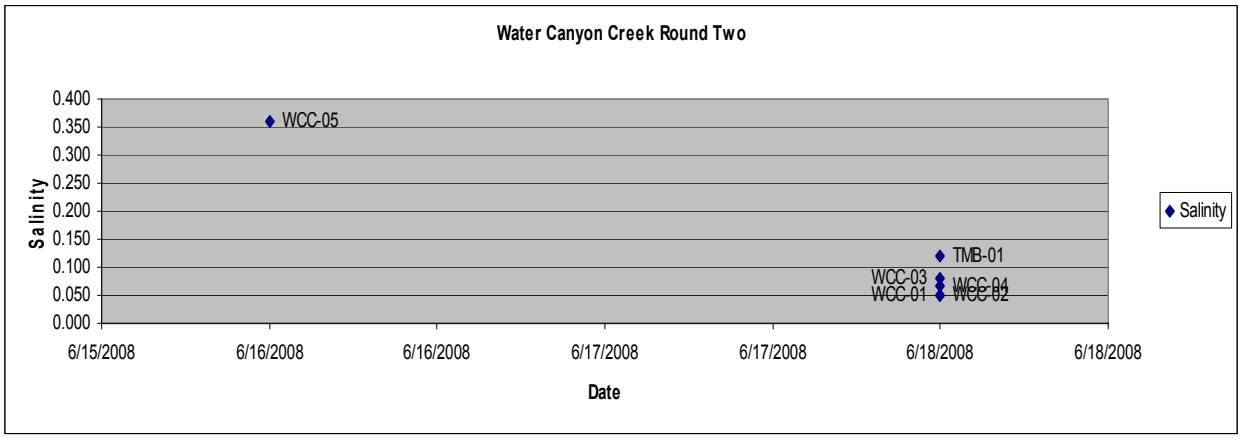

Water Canyon Creek Round One
Total Dissolved Solids
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
TDS

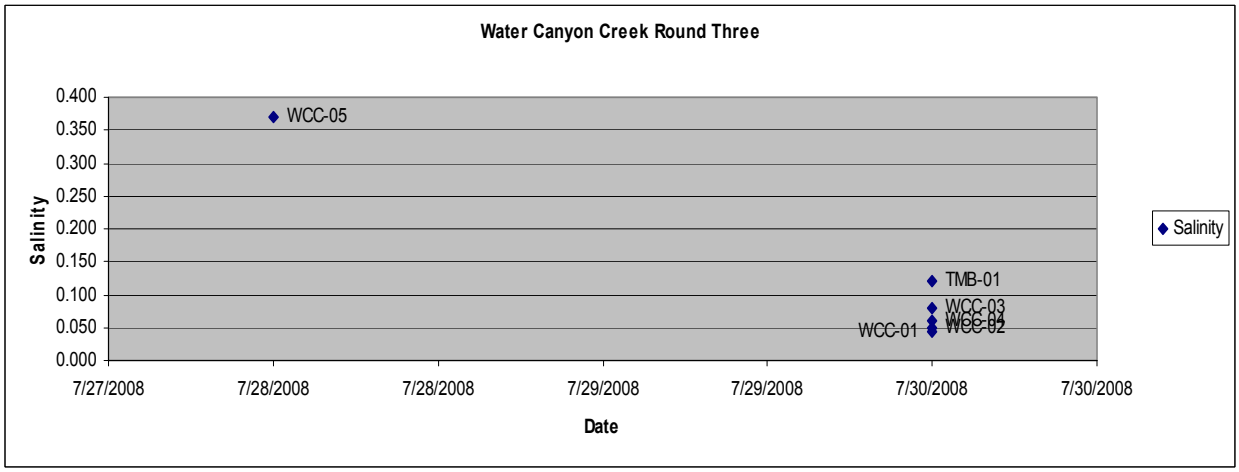

Water Canyon Creek Round Two
Total Dissolved Solids
0.600
0.500
0.400
0.300
0.200
0.100
0.000
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
TDS

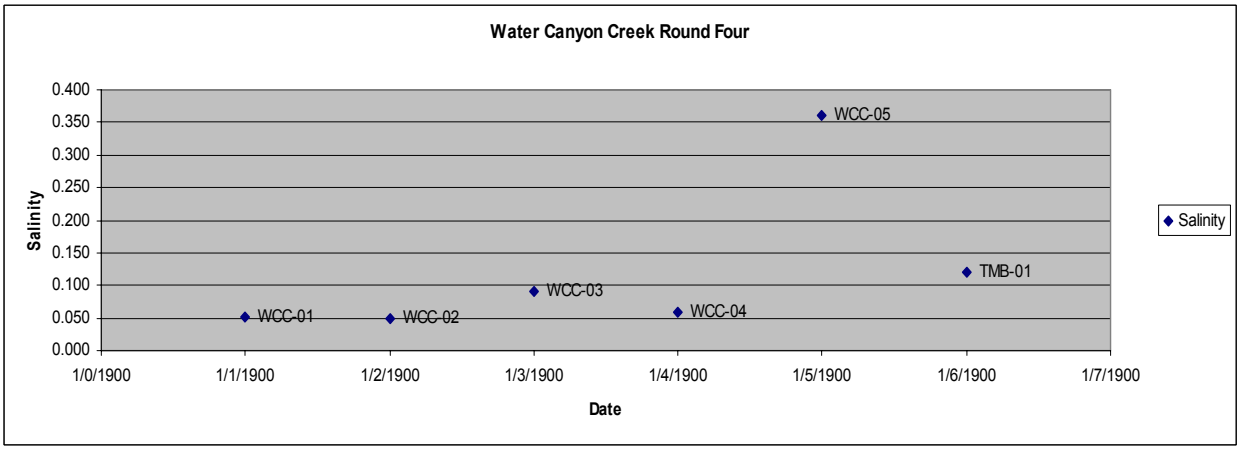

Water Canyon Creek Round Three
Total Dissolved Solids
0.600
0.500
0.400
0.300
0.200
0.100
0.000
WCC-05
TMB-01
WCC-03
WCC-01
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
TDS

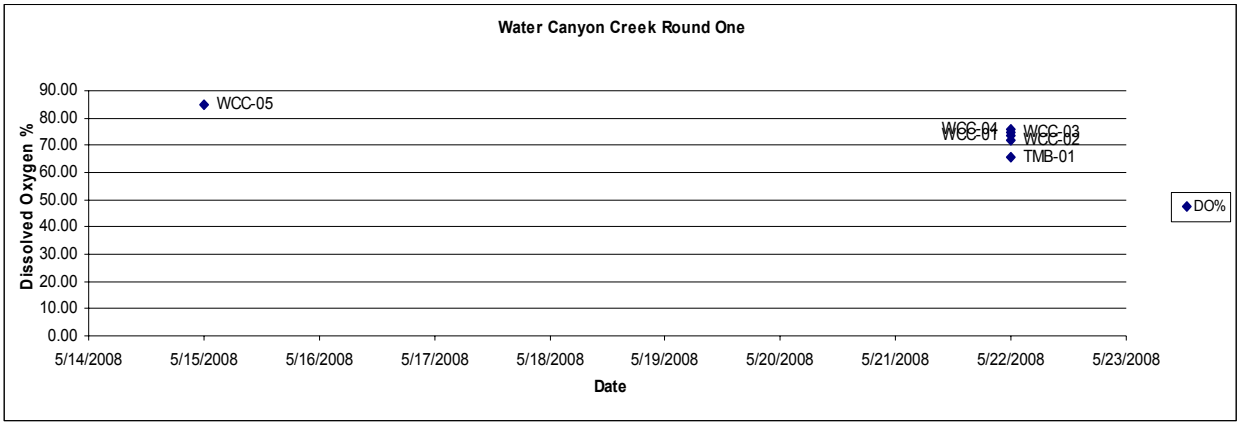

Water Canyon Creek Round Four
Total Dissolved Solids
0.60
0.50
0.40
0.30
0.20
0.10
0.00
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
TDS

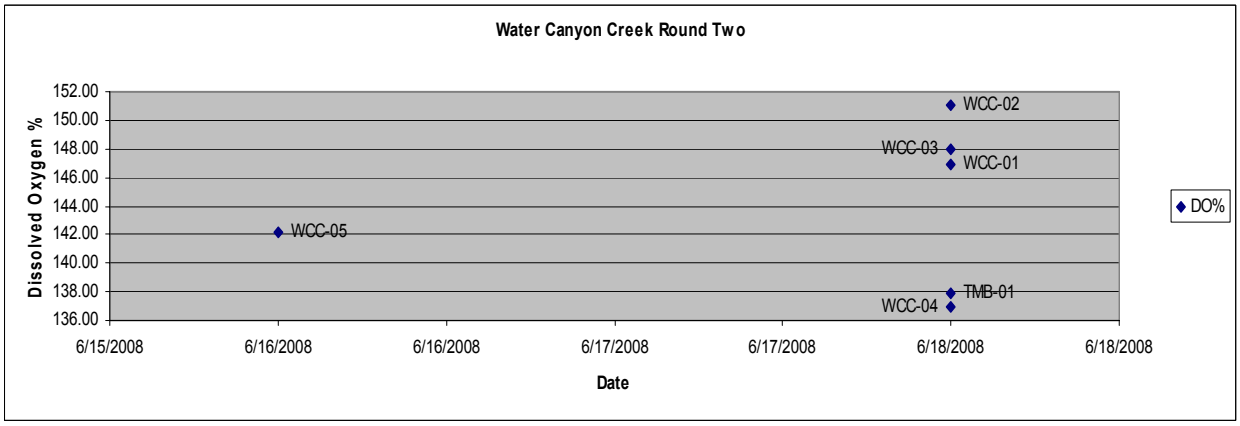

Water Canyon Creek Round One
Salinity
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
WCC-05
TMB-01
WCC-03
WCC-02
WCC-02
WCC-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
Salinity

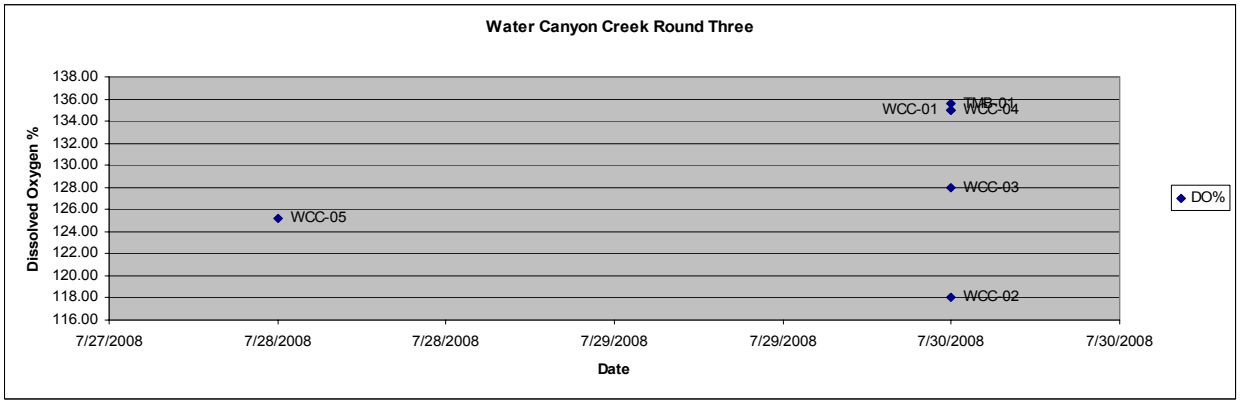

Water Canyon Creek Round Two
Salinity
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
Salinity

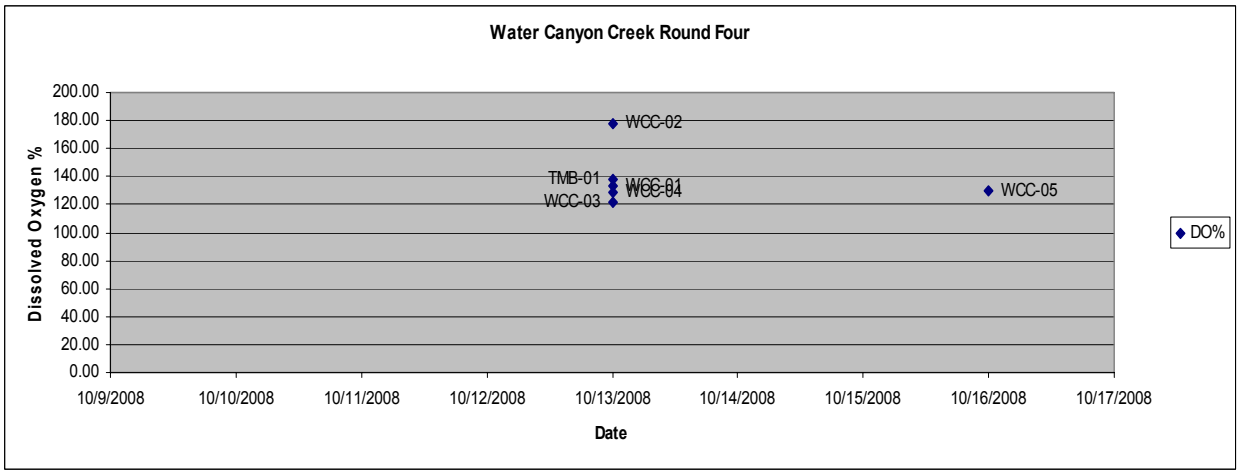

Water Canyon Creek Round Three
Salinity
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
Salinity

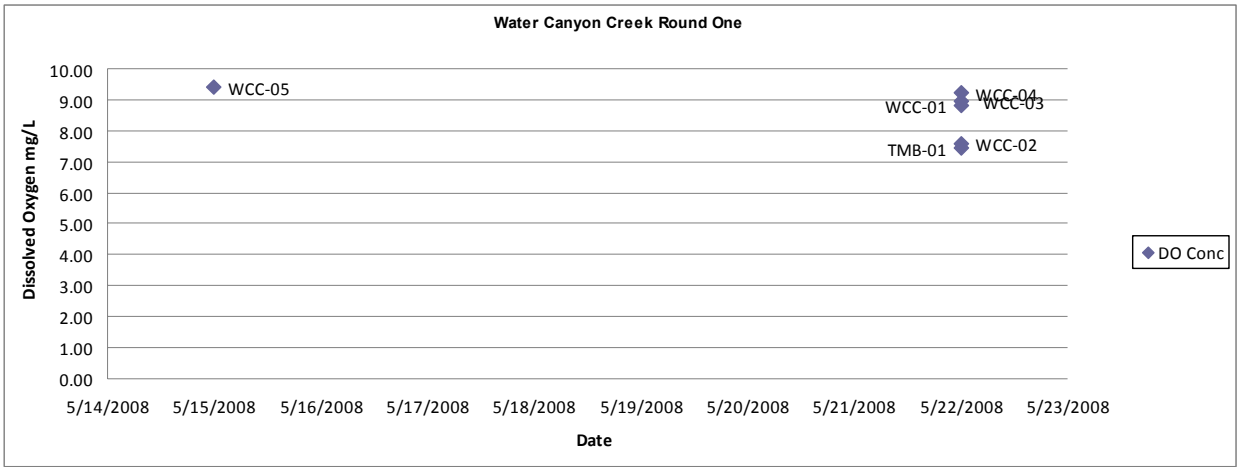

Water Canyon Creek Round Four
Salinity
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
1/0/1900
1/1/1900
1/2/1900
1/3/1900
1/4/1900
1/5/1900
1/6/1900
1/7/1900
Date
Salinity

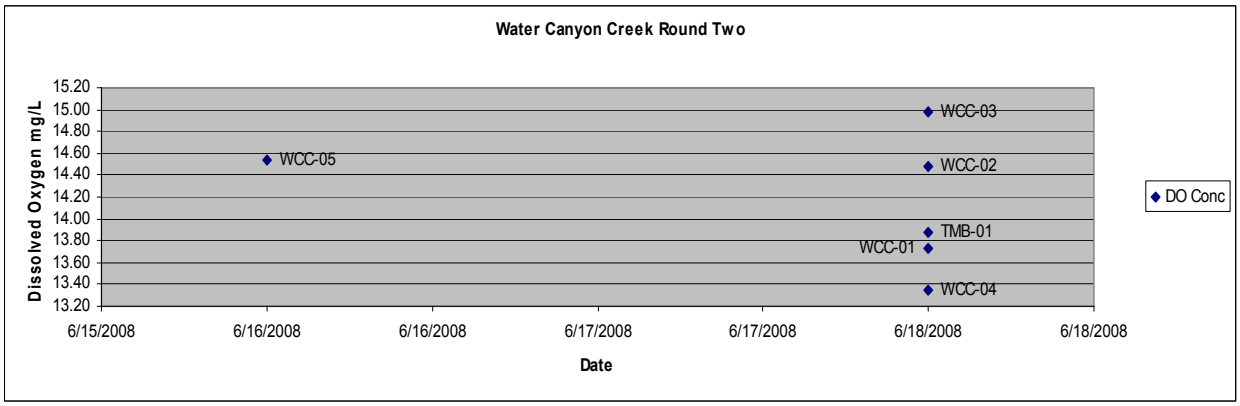

Water Canyon Creek Round One
Dissolved Oxygen %
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
WCC-05
WCC-04
WCC-01
WCC-03
WCC-02
TMB-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
DO%

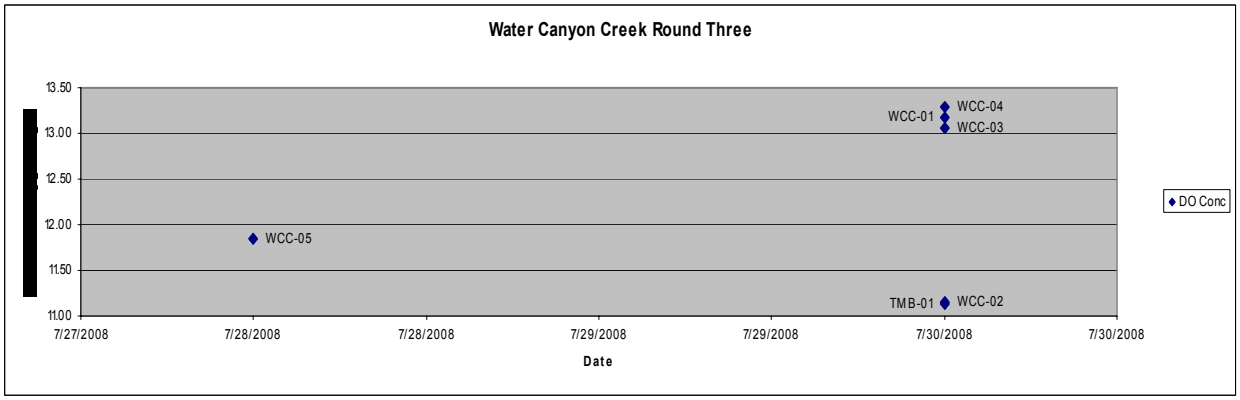

Water Canyon Creek Round Two
Dissolved Oxygen %
152.00
150.00
148.00
146.00
144.00
142.00
140.00
138.00
136.00
WCC-02
WCC-03
WCC-01
WCC-05
TMB-01
WCC-04
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
DO%

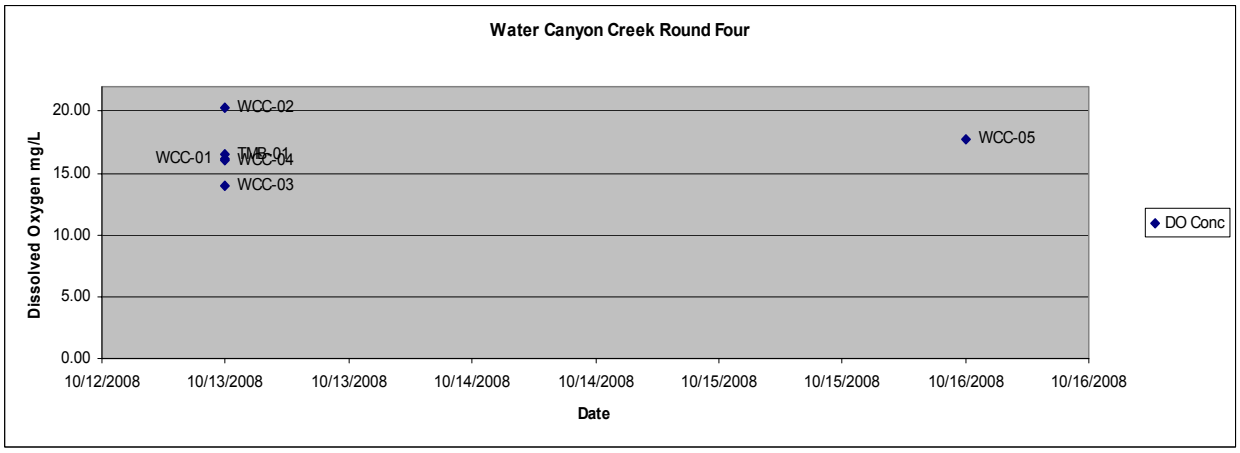

Water Canyon Creek Round Three
Dissolved Oxygen %
138.00
136.00
134.00
132.00
130.00
128.00
126.00
124.00
122.00
120.00
118.00
116.00
WCC-01
TMB-01
WCC-04
WCC-03
WCC-05
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
DO%

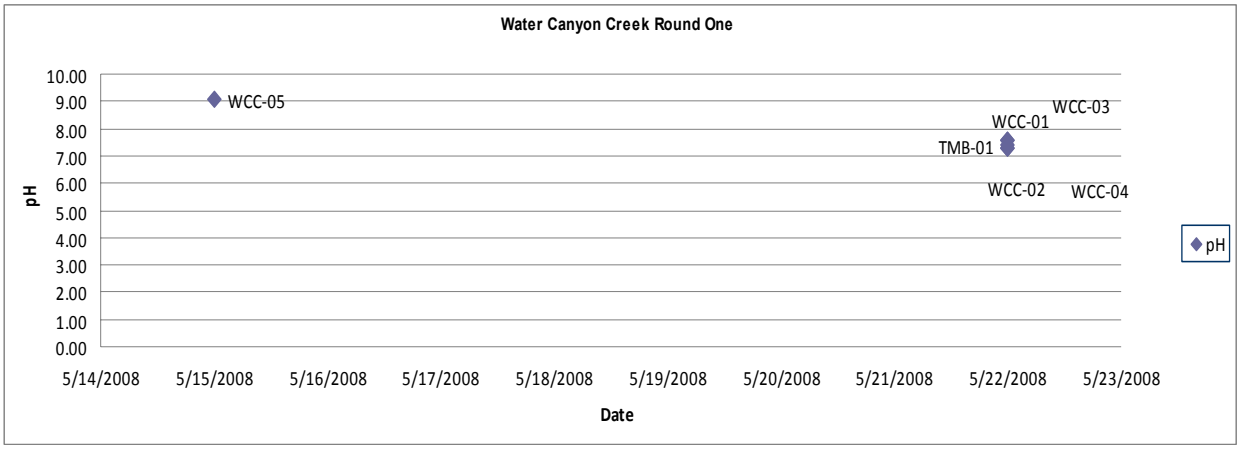

Water Canyon Creek Round Four
Dissolved Oxygen %
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
WCC-02
TMB-01
WCC-01
WCC-04
WCC-03
WCC-05
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
10/15/2008
10/16/2008
10/17/2008
Date
DO%

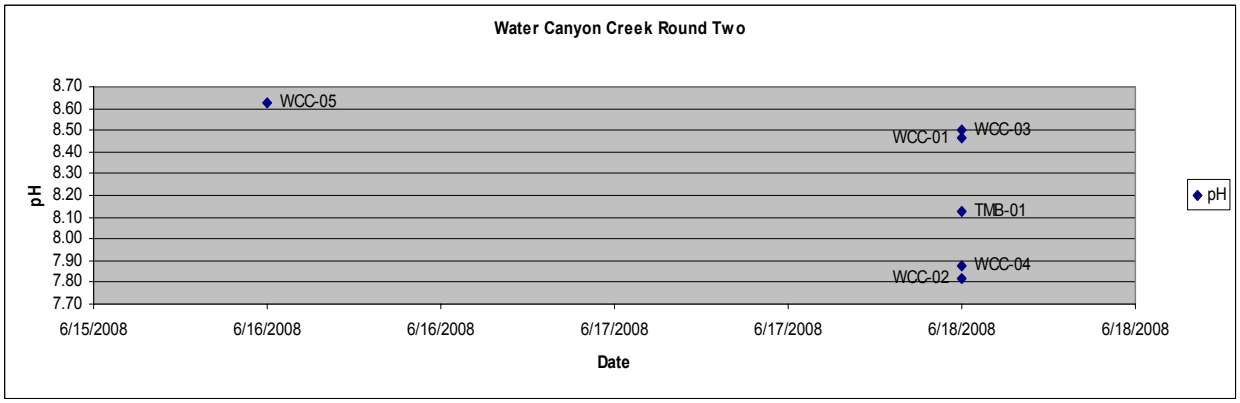

Water Canyon Creek Round One
Dissolved Oxygen mg/L
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
WCC-05
WCC-04
WCC-01
WCC-03
TMB-01
WCC-02
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
DO Conc

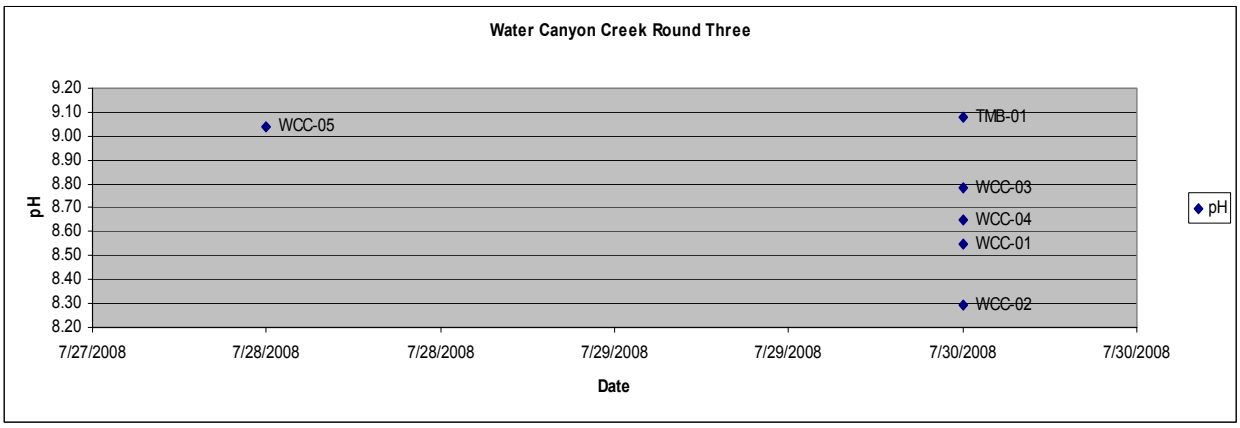

Water Canyon Creek Round Two
Dissolved Oxygen mg/L
15.20
15.00
14.80
14.60
14.40
14.20
14.00
13.80
13.60
13.40
13.20
WCC-03
WCC-05
WCC-02
TMB-01
WCC-01
WCC-04
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
DO Conc

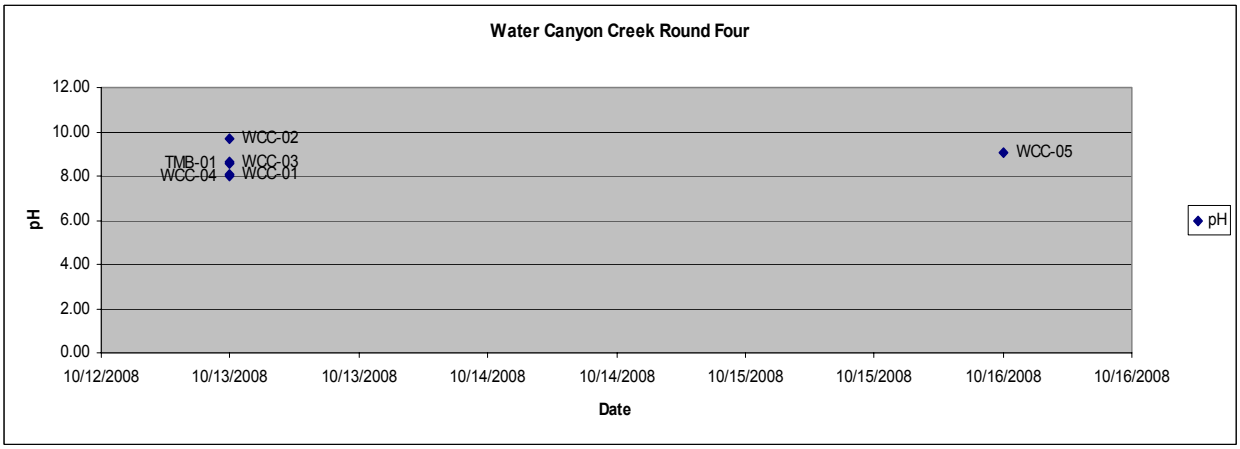

Water Canyon Creek Round Three
13.50
13.00
12.50
12.00
11.50
11.00
WCC-04
WCC-01
WCC-03
WCC-05
TMB-01
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
DO Conc

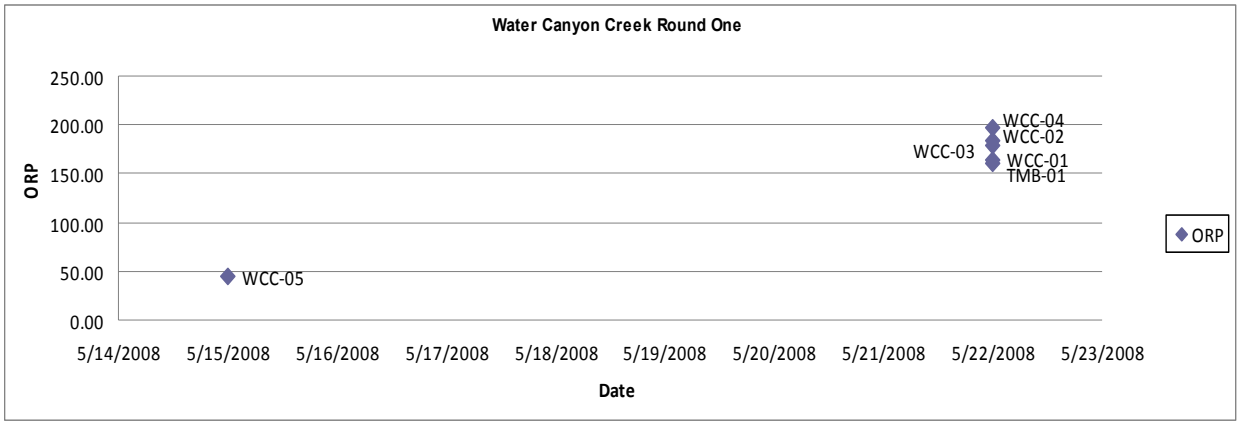

Water Canyon Creek Round Four
Dissolved Oxygen mg/L
20.00
15.00
10.00
5.00
0.00
WCC-02
WCC-05
WCC-01
TMB-01
WCC-04
WCC-03
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
DO Conc

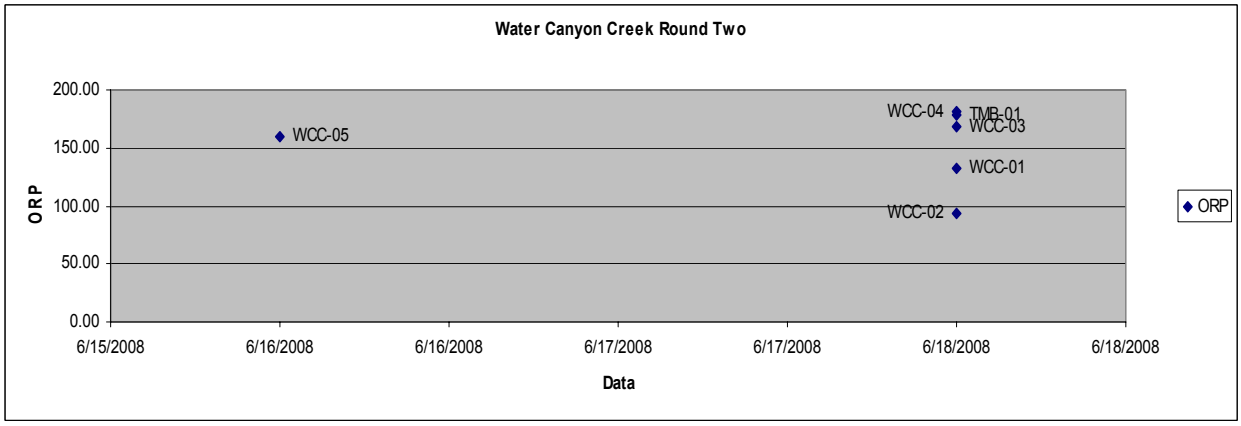

Water Canyon Creek Round One
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
WCC-05
WCC-03
WCC-01
TMB-01
WCC-02
WCC-04
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
pH

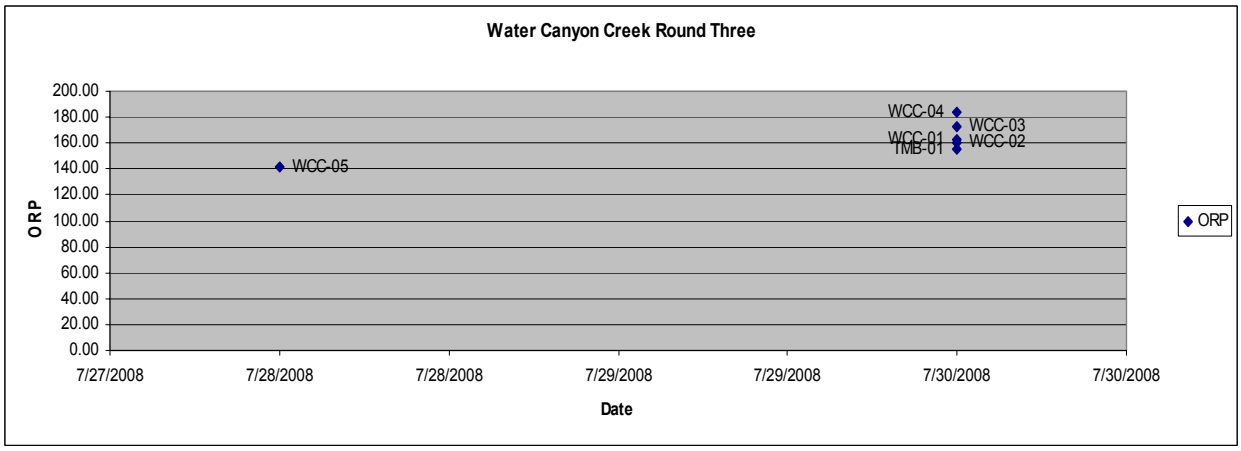

Water Canyon Creek Round Two
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
7.80
7.70
pH
WCC-05
WCC-01
WCC-03
TMB-01
WCC-04
WCC-02
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date
pH

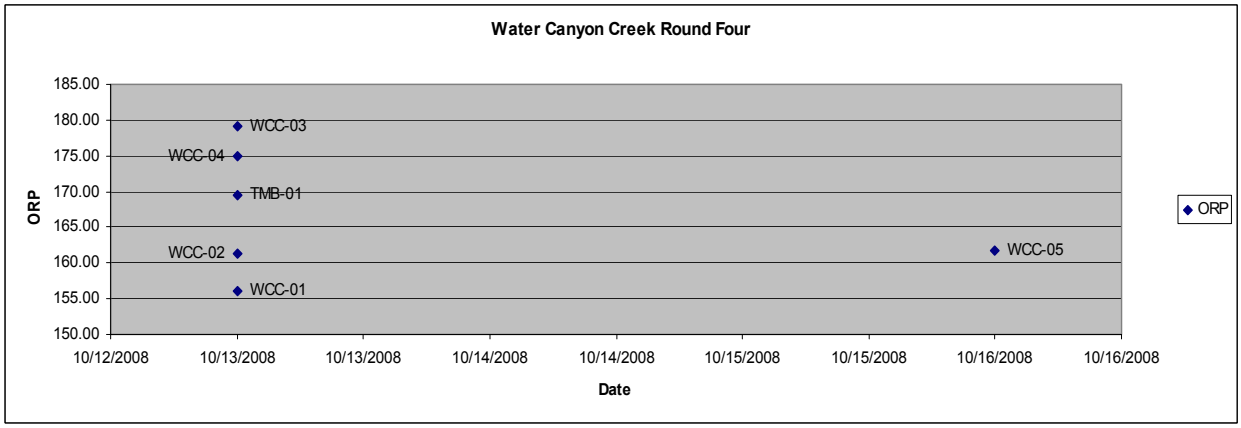

Water Canyon Creek Round Three
9.20
9.10
9.00
8.90
8.80
8.70
8.60
8.50
8.40
8.30
8.20
pH
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
pH

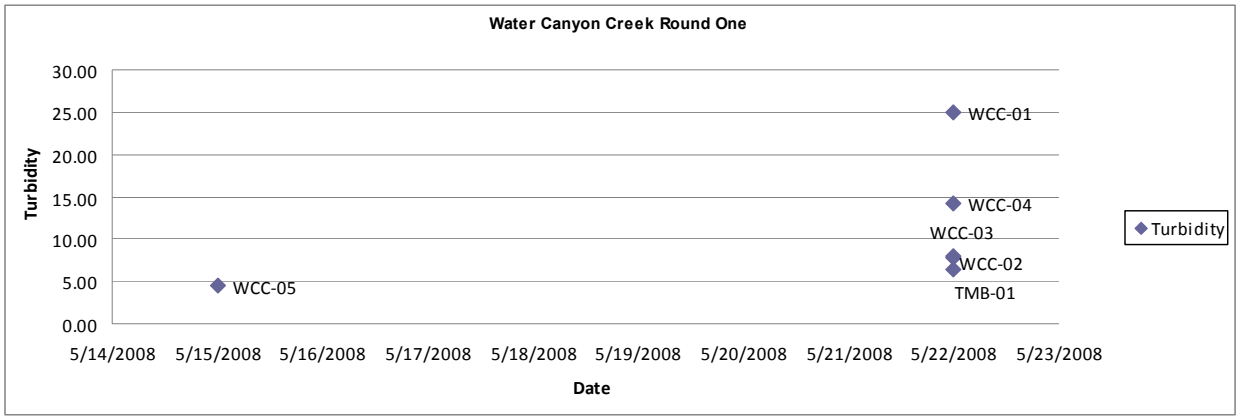

Water Canyon Creek Round Four
12.00
10.00
8.00
6.00
4.00
2.00
0.00
pH
WCC-02
TMB-01
WCC-03
WCC-04
WCC-01
WCC-05
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
pH

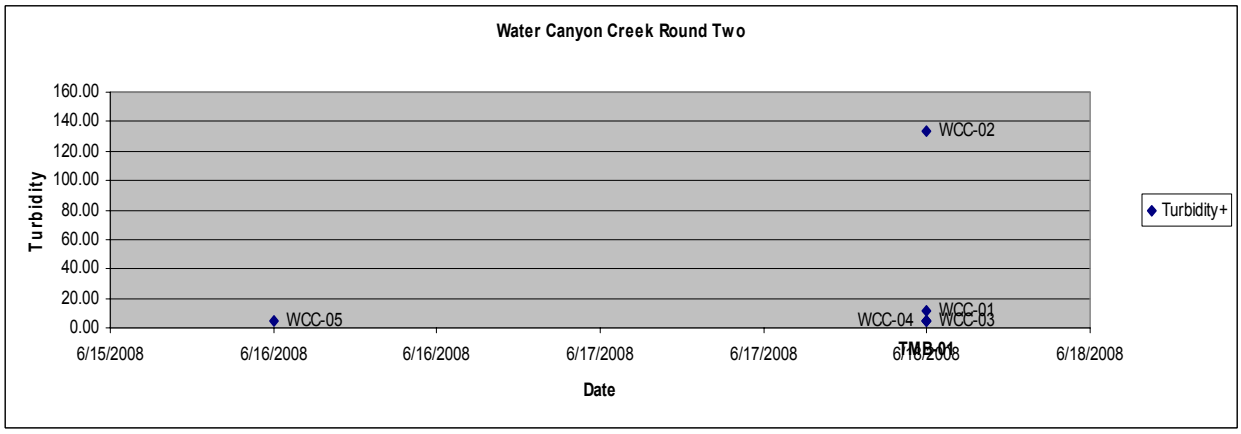

Water Canyon Creek Round One
ORP
250.00
200.00
150.00
100.00
50.00
0.00
WCC-05
WCC-04
WCC-02
WCC-03
WCC-01
TMB-01
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
ORP

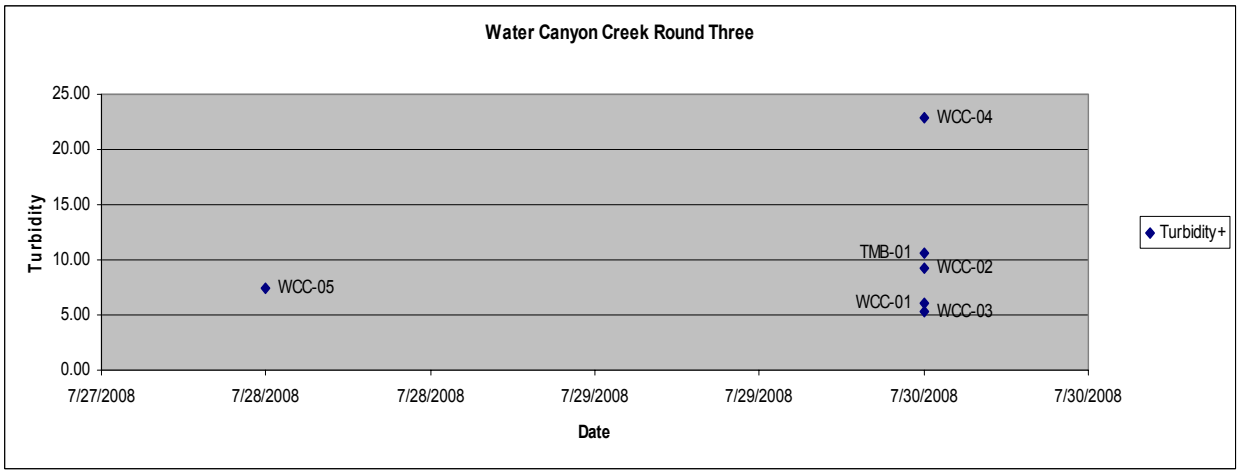

Water Canyon Creek Round Two
ORP
200.00
150.00
100.00
50.00
0.00
WCC-05
WCC-04
TMB-01
WCC-03
WCC-01
WCC-02
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Data
ORP

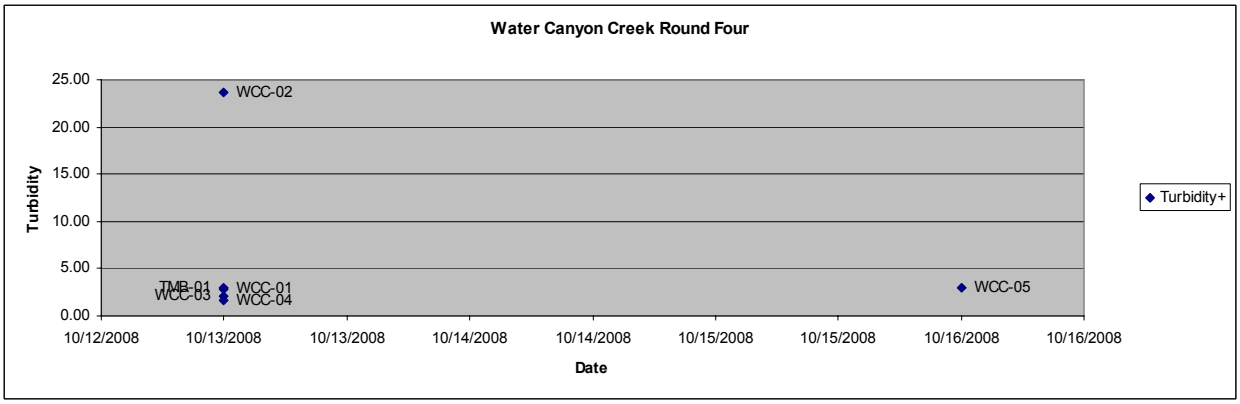

Water Canyon Creek Round Three
ORP
200.00
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
WCC-05
WCC-04
WCC-03
WCC-01
WCC-02
TMB-01
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
ORP

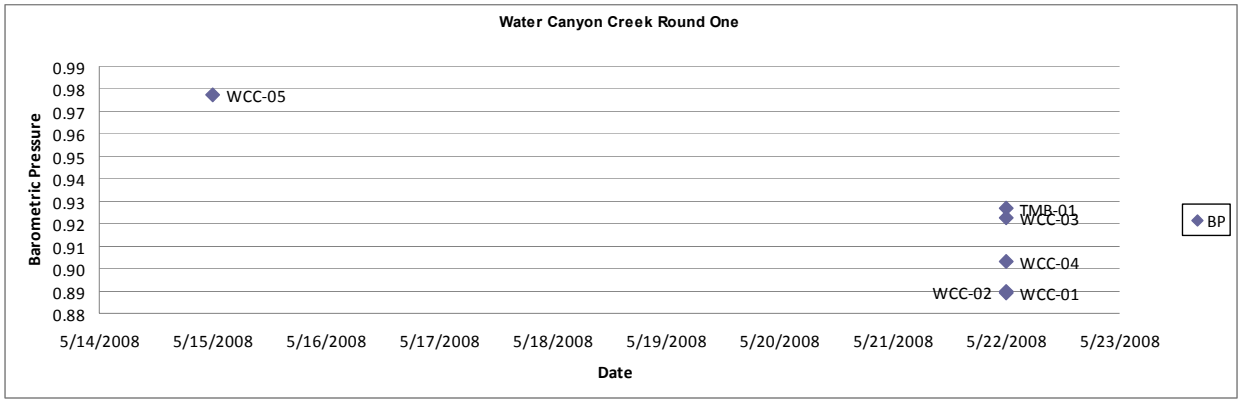

Water Canyon Creek Round Four
ORP
185.00
180.00
175.00
170.00
165.00
160.00
155.00
150.00
WCC-03
WCC-04
TMB-01
WCC-02
WCC-01
WCC-05
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
ORP

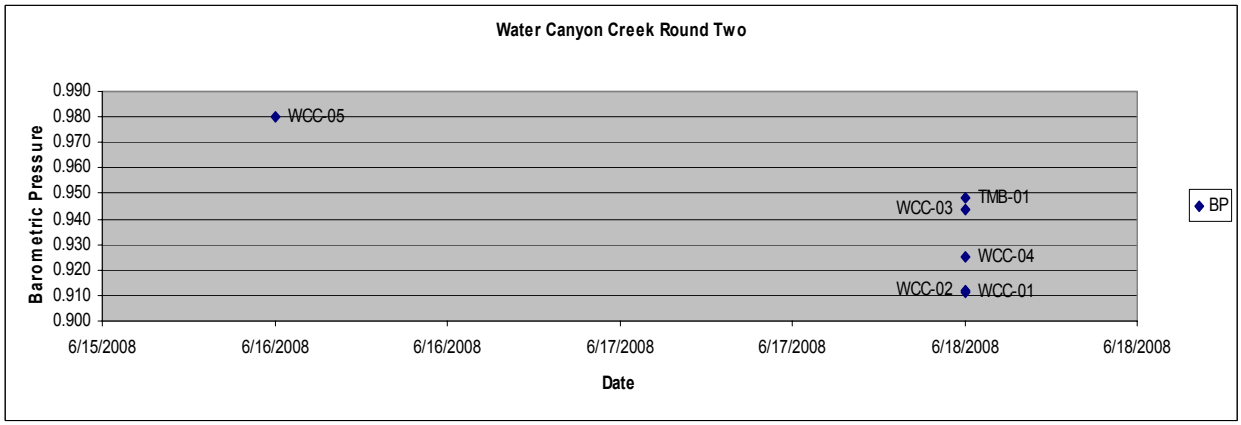

Water Canyon Creek Round One
Turbidity
30.00
25.00
20.00
15.00
10.00
5.00
0.00
WCC-01
WCC-04
WCC-03
WCC-02
TMB-01
WCC-05
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date
Turbidity

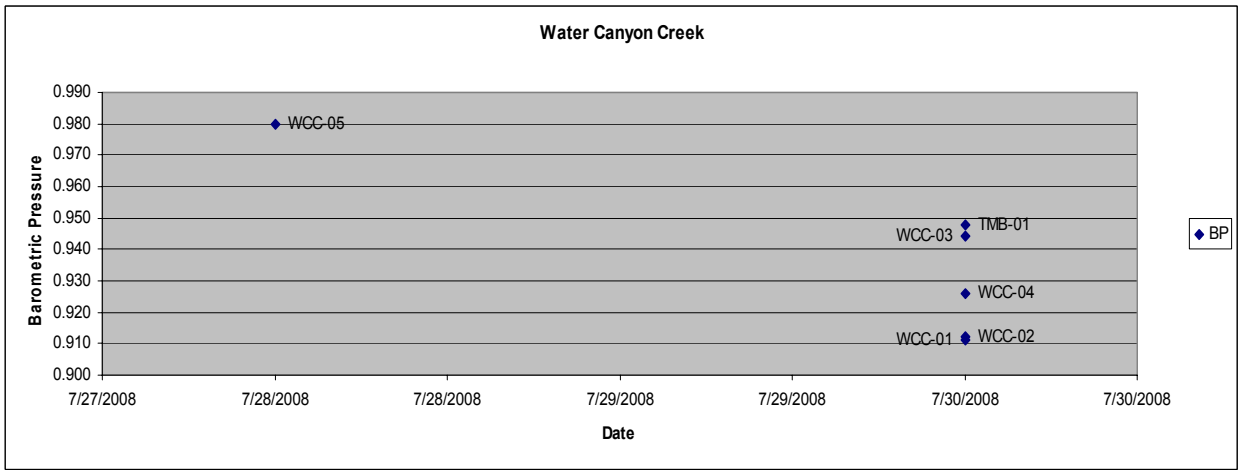

Water Canyon Creek Round Two
Turbidity
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
WCC-02
WCC-05
WCC-04
WCC-01
WCC-03
TMB-01
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
Date
Turbidity+

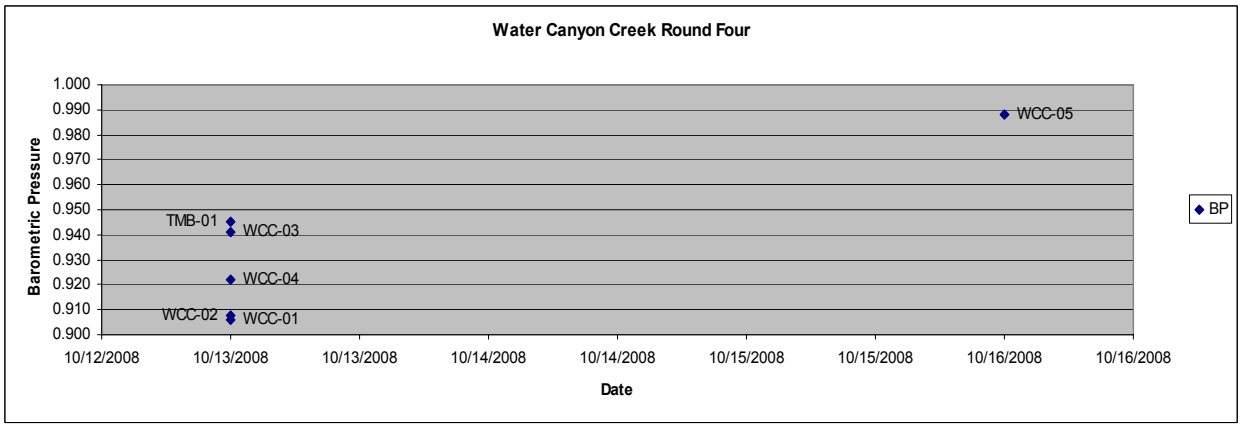

Water Canyon Creek Round Three
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
WCC-04
TMB-01
WCC-02
WCC-05
WCC-01
WCC-03
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date
Turbidity+


Water Canyon Creek Round Four
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
WCC-02
TMB-01
WCC-03
WCC-01
WCC-04
WCC-05
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date
Turbidity+

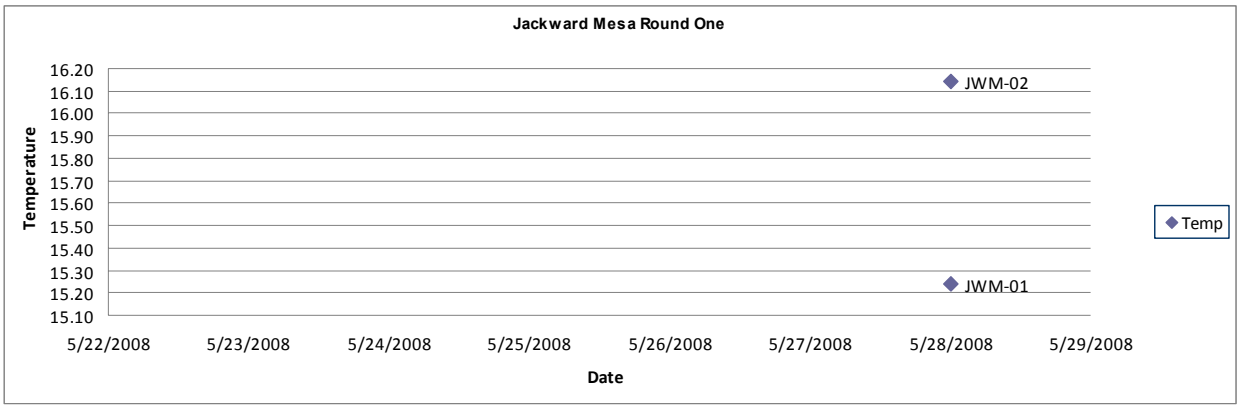

Water Canyon Creek Round One
Barometric Pressure
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
0.89
0.88
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
BP
5/14/2008
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
5/23/2008
Date

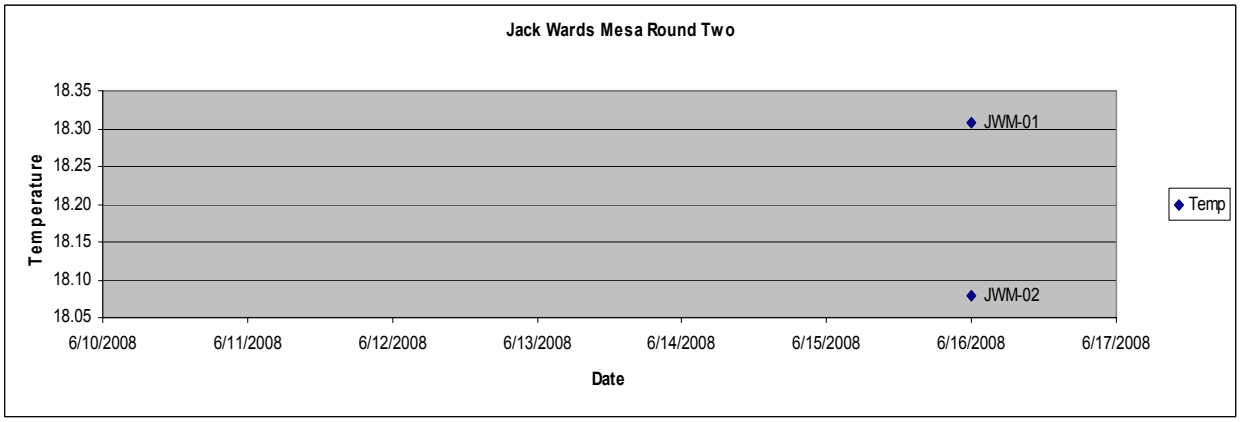

Water Canyon Creek Round Two
Barometric Pressure
0.990
0.980
0.970
0.960
0.950
0.940
0.930
0.920
0.910
0.900
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
BP
6/15/2008
6/16/2008
6/16/2008
6/17/2008
6/17/2008
6/18/2008
6/18/2008
Date

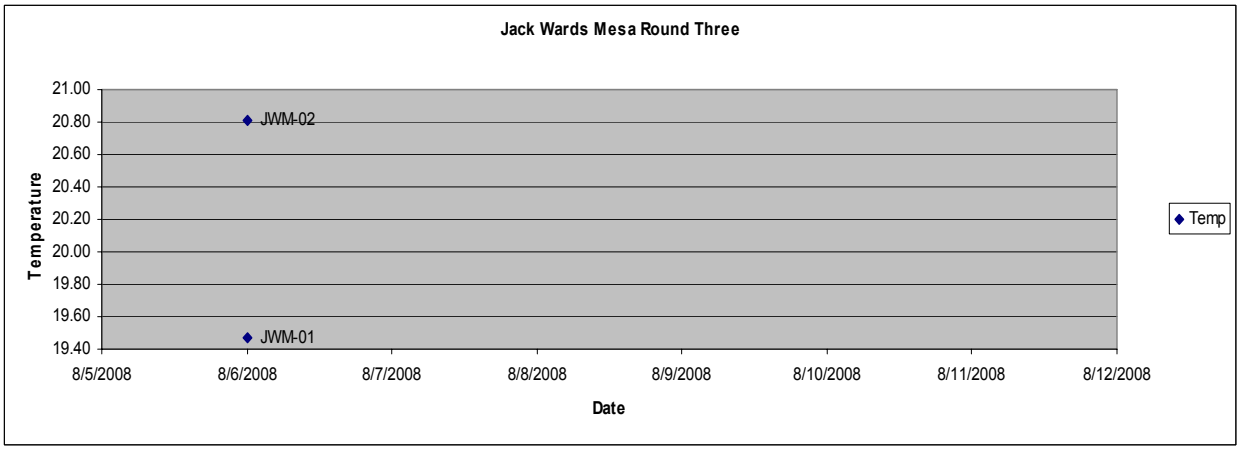

Water Canyon Creek
Barometric Pressure
0.990
0.980
0.970
0.960
0.950
0.940
0.930
0.920
0.910
0.900
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
BP
7/27/2008
7/28/2008
7/28/2008
7/29/2008
7/29/2008
7/30/2008
7/30/2008
Date

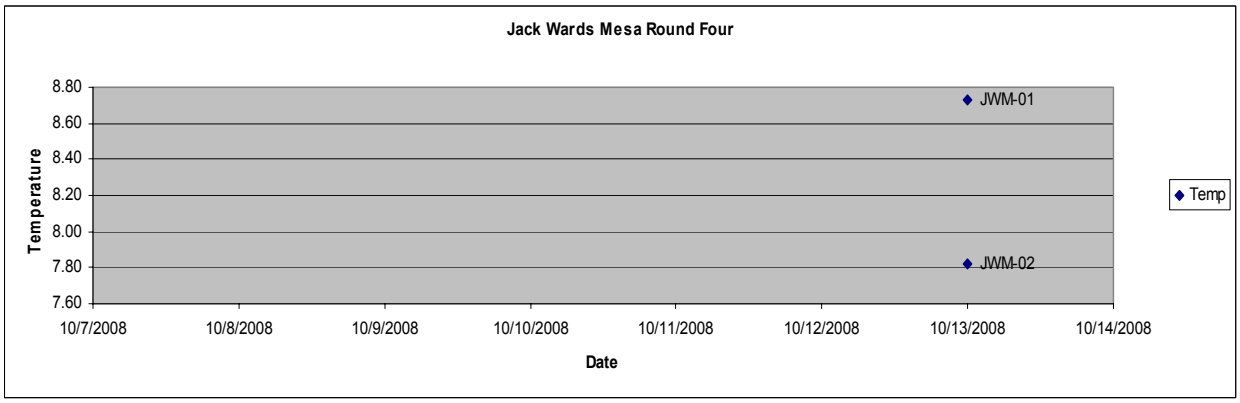

Water Canyon Creek Round Four
Barometric Pressure
1.000
0.990
0.980
0.970
0.960
0.950
0.940
0.930
0.920
0.910
0.900
WCC-05
TMB-01
WCC-03
WCC-04
WCC-02
WCC-01
BP
10/12/2008
10/13/2008
10/13/2008
10/14/2008
10/14/2008
10/15/2008
10/15/2008
10/16/2008
10/16/2008
Date

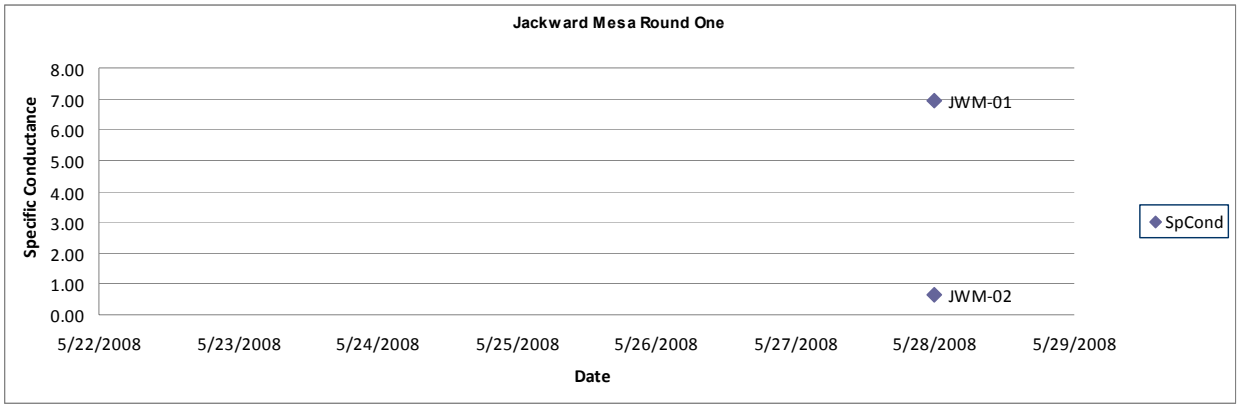
Jack Wards Mesa

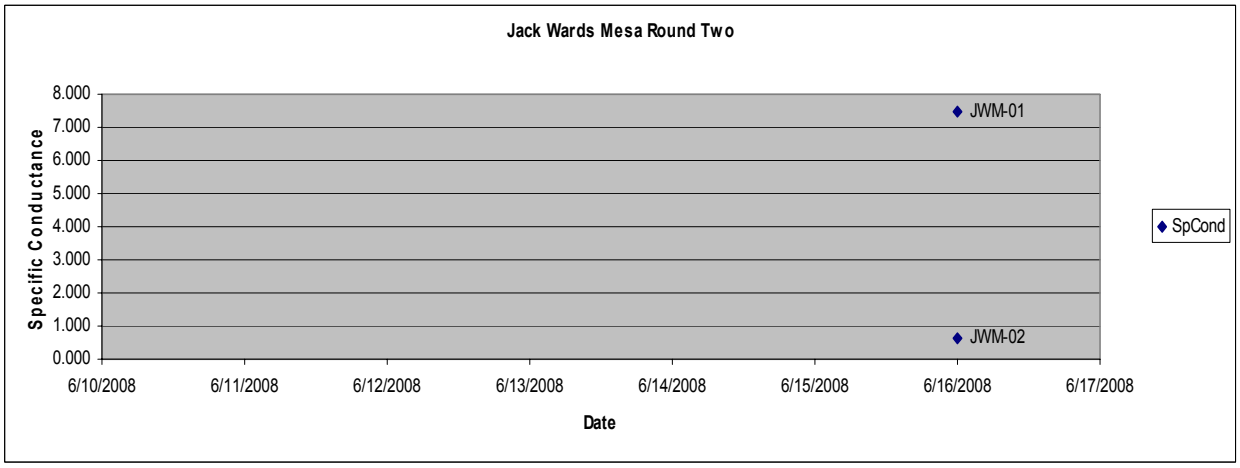


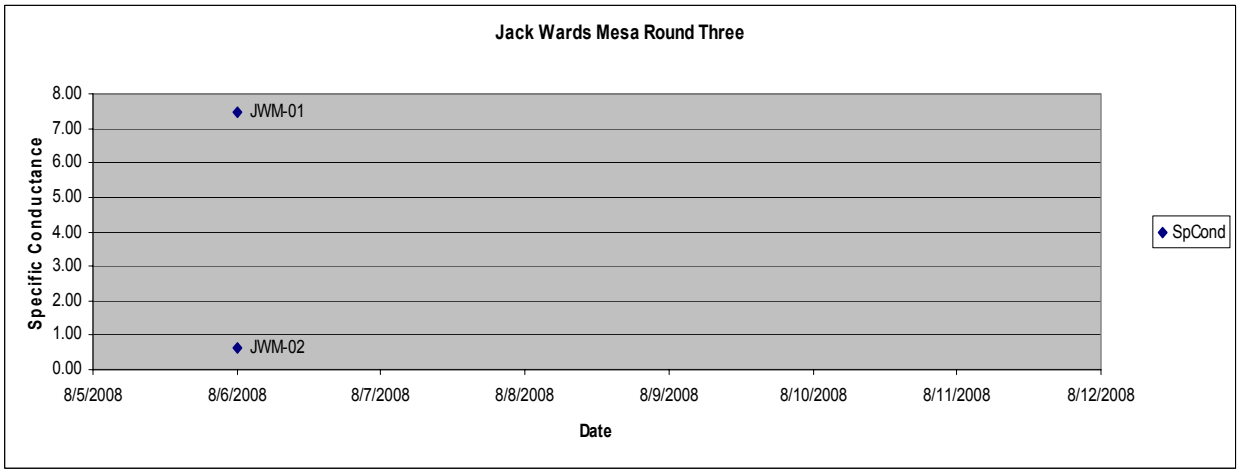


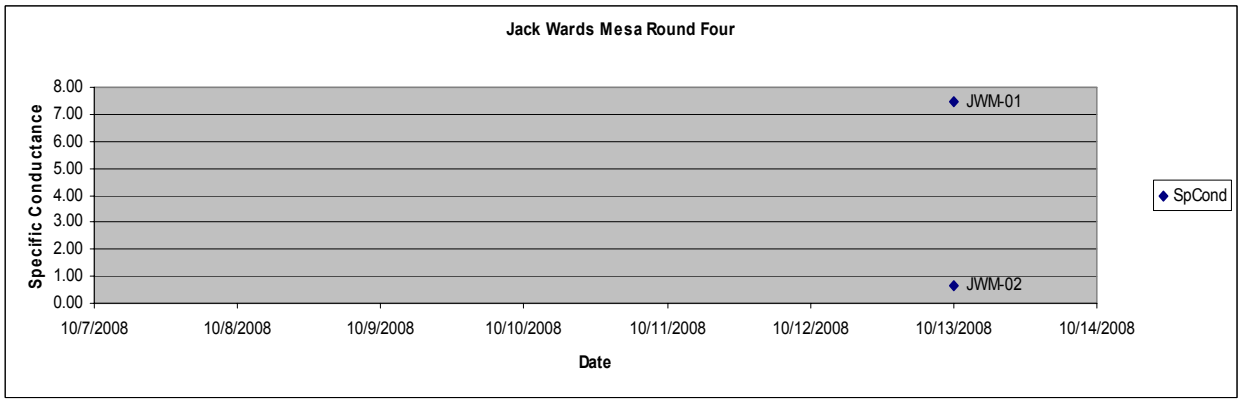


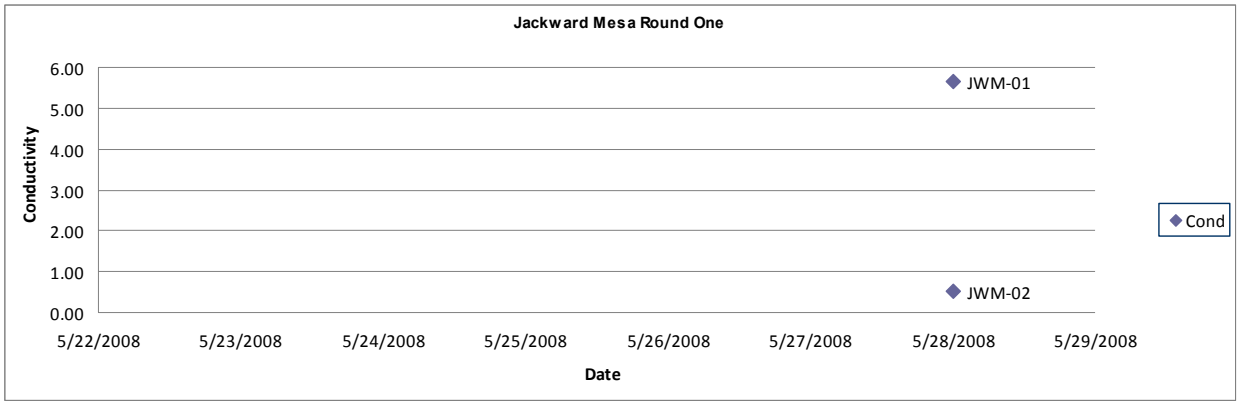


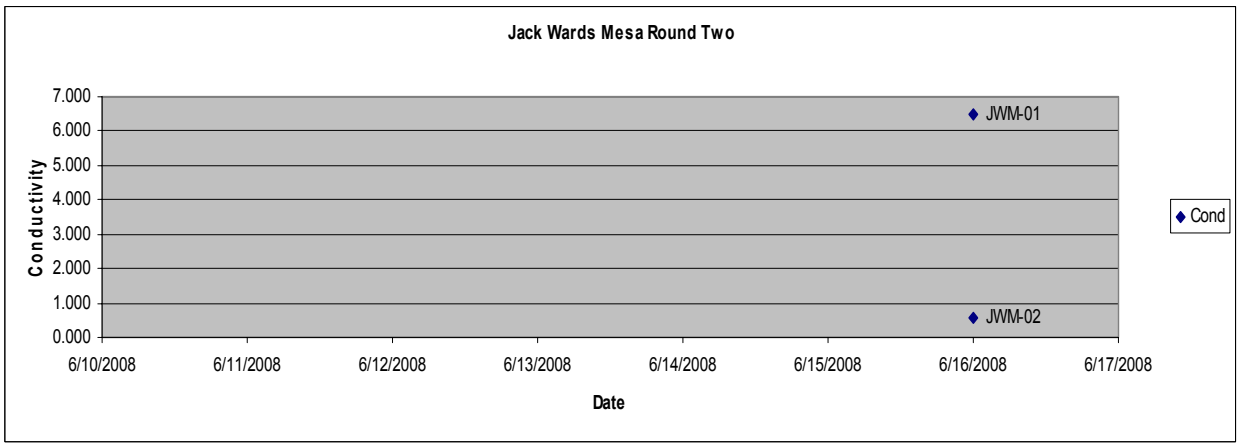

Jackward Mesa Round One
Specific Conductance
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
SpCond
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

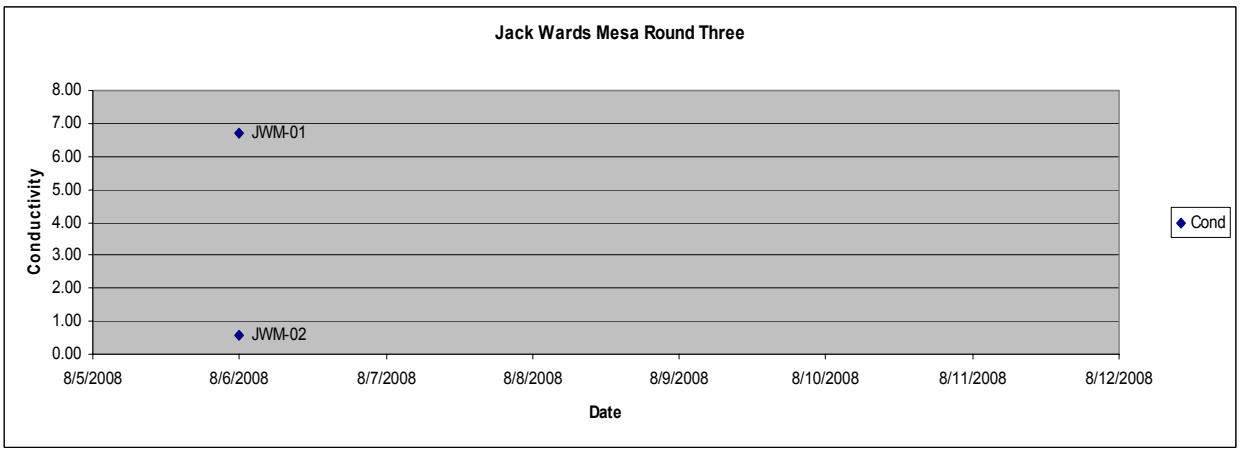

Jack Wards Mesa Round Two
Specific Conductance
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
JWM-01
JWM-02
SpCond
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

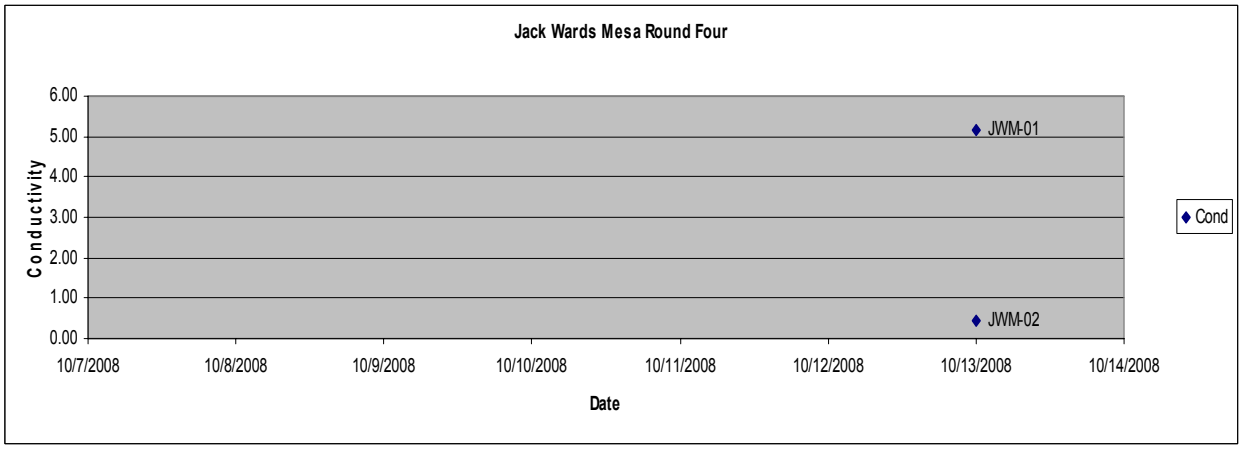

Jack Wards Mesa Round Three
Specific Conductance
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
SpCond
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

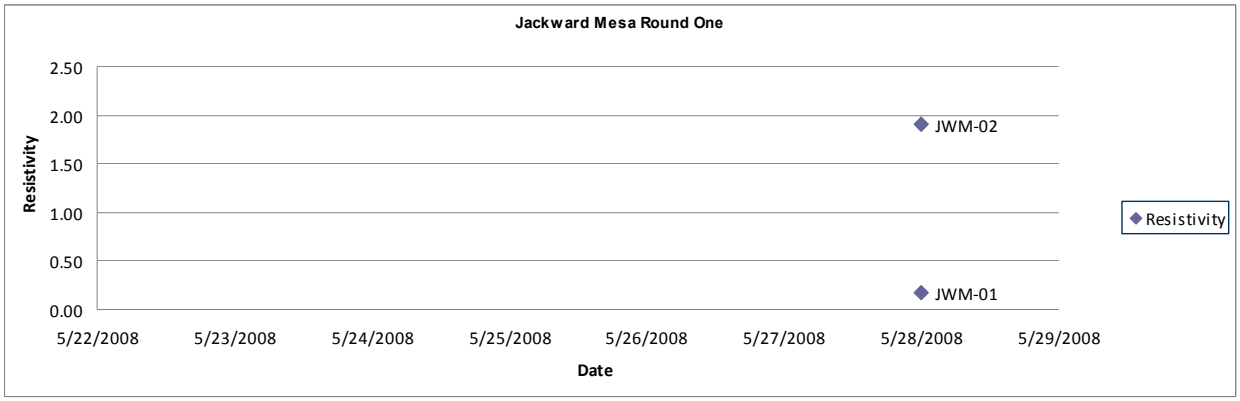

Jack Wards Mesa Round Four
Specific Conductance
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
SpCond
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

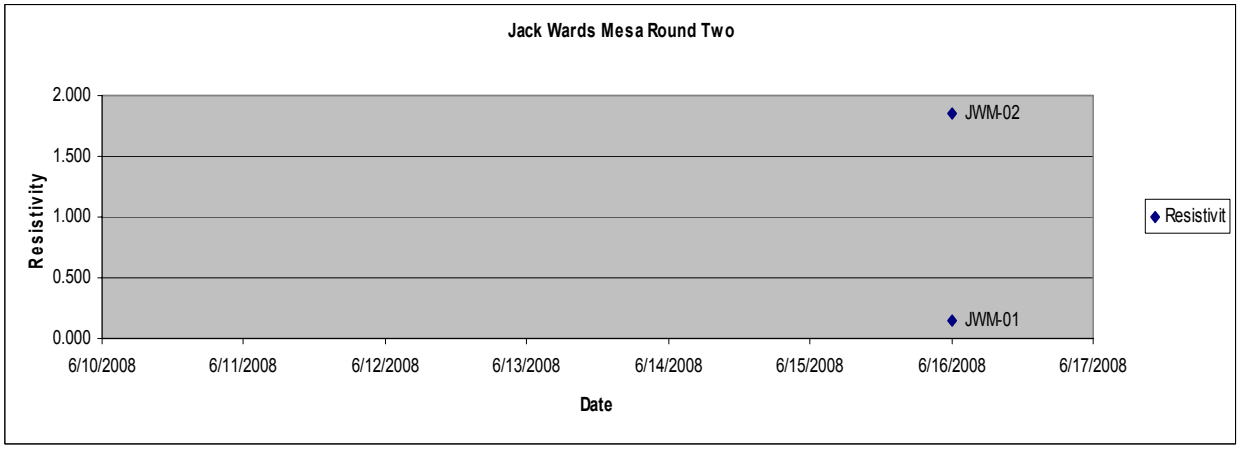

Jackward Mesa Round One
Conductivity
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Cond
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

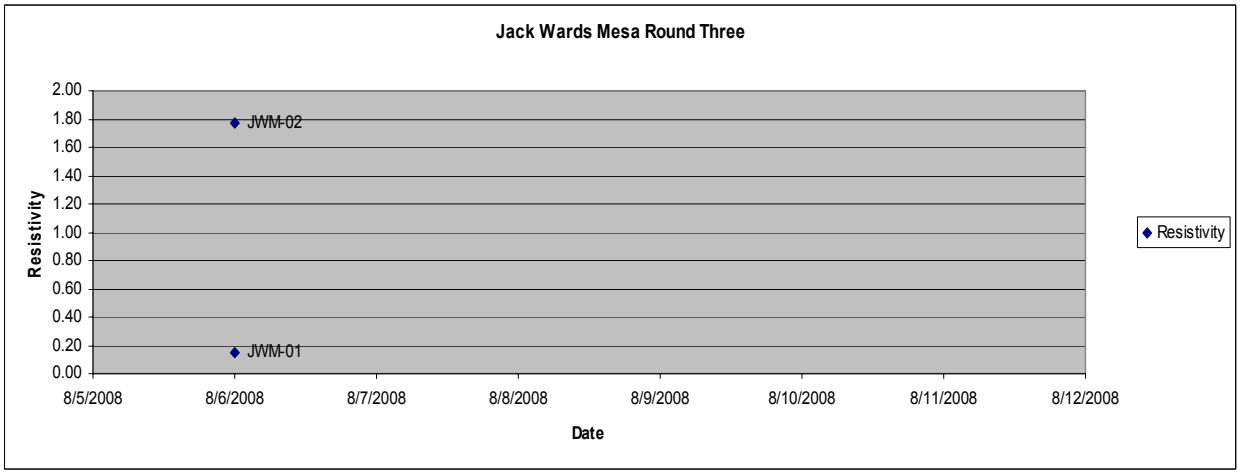

Jack Wards Mesa Round Two
Conductivity
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
JWM-01
JWM-02
Cond
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

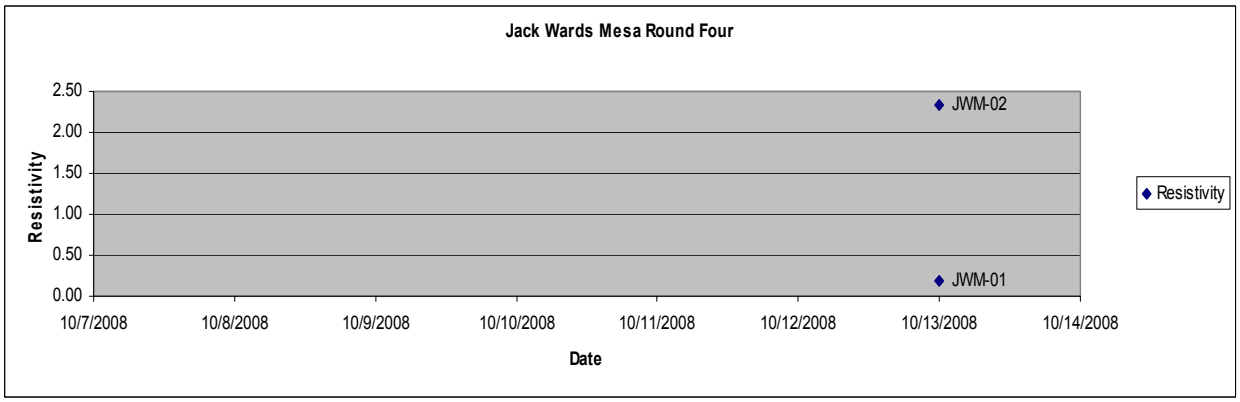

Jack Wards Mesa Round Three
Conductivity
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Cond
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

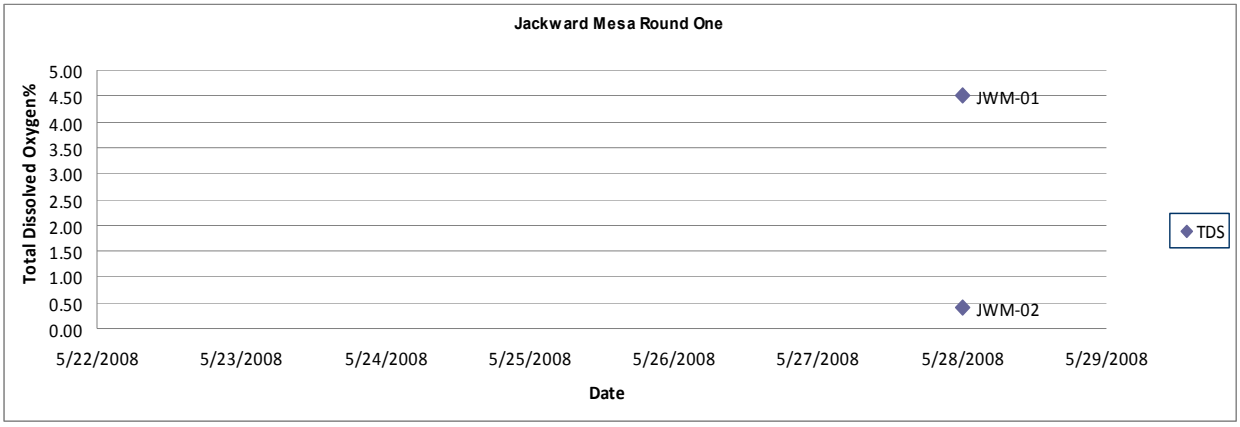

Jack Wards Mesa Round Four
Conductivity
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Cond
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

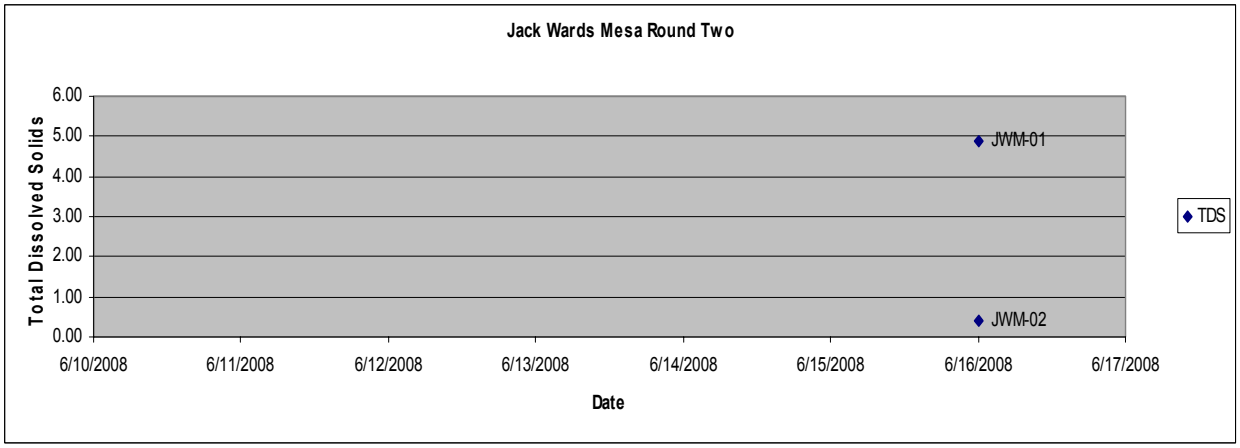

Jackward Mesa Round One
Resistivity
2.50
2.00
1.50
1.00
0.50
0.00
JWM-02
JWM-01
Resistivity
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

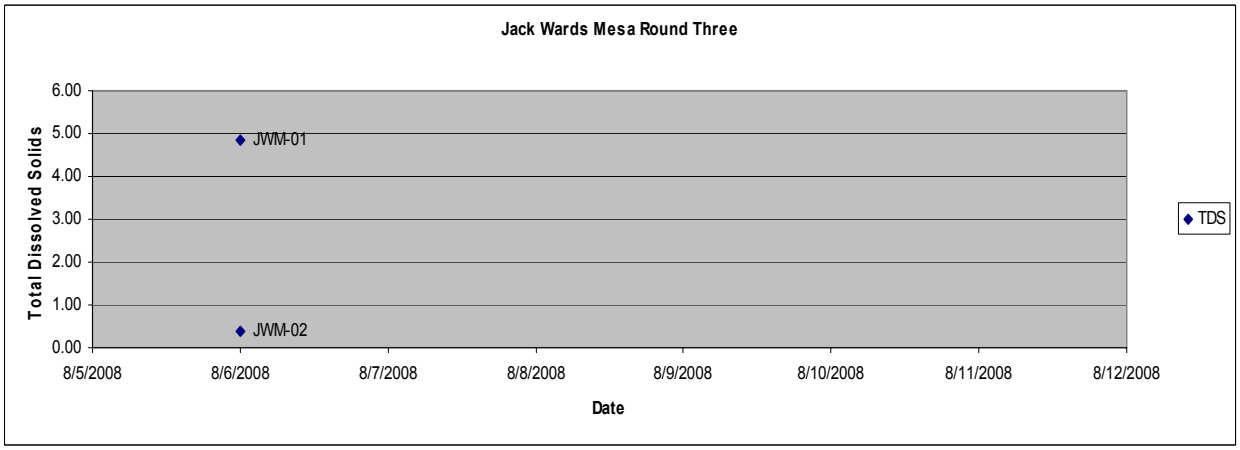

Jack Wards Mesa Round Two
Resistivity
2.000
1.500
1.000
0.500
0.000
JWM-02
JWM-01
Resistivit
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

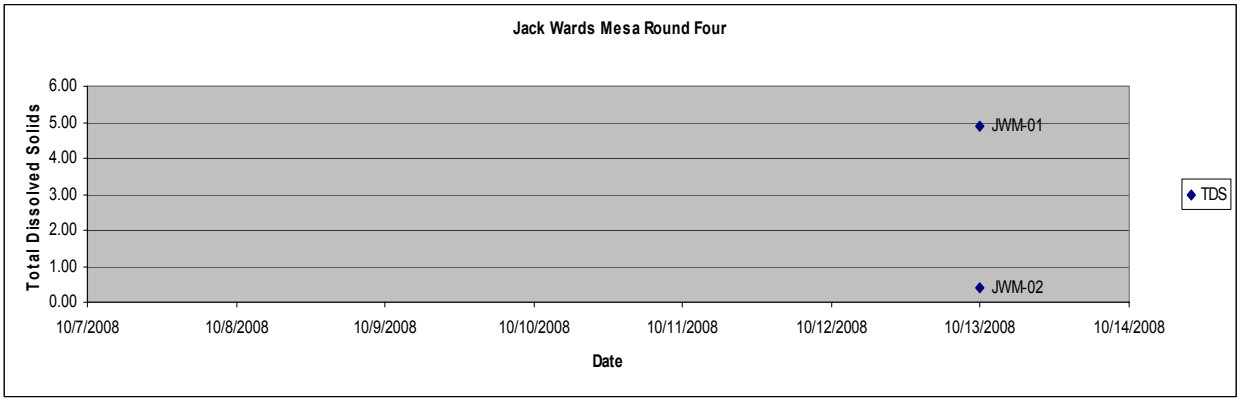

Jack Wards Mesa Round Three
Resistivity
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
JWM-02
JWM-01
Resistivity
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

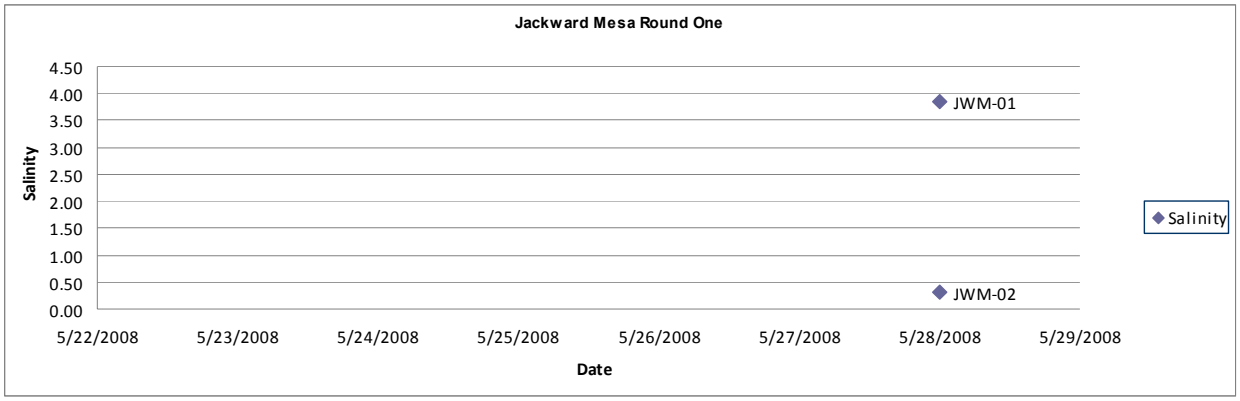

Jack Wards Mesa Round Four
Resistivity
2.50
2.00
1.50
1.00
0.50
0.00
JWM-02
JWM-01
Resistivity
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

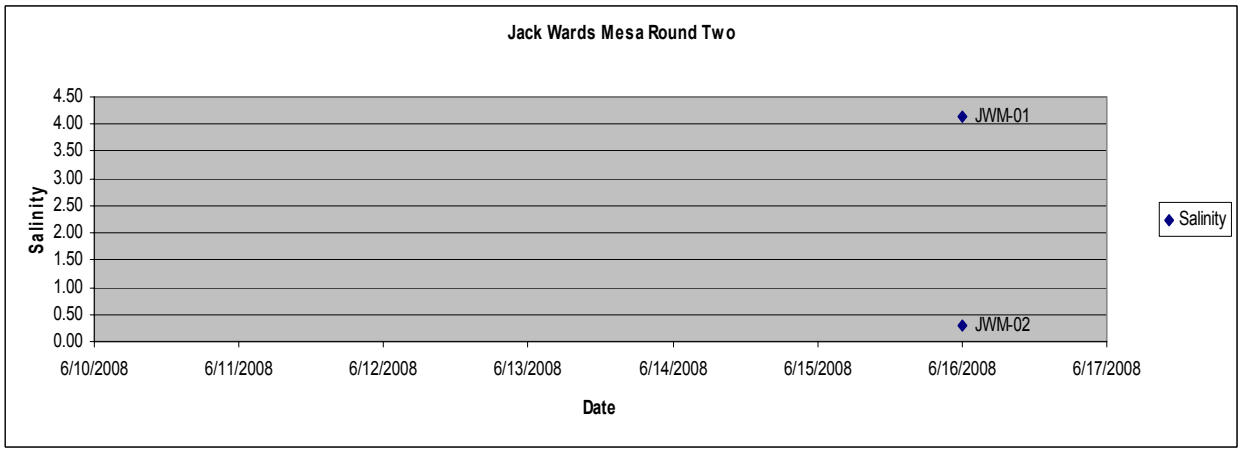

Jackward Mesa Round One
Total Dissolved Oxygen%
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
JWM-01
JWM-02
TDS
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

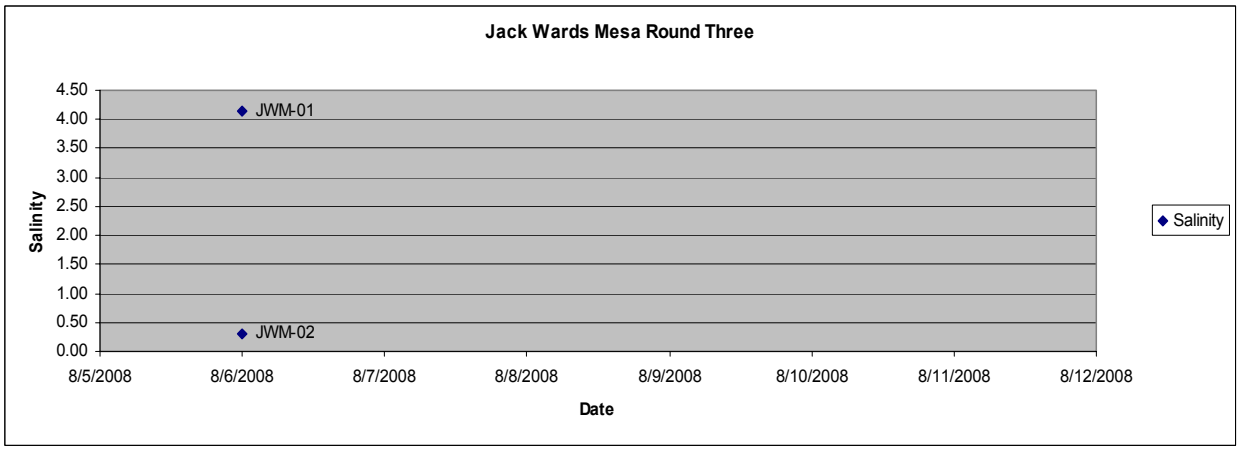

Jack Wards Mesa Round Two
Total Dissolved Solids
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
TDS
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

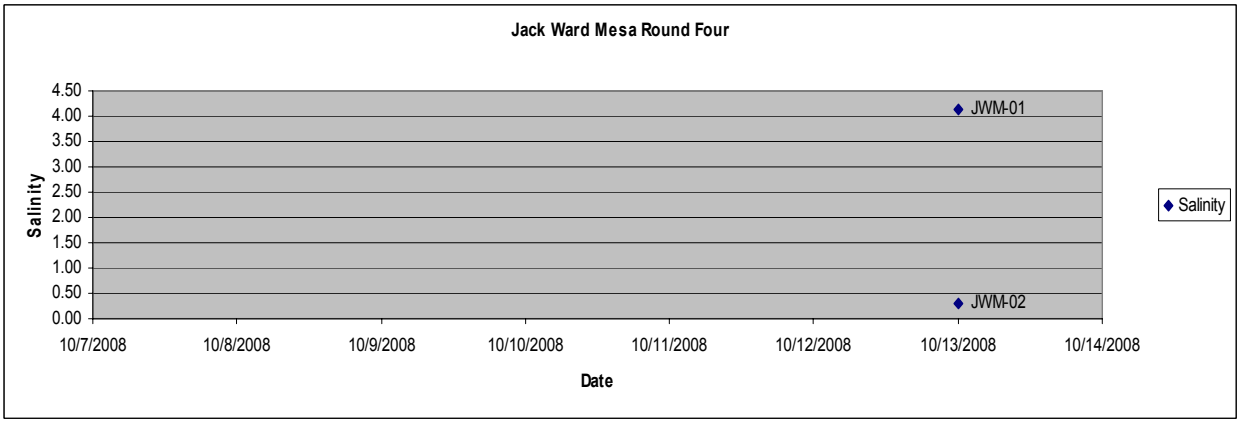

Jack Wards Mesa Round Three
Total Dissolved Solids
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
TDS
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

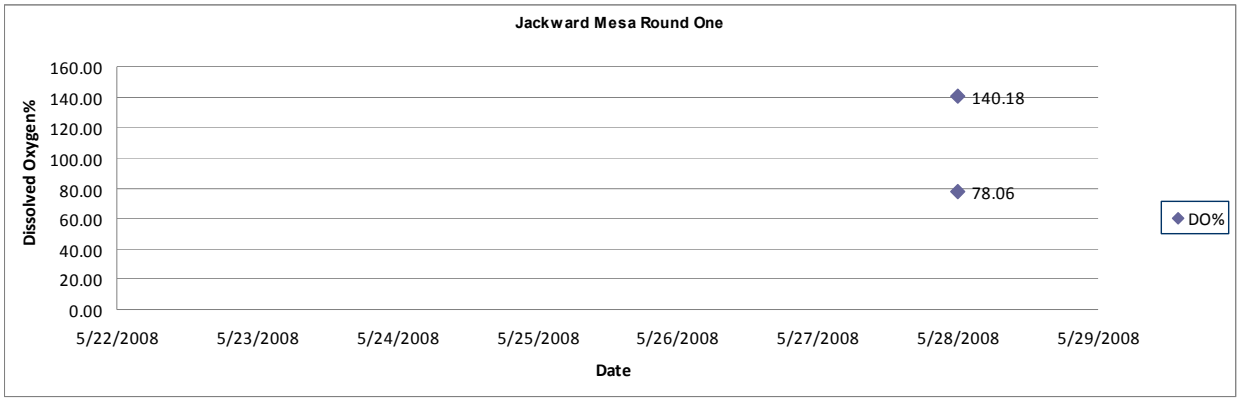

Jack Wards Mesa Round Four
Total Dissolved Solids
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
TDS
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

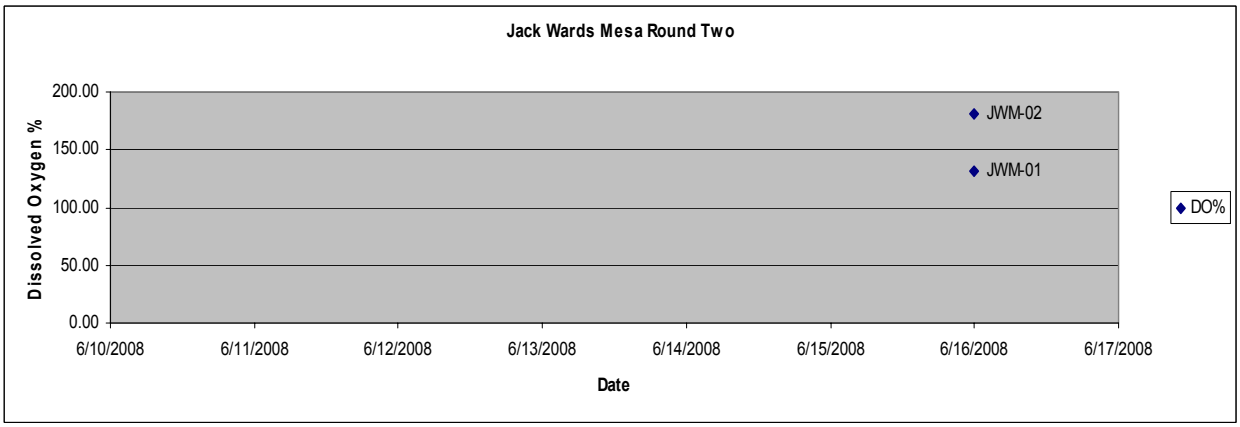

Jackward Mesa Round One
Salinity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
JWM-01
JWM-02
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date
Salinity

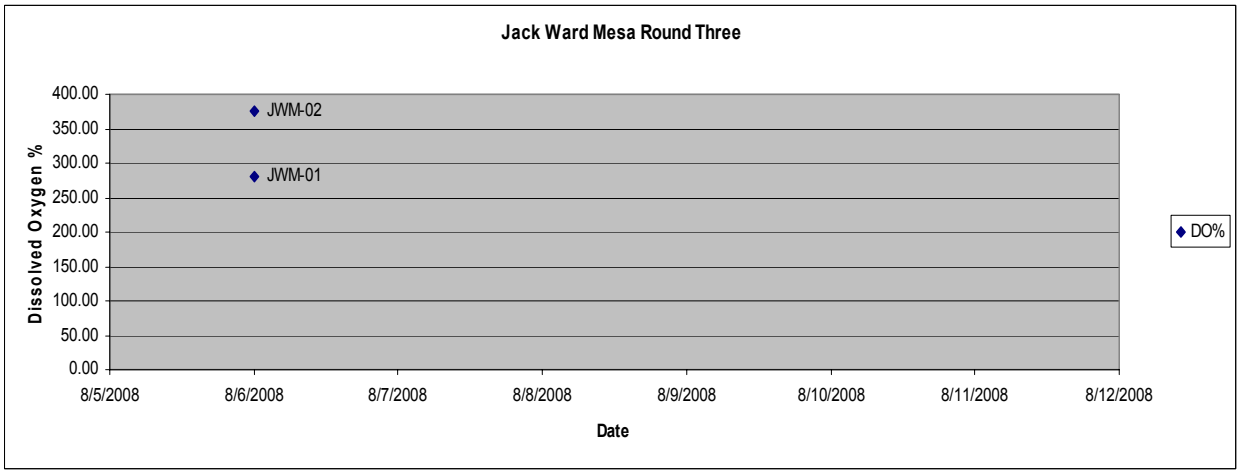

Jack Wards Mesa Round Two
Salinity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
JWM-01
JWM-02
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date
Salinity

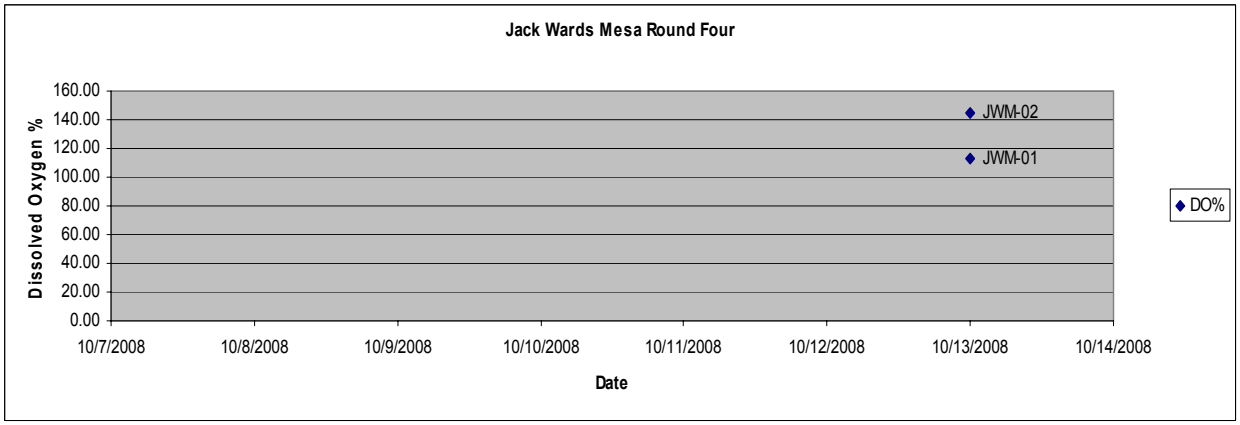

Jack Wards Mesa Round Three
Salinity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
JWM-01
JWM-02
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date
Salinity

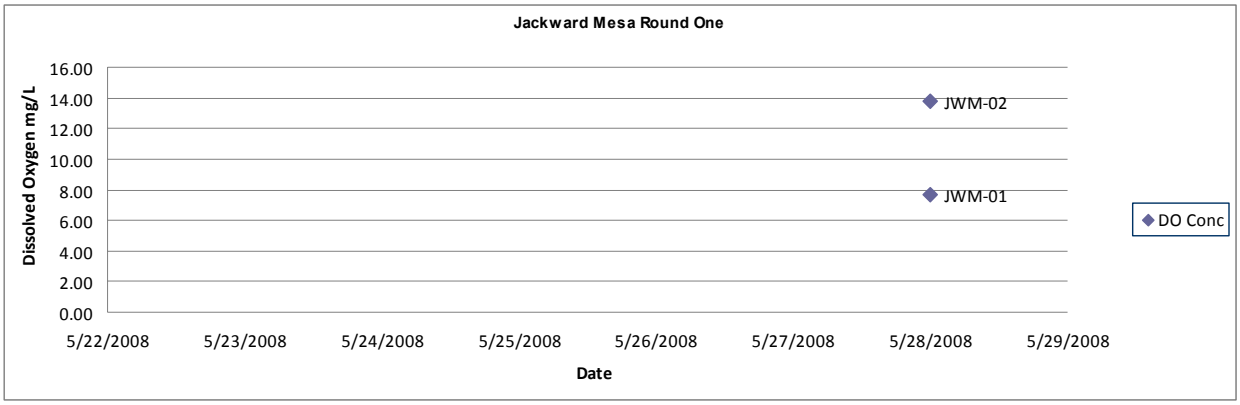

Jack Ward Mesa Round Four
Salinity
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
JWM-01
JWM-02
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date
Salinity

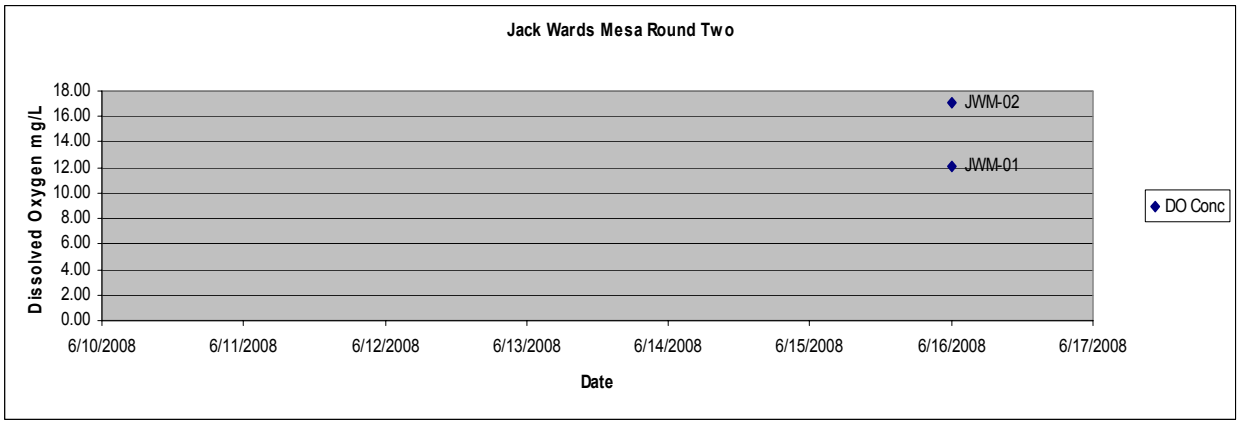

Jackward Mesa Round One
Dissolved Oxygen%
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
140.18
78.06
DO%
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

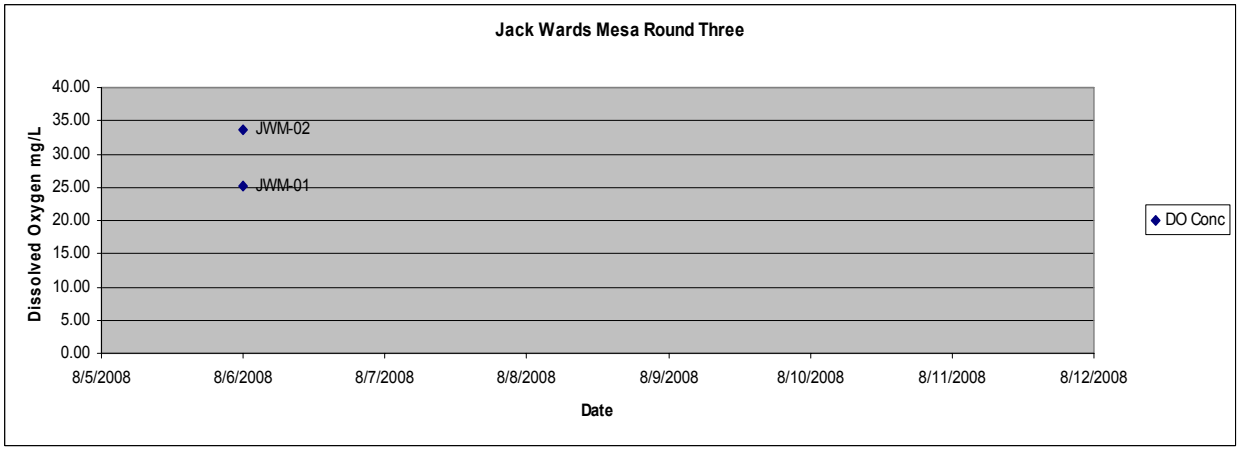

Jack Wards Mesa Round Two
Dissolved Oxygen %
200.00
150.00
100.00
50.00
0.00
JWM-02
JWM-01
DO%
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

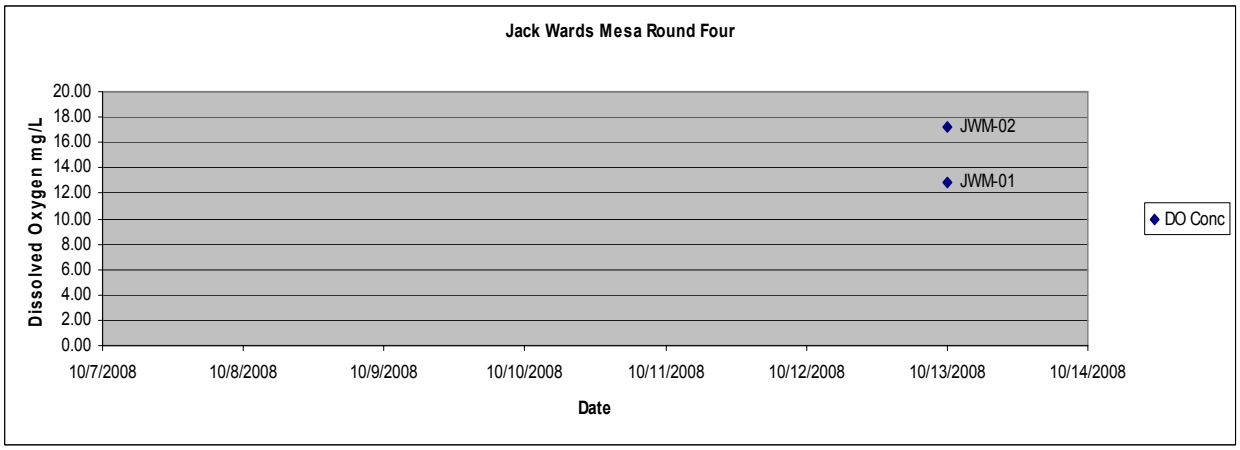

Jack Ward Mesa Round Three
Dissolved Oxygen %
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
JWM-02
JWM-01
DO%
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

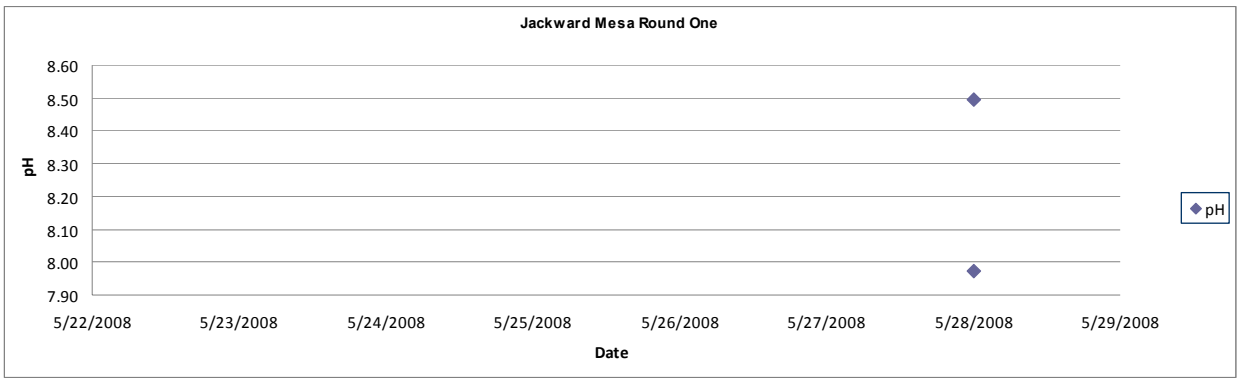

Jack Wards Mesa Round Four
Dissolved Oxygen %
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
JWM-02
JWM-01
DO%
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

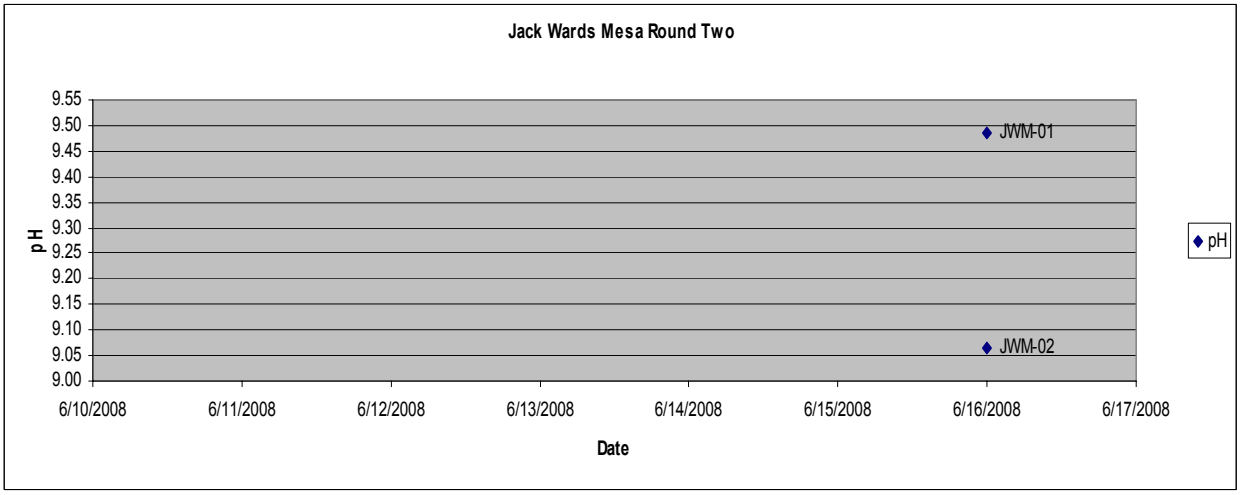

Jackward Mesa Round One
Dissolved Oxygen mg/L
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-02
JWM-01
DO Conc
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

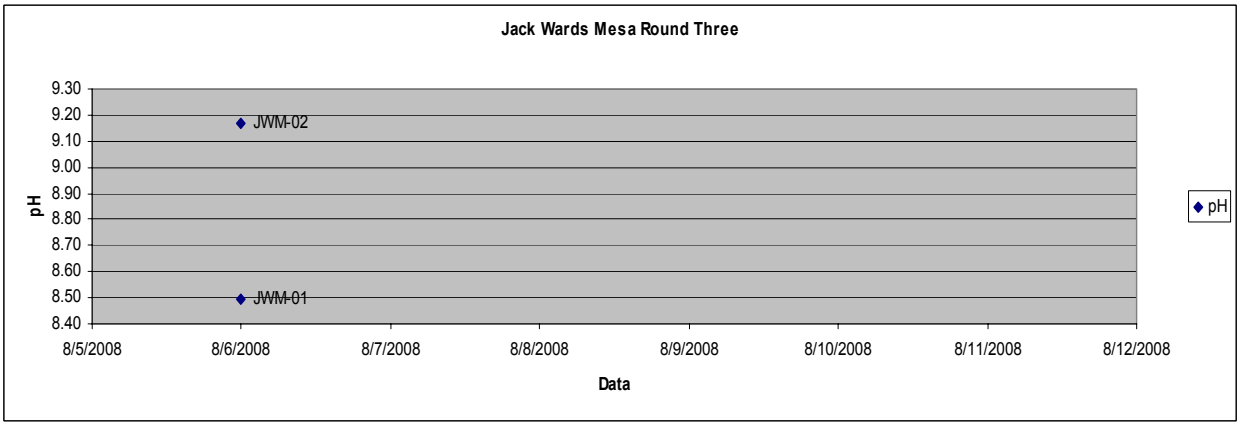

Jack Wards Mesa Round Two
Dissolved Oxygen mg/L
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-02
JWM-01
DO Conc
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

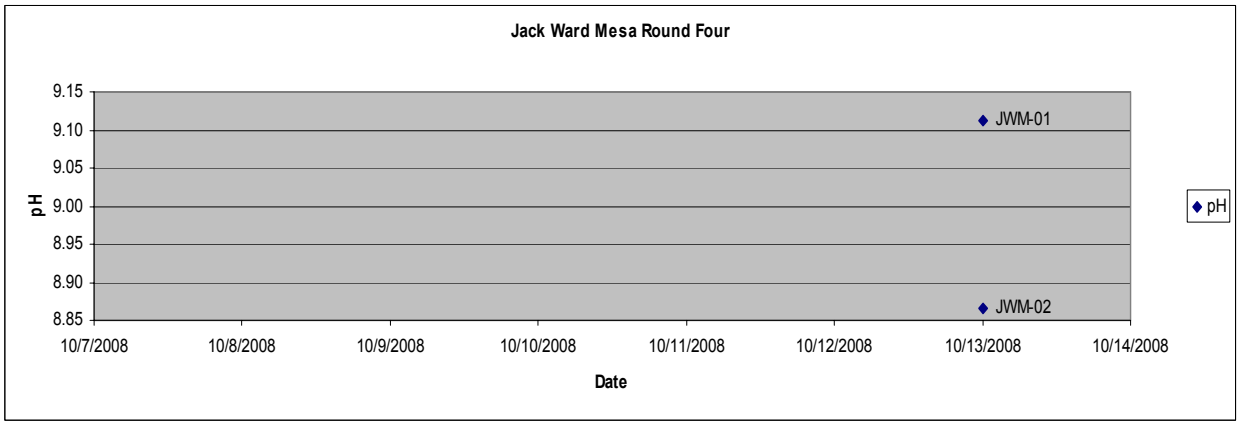

Jack Wards Mesa Round Three
Dissolved Oxygen mg/L
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
JWM-02
JWM-01
DO Conc
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

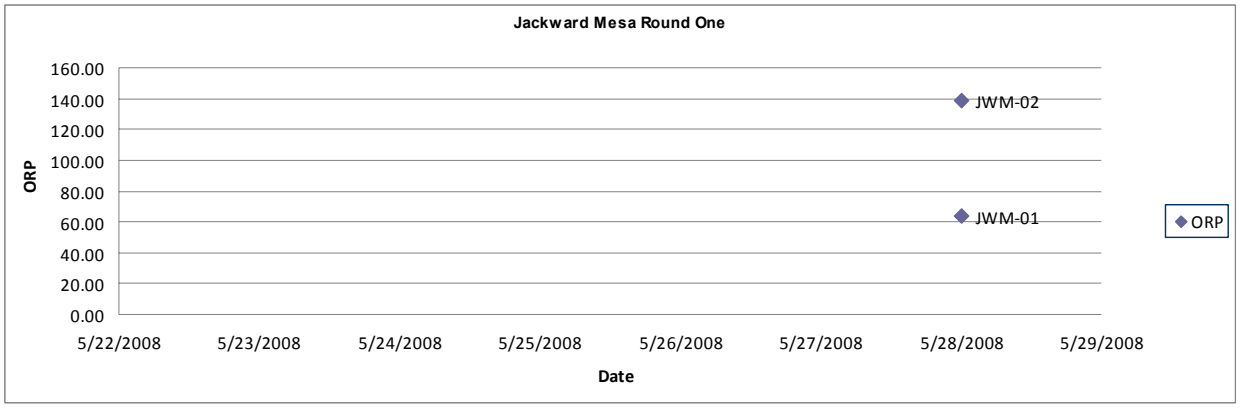

Jack Wards Mesa Round Four
Dissolved Oxygen mg/L
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-02
JWM-01
DO Conc
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

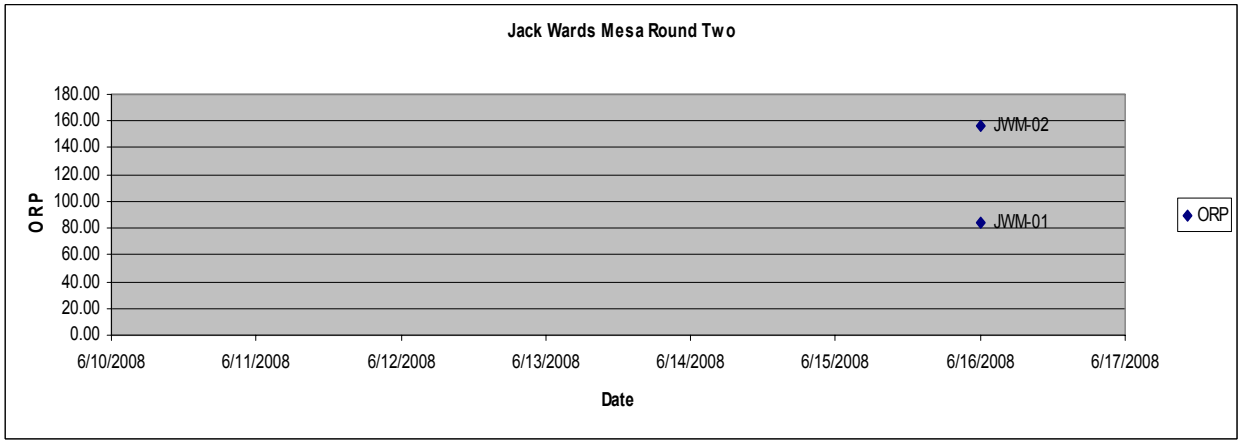

Jackward Mesa Round One
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
pH
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date
pH

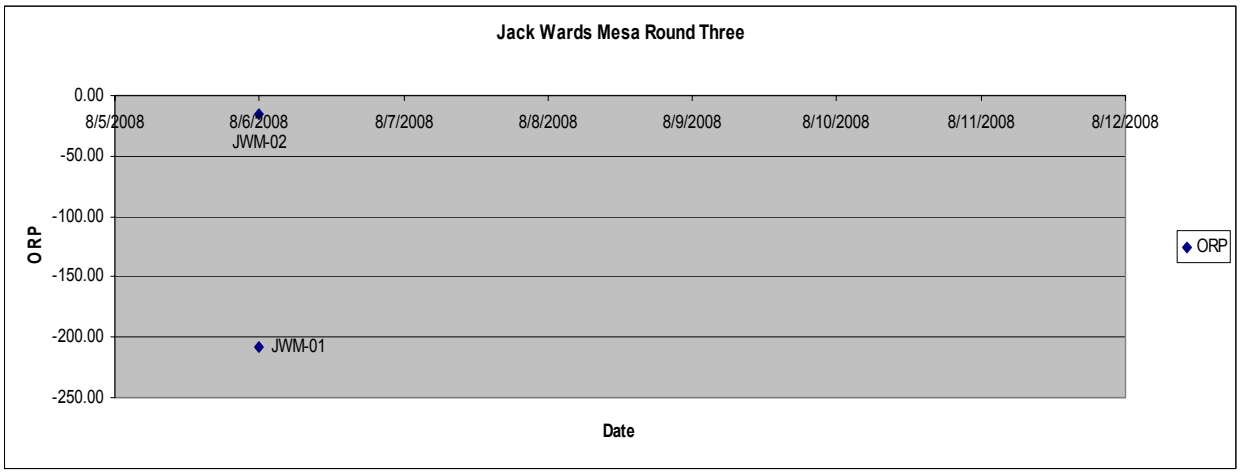

Jack Wards Mesa Round Two
9.55
9.50
9.45
9.40
9.35
9.30
9.25
9.20
9.15
9.10
9.05
9.00
pH
JWM-01
JWM-02
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date
pH

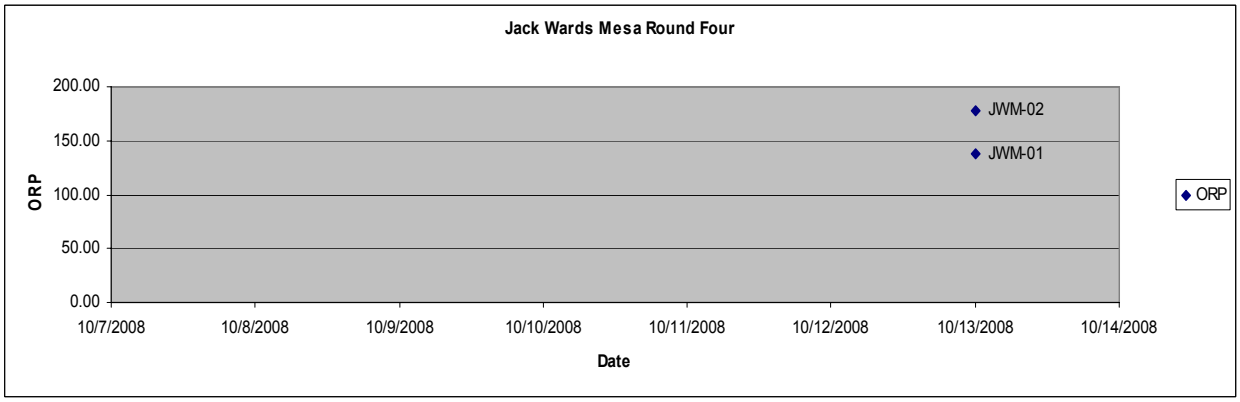

Jack Wards Mesa Round Three
9.30
9.20
9.10
9.00
8.90
8.80
8.70
8.60
8.50
8.40
pH
JWM-02
JWM-01
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Data
pH

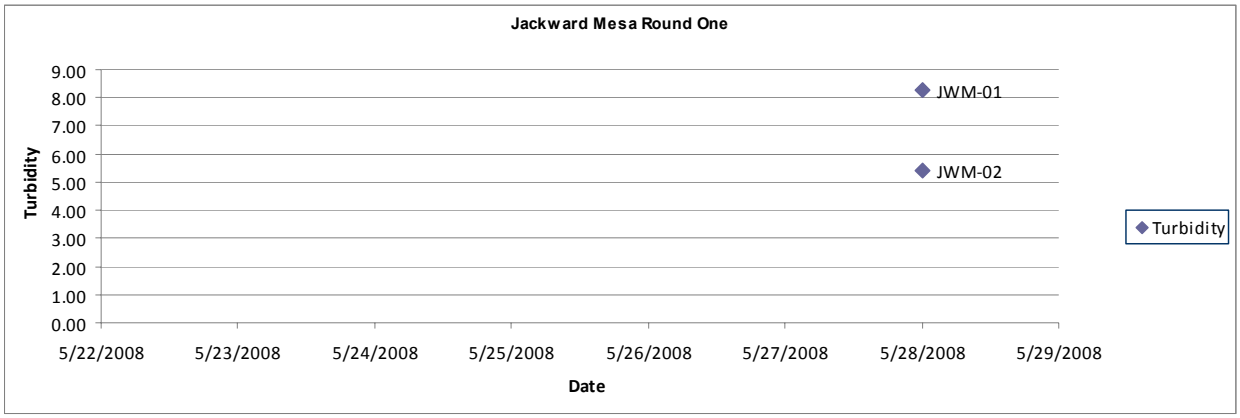

Jack Ward Mesa Round Four
9.15
9.10
9.05
9.00
8.95
8.90
8.85
pH
JWM-01
JWM-02
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date
pH

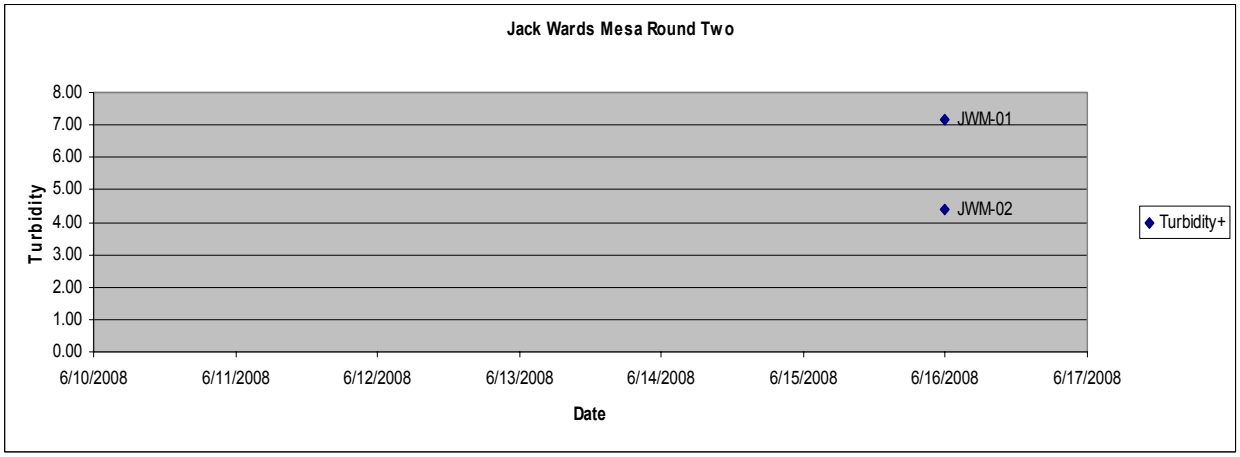

Jackward Mesa Round One
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
JWM-02
JWM-01
ORP
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

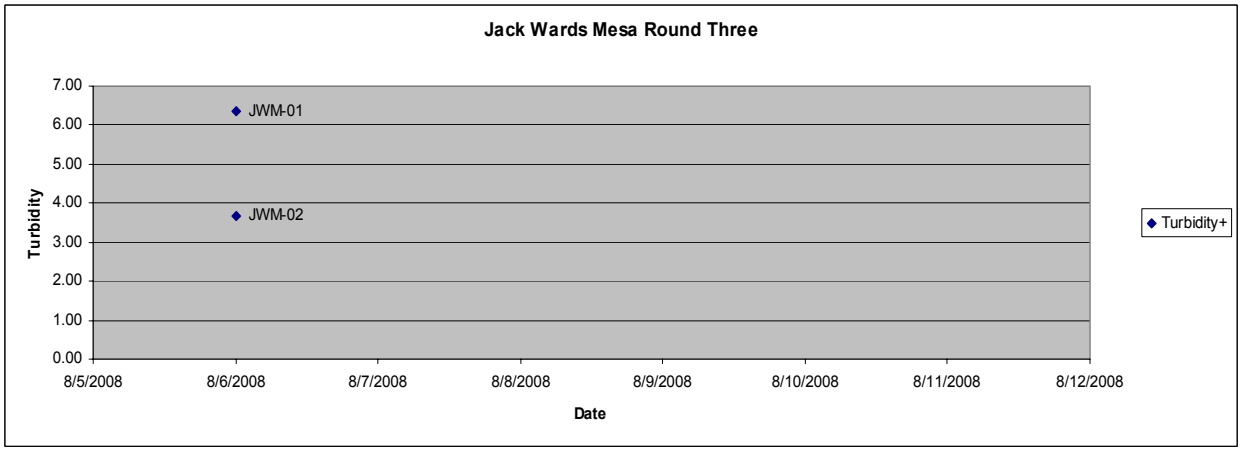

Jack Wards Mesa Round Two
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
JWM-02
JWM-01
ORP
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

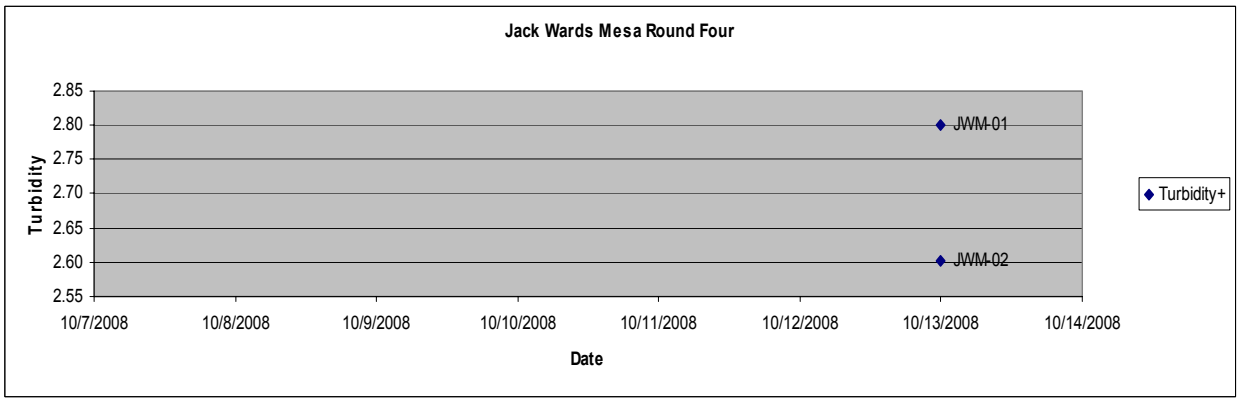

Jack Wards Mesa Round Three
0.00
-50.00
-100.00
-150.00
-200.00
-250.00
ORP
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
JWM-02
JWM-01
ORP
Date

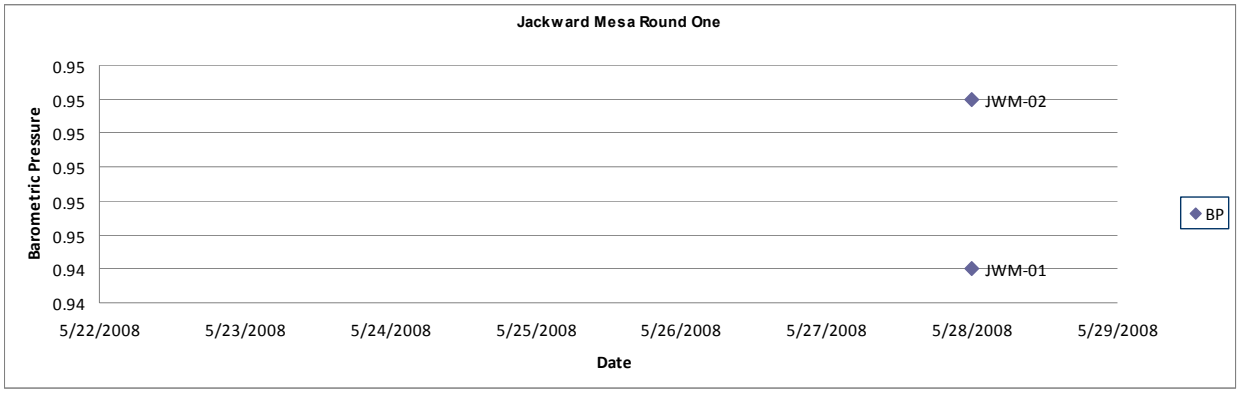

Jack Wards Mesa Round Four
200.00
150.00
100.00
50.00
0.00
ORP
JWM-02
JWM-01
ORP
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

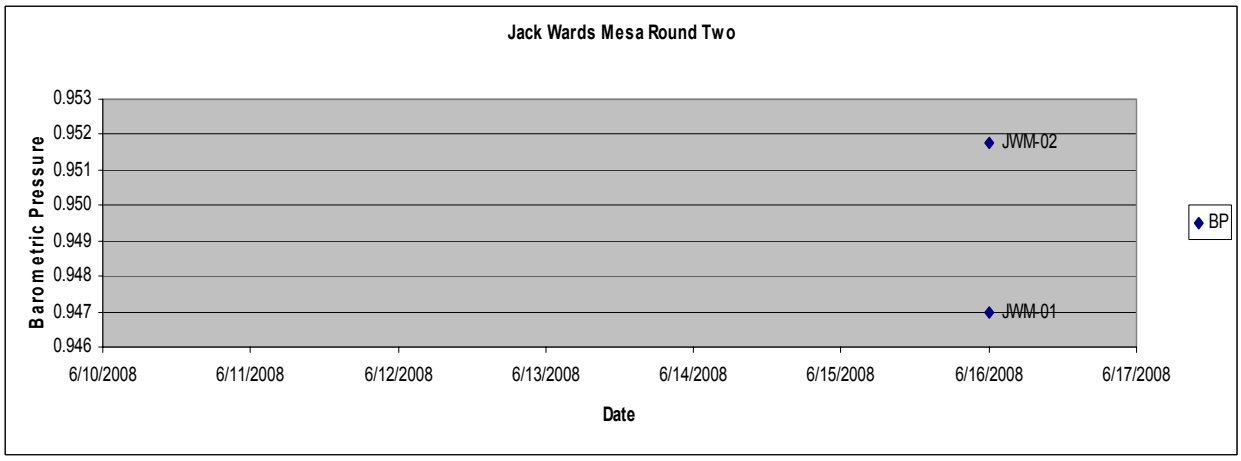

Jackward Mesa Round One
Turbidity
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Turbidity
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

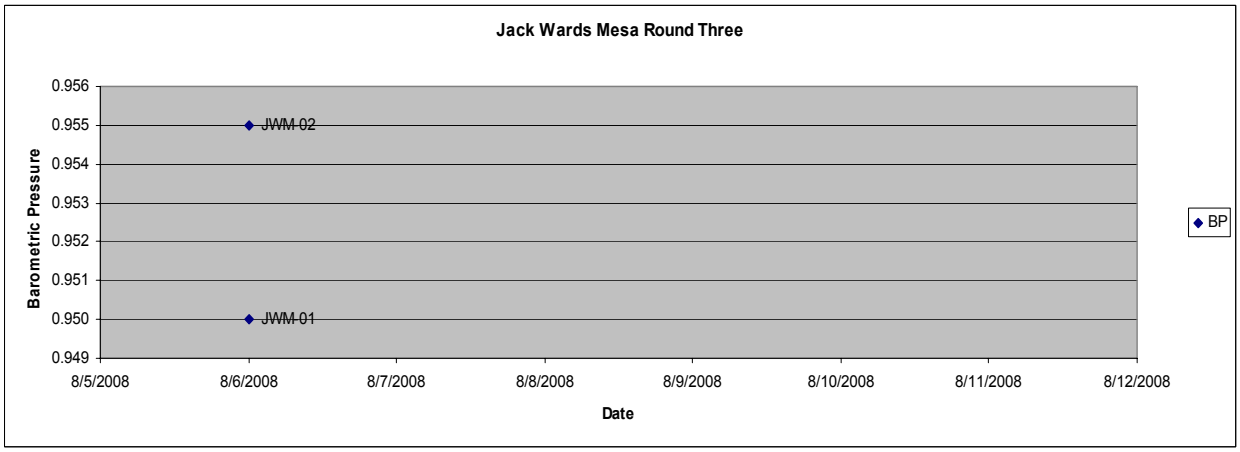

Jack Wards Mesa Round Two
Turbidity
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Turbidity+
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

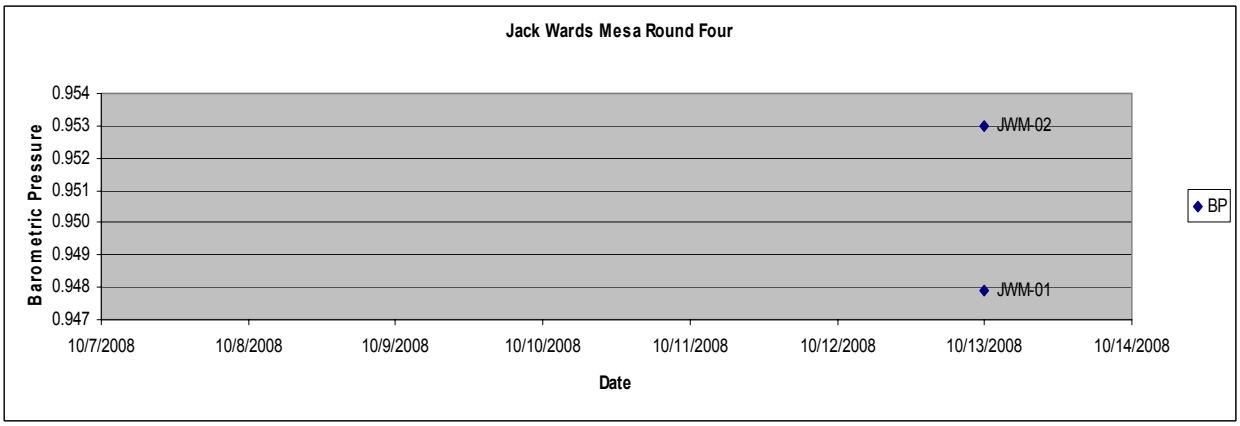

Jack Wards Mesa Round Three
Turbidity
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
JWM-01
JWM-02
Turbidity+
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date


Jack Wards Mesa Round Four
Turbidity
2.85
2.80
2.75
2.70
2.65
2.60
2.55
JWM-01
JWM-02
Turbidity+
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

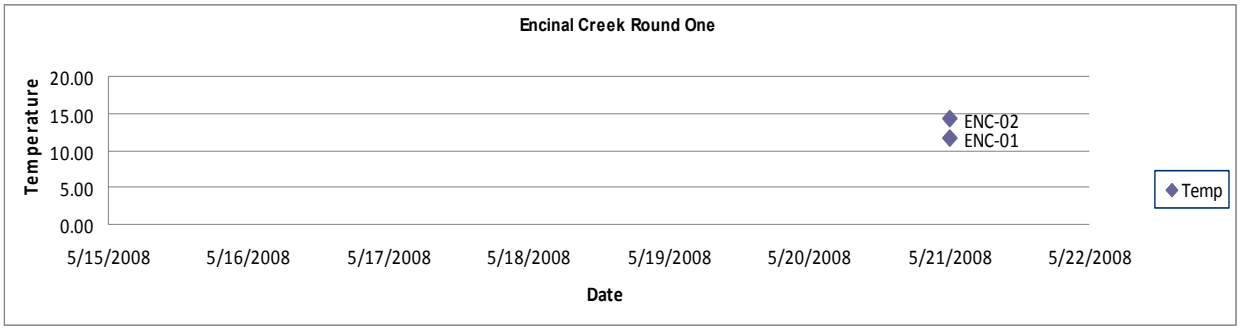

Jackward Mesa Round One
Barometric Pressure
0.95
0.95
0.95
0.95
0.95
0.95
0.94
0.94
JWM-02
JWM-01
BP
5/22/2008
5/23/2008
5/24/2008
5/25/2008
5/26/2008
5/27/2008
5/28/2008
5/29/2008
Date

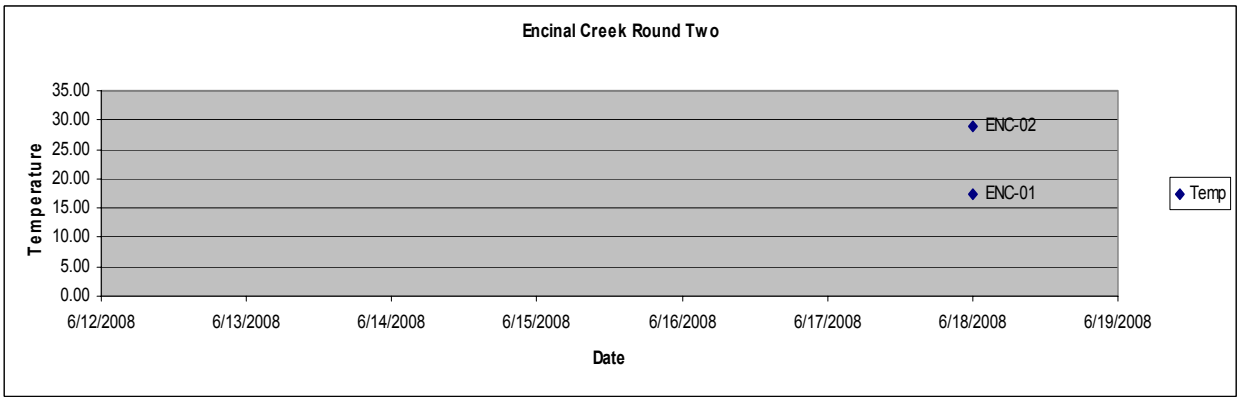

Jack Wards Mesa Round Two
Barometric Pressure
0.953
0.952
0.951
0.950
0.949
0.948
0.947
0.946
JWM-02
JWM-01
BP
6/10/2008
6/11/2008
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
Date

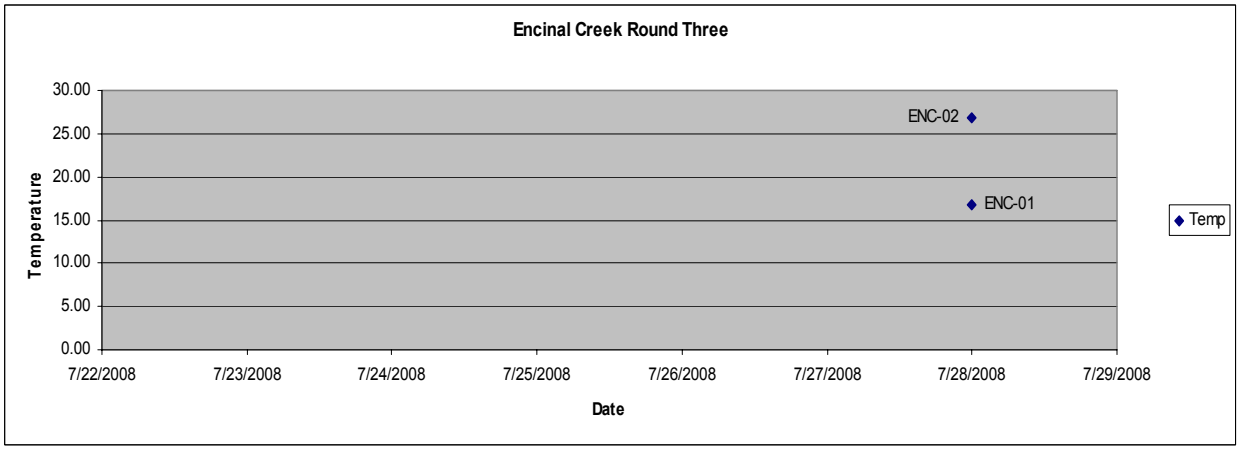

Jack Wards Mesa Round Three
Barometric Pressure
0.956
0.955
0.954
0.953
0.952
0.951
0.950
0.949
JWM-02
JWM-01
BP
8/5/2008
8/6/2008
8/7/2008
8/8/2008
8/9/2008
8/10/2008
8/11/2008
8/12/2008
Date

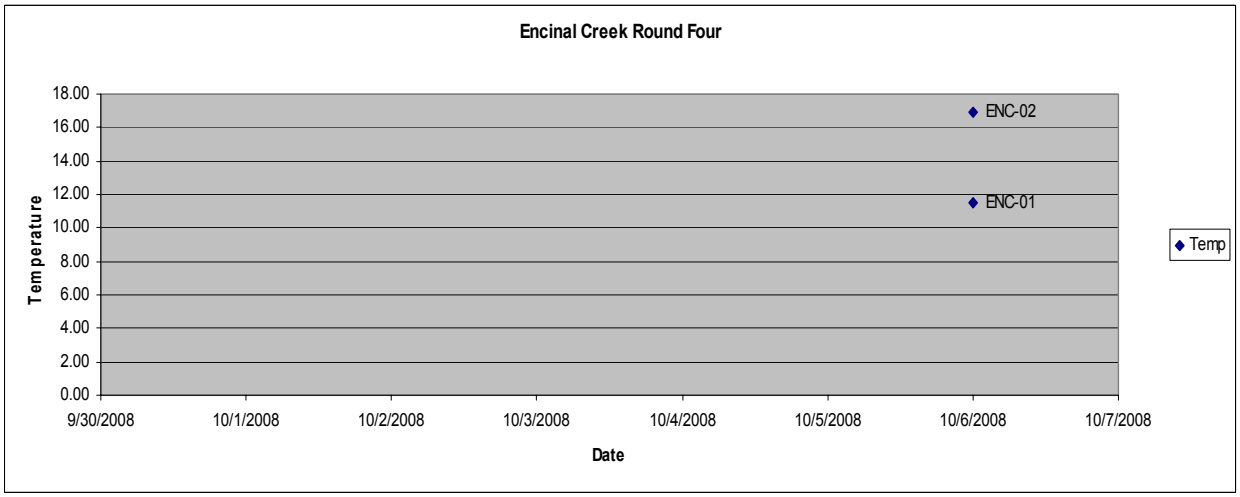

Jack Wards Mesa Round Four
Barometric Pressure
0.954
0.953
0.952
0.951
0.950
0.949
0.948
0.947
JWM-02
JWM-01
BP
10/7/2008
10/8/2008
10/9/2008
10/10/2008
10/11/2008
10/12/2008
10/13/2008
10/14/2008
Date

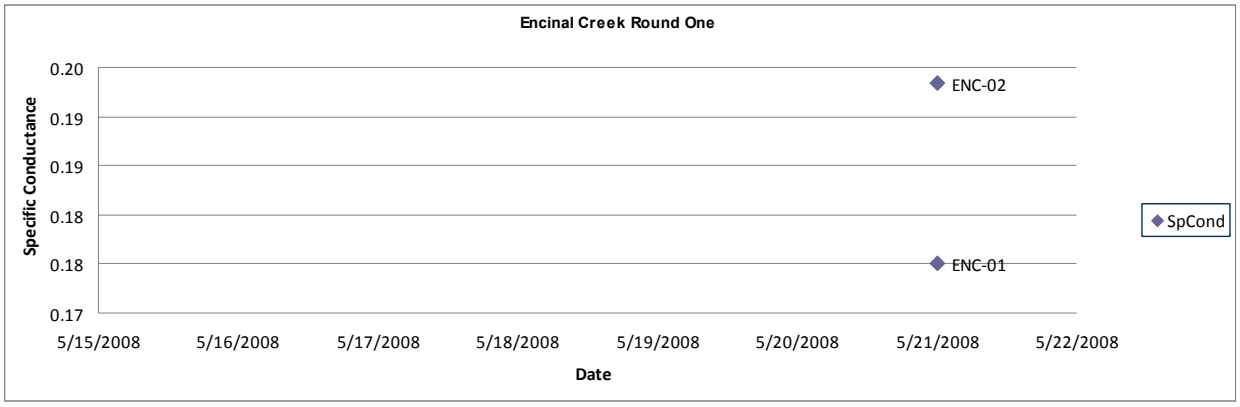
Encinal Creek

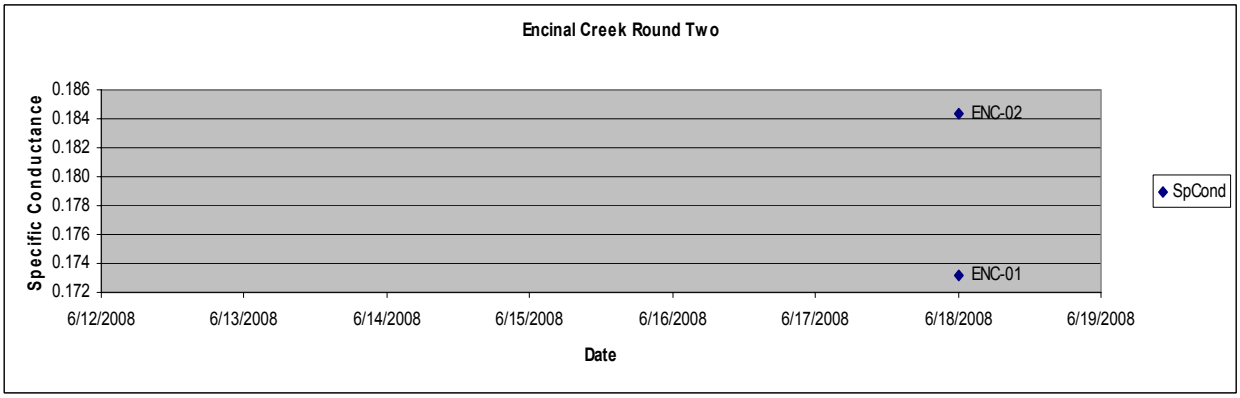


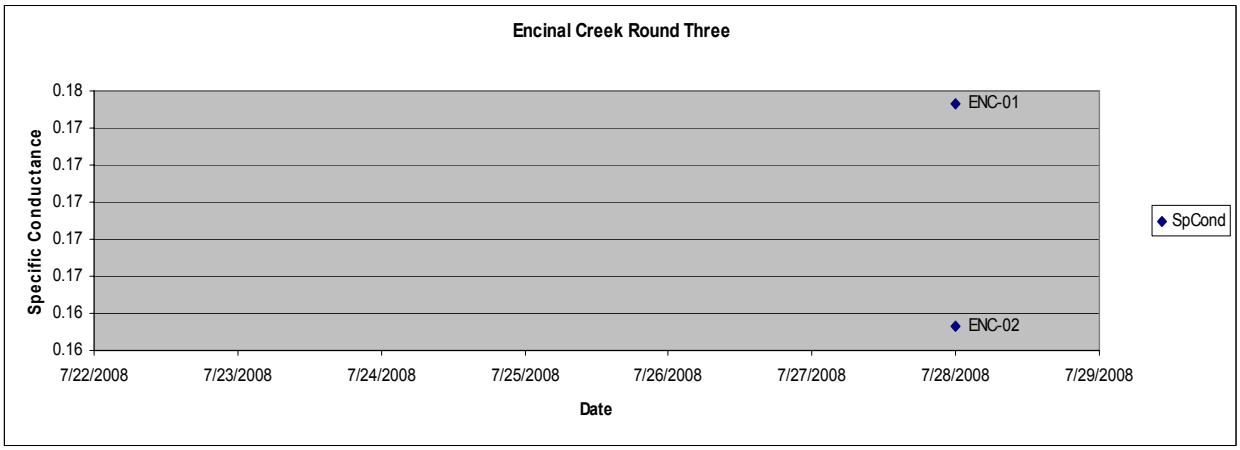


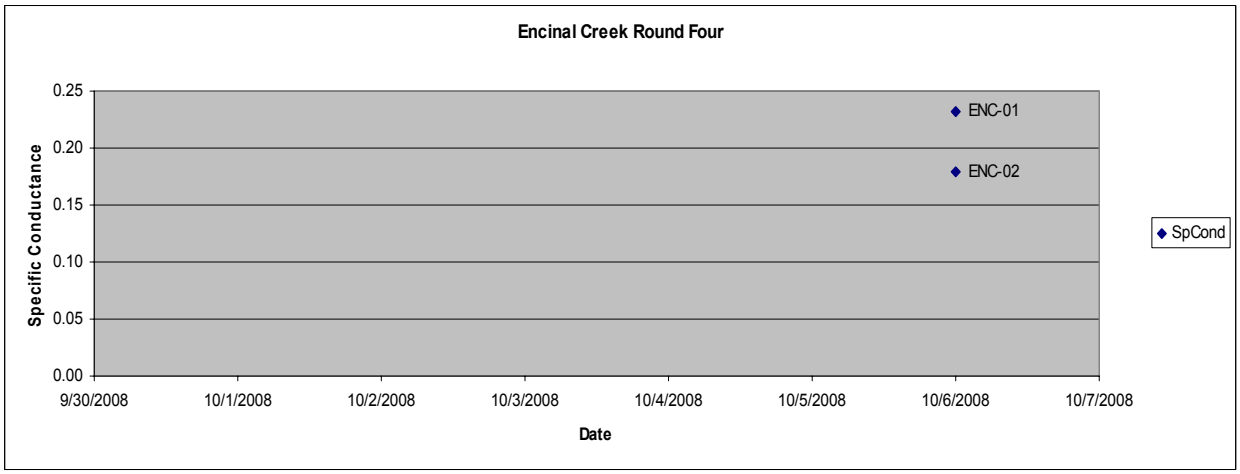


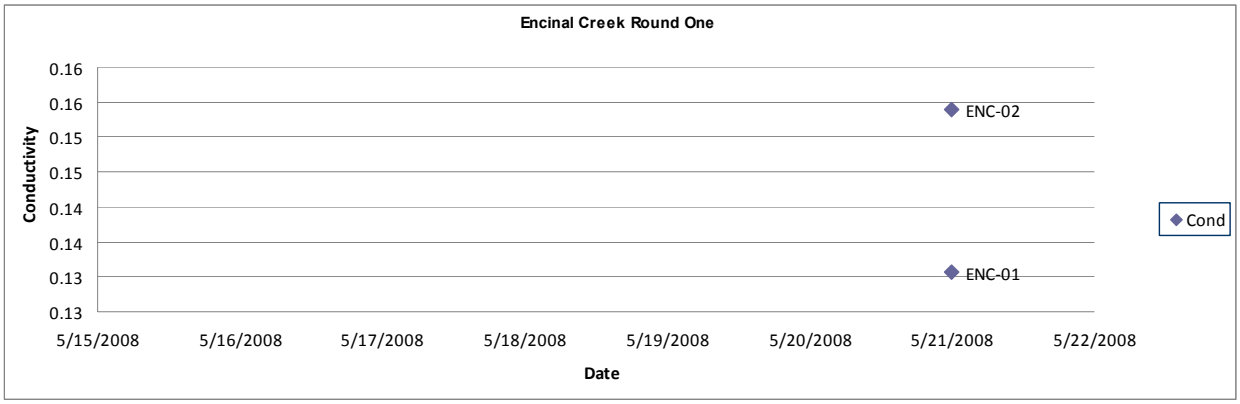


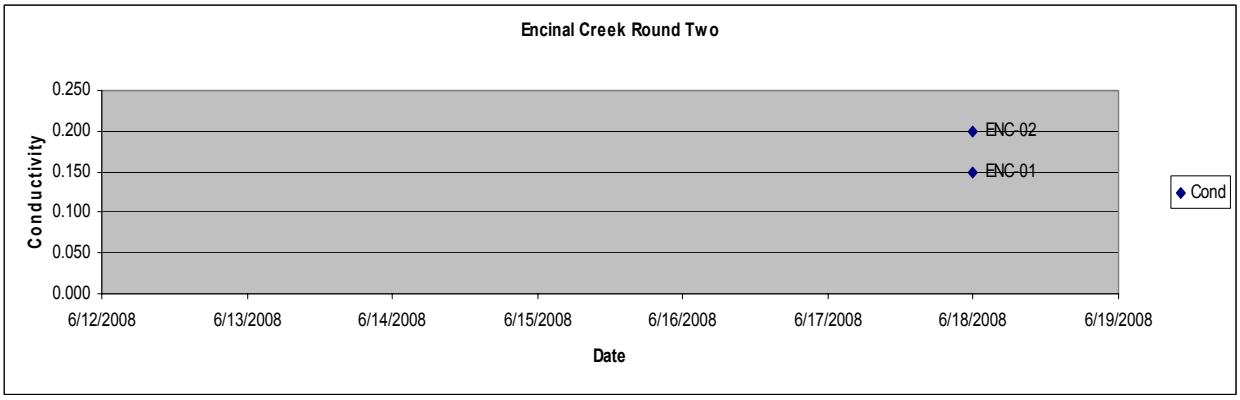

Encinal Creek Round One
Specific Conductance
0.20
0.19
0.19
0.18
0.18
0.17
ENC-02
ENC-01
SpCond
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

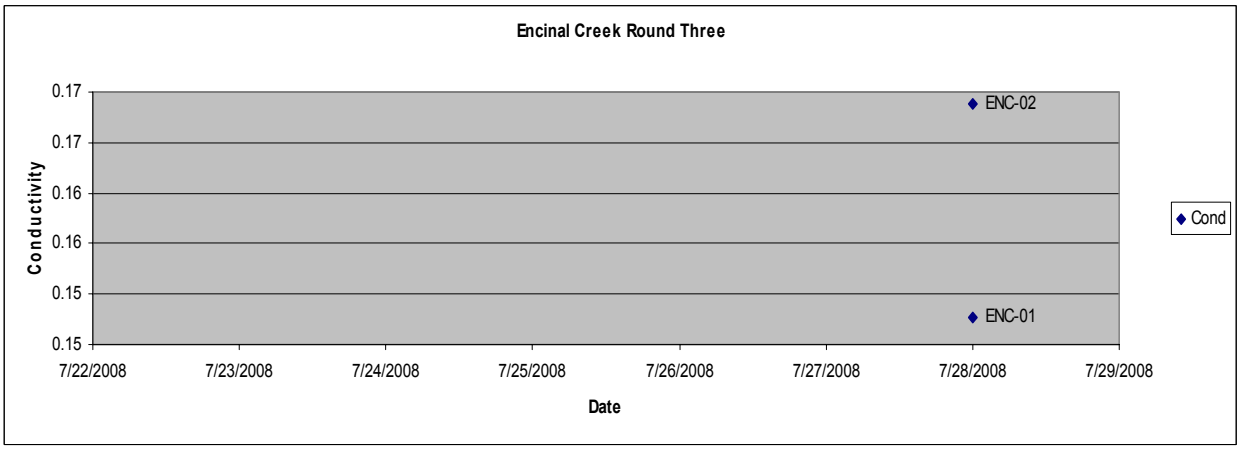

Encinal Creek Round Two
Specific Conductance
0.186
0.184
0.182
0.180
0.178
0.176
0.174
0.172
ENC-02
ENC-01
SpCond
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

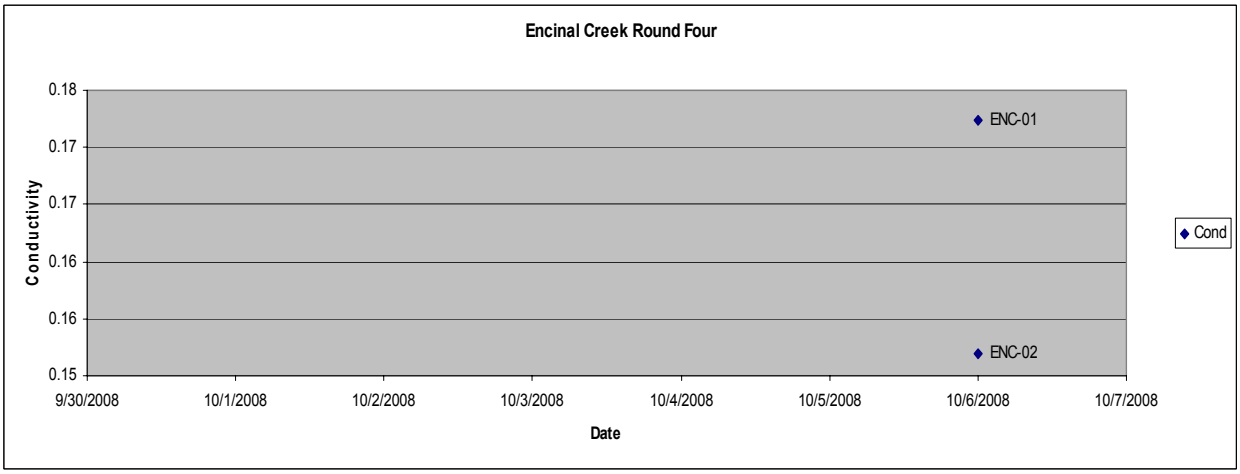

Encinal Creek Round Three
Specific Conductance
0.18
0.17
0.17
0.17
0.17
0.17
0.16
0.16
ENC-01
ENC-02
SpCond
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

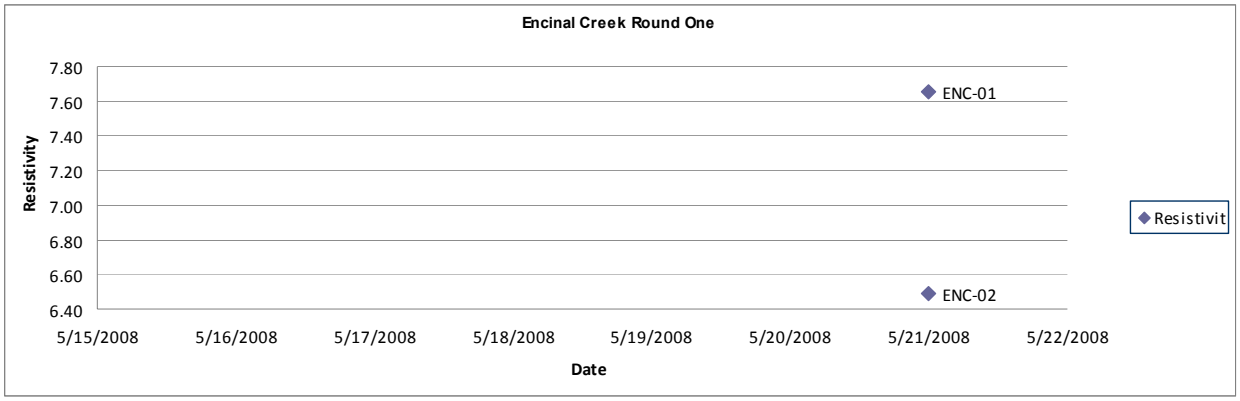

Encinal Creek Round Four
Specific Conductance
0.25
0.20
0.15
0.10
0.05
0.00
ENC-01
ENC-02
SpCond
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

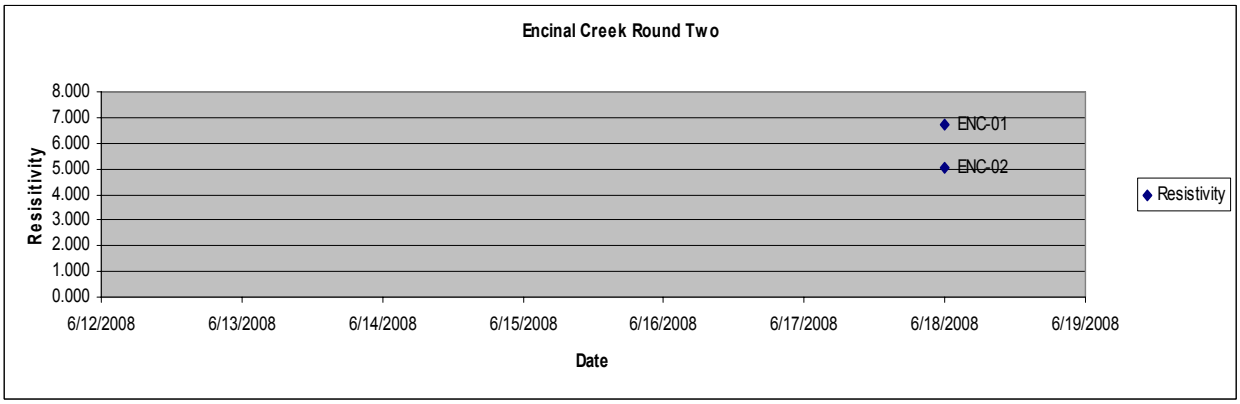

Encinal Creek Round One
Conductivity
0.16
0.16
0.15
0.15
0.14
0.14
0.13
0.13
ENC-02
ENC-01
Cond
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

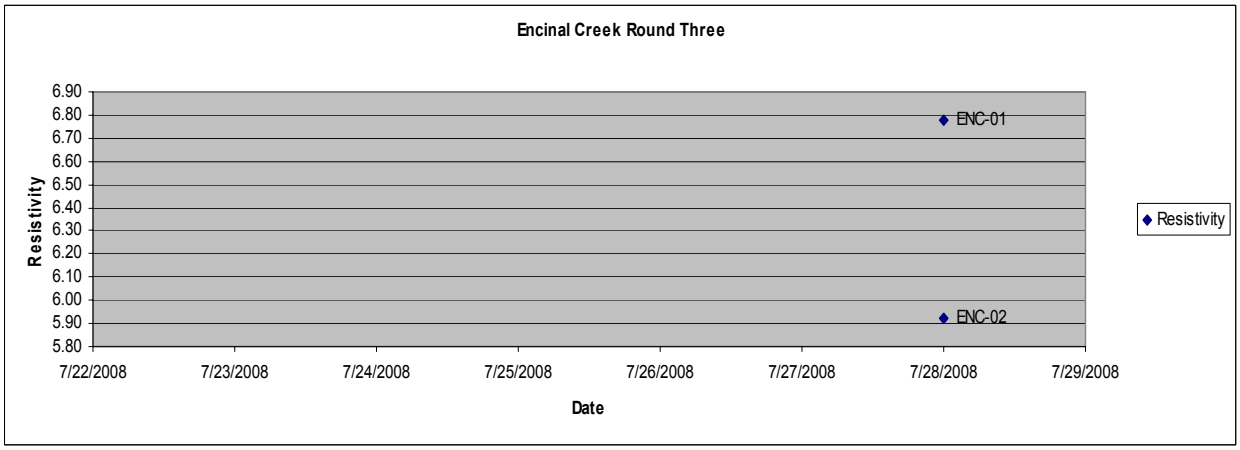

Encinal Creek Round Two
Conductivity
0.250
0.200
0.150
0.100
0.050
0.000
ENC-02
ENC-01
Cond
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

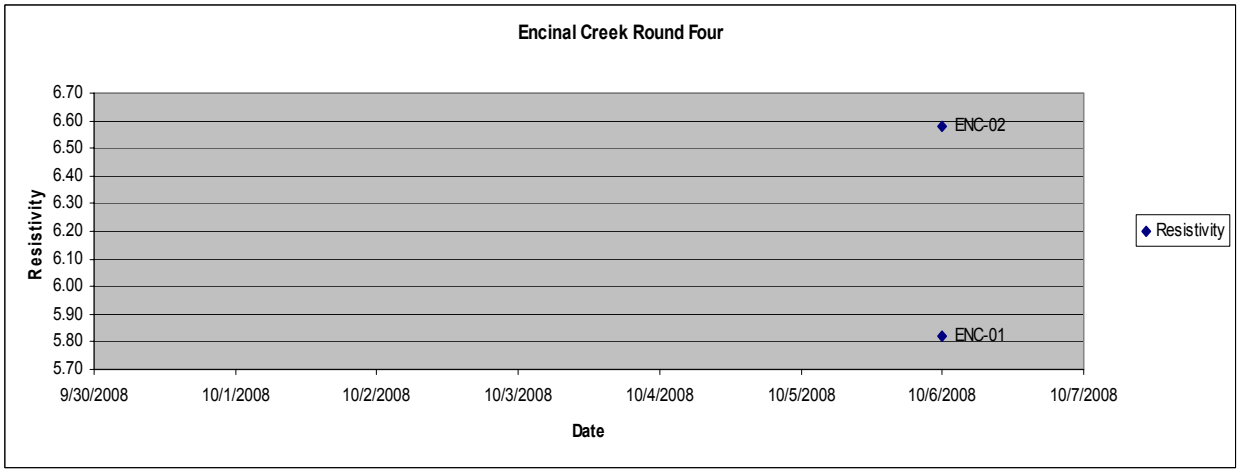

Encinal Creek Round Three
Conductivity
0.17
0.17
0.16
0.16
0.15
0.15
ENC-02
ENC-01
Cond
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

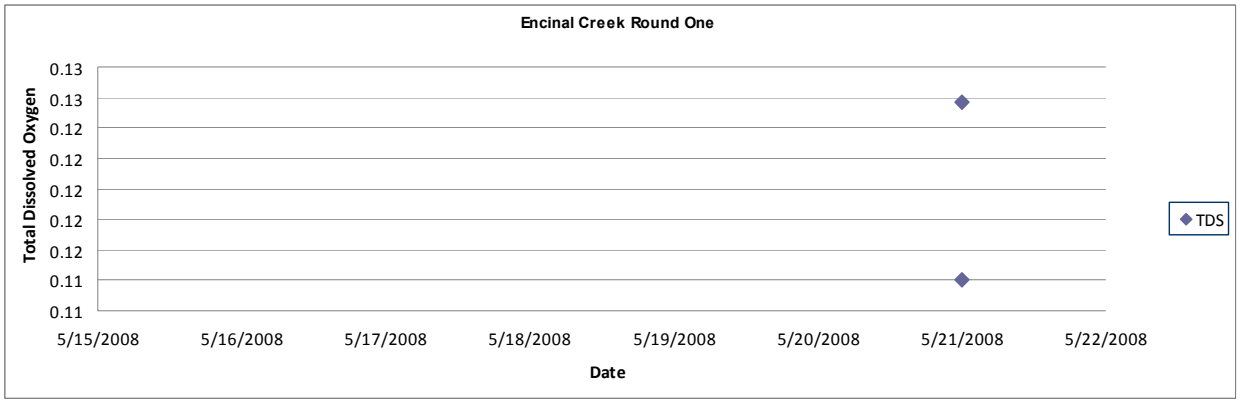

Encinal Creek Round Four
Conductivity
0.18
0.17
0.17
0.16
0.16
0.15
ENC-01
ENC-02
Cond
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

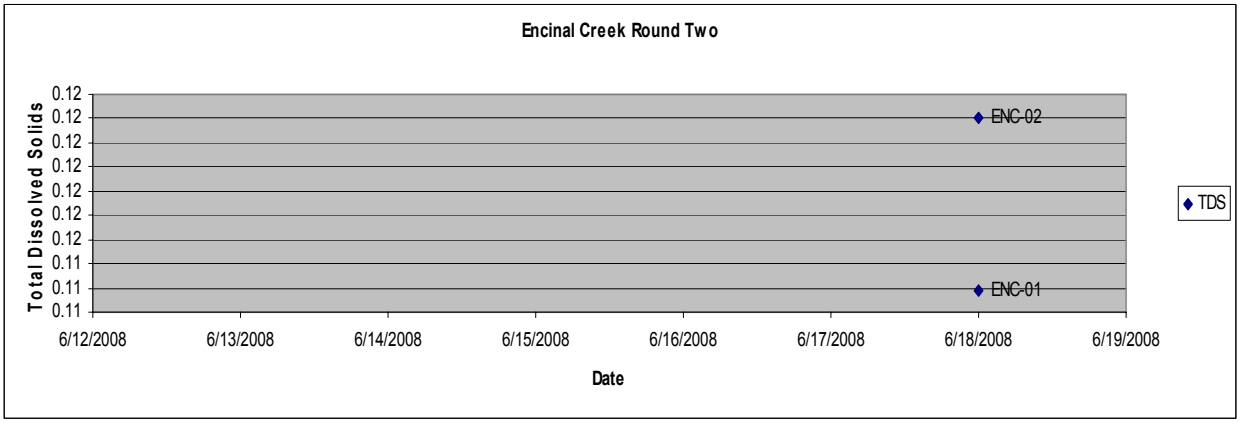

Encinal Creek Round One
Resistivity
7.80
7.60
7.40
7.20
7.00
6.80
6.60
6.40
ENC-01
ENC-02
Resistivit
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

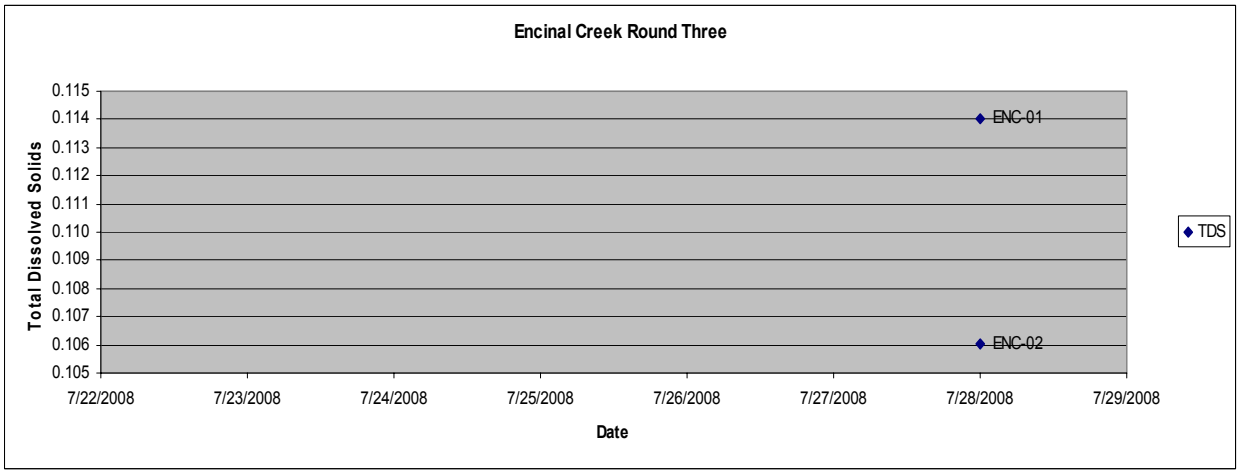

Encinal Creek Round Two
Resistivity
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
ENC-01
ENC-02
Resistivity
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

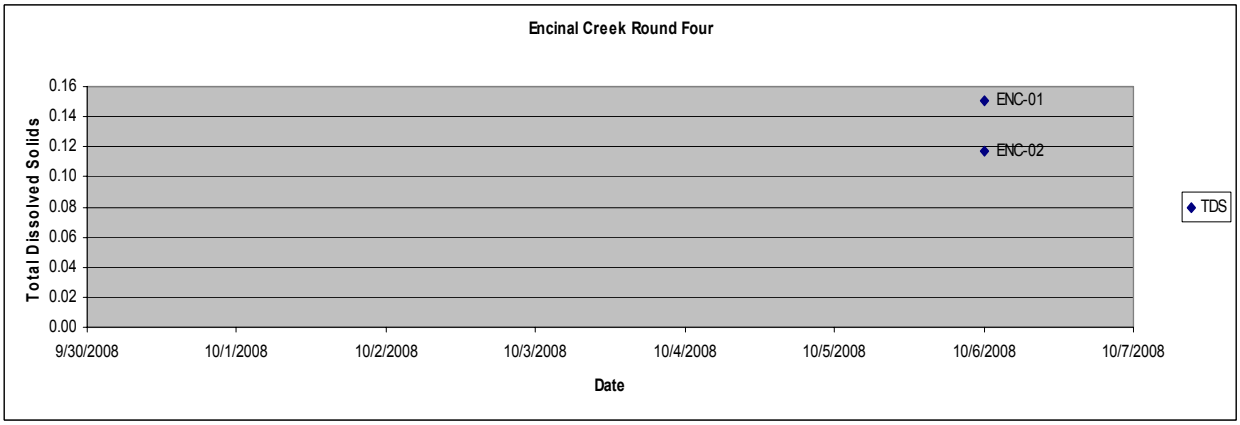

Encinal Creek Round Three
Resistivity
6.90
6.80
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
ENC-01
ENC-02
Resistivity
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

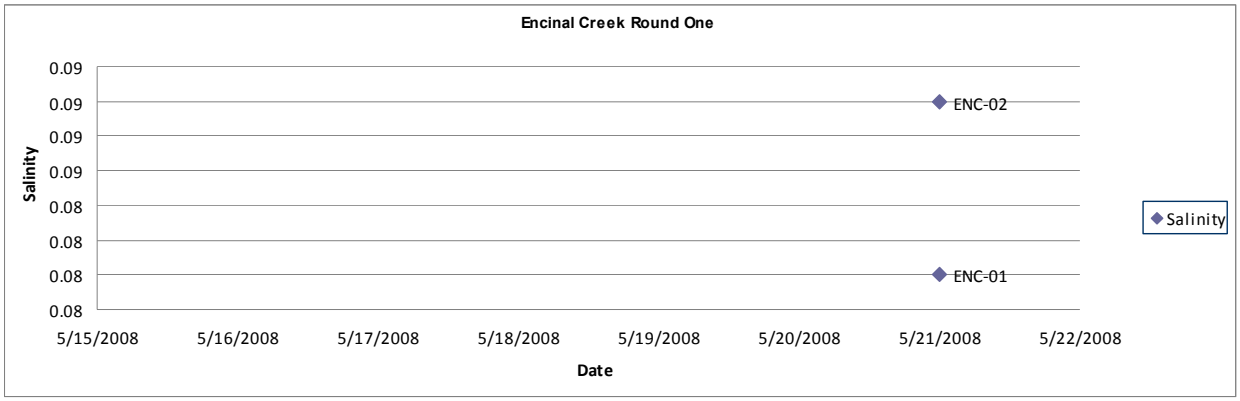

Encinal Creek Round Four
Resistivity
6.70
6.60
6.50
6.40
6.30
6.20
6.10
6.00
5.90
5.80
5.70
ENC-02
ENC-01
Resistivity
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

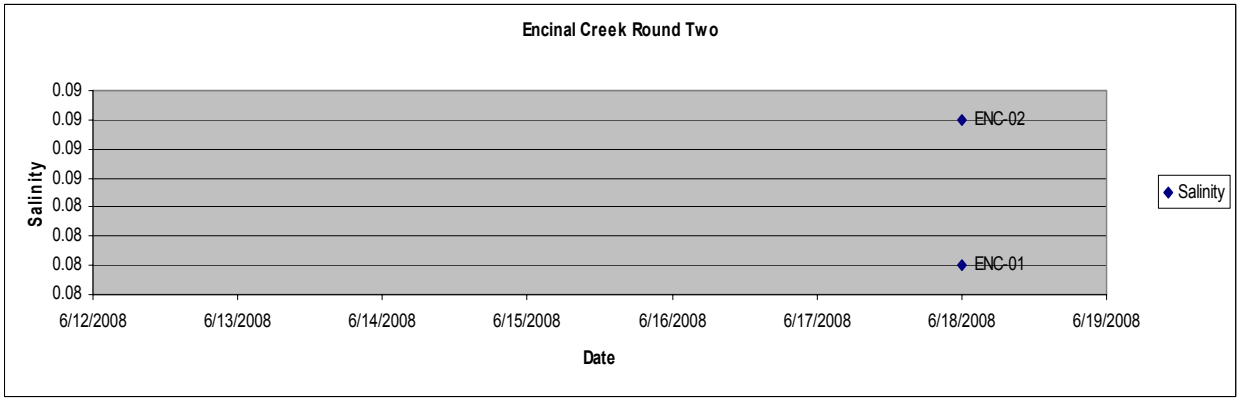

Encinal Creek Round One
Total Dissolved Oxygen
0.13
0.13
0.12
0.12
0.12
0.12
0.12
0.11
0.11
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date
TDS

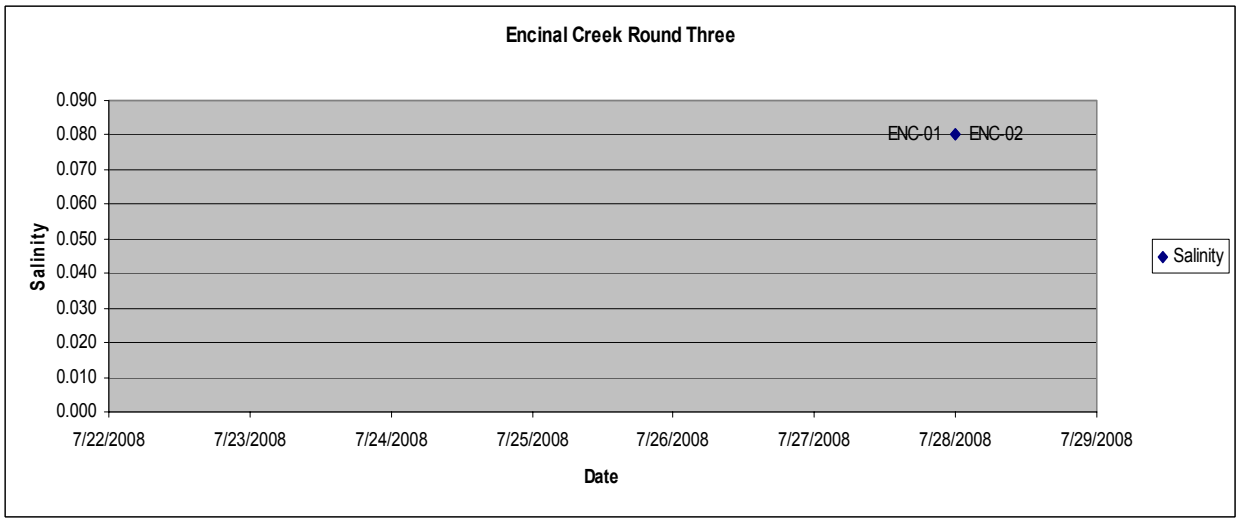

Encinal Creek Round Two
Total Dissolved Solids
0.12
0.12
0.12
0.12
0.12
0.12
0.12
0.11
0.11
0.11
ENC-02
ENC-01
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date
TDS

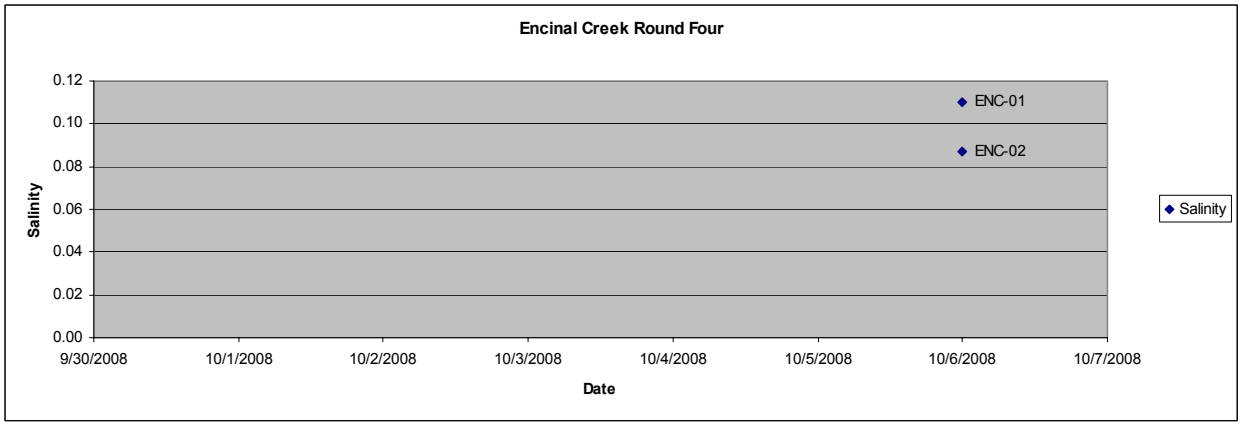

Encinal Creek Round Three
Total Dissolved Solids
0.115
0.114
0.113
0.112
0.111
0.110
0.109
0.108
0.107
0.106
0.105
ENC-01
ENC-02
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date
TDS

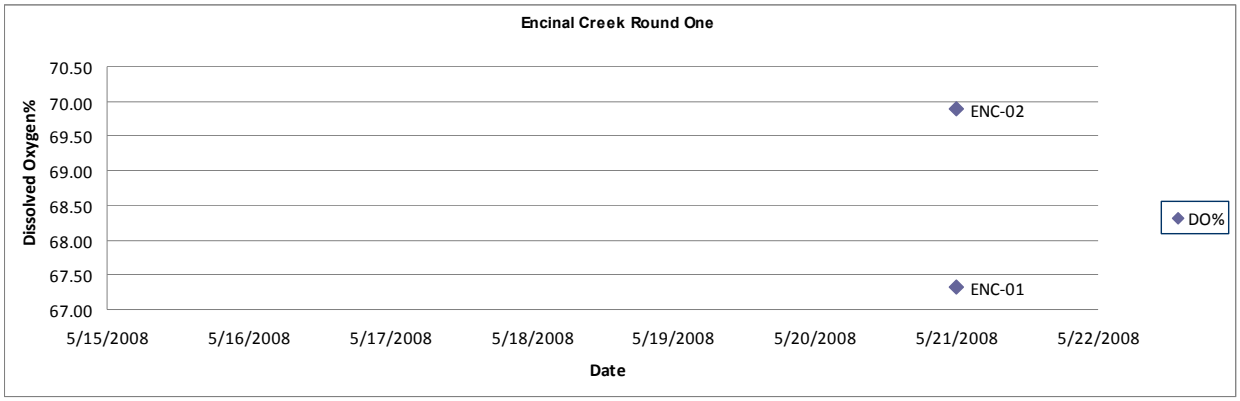

Encinal Creek Round Four
Total Dissolved Solids
0.16
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
ENC-01
ENC-02
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date
TDS

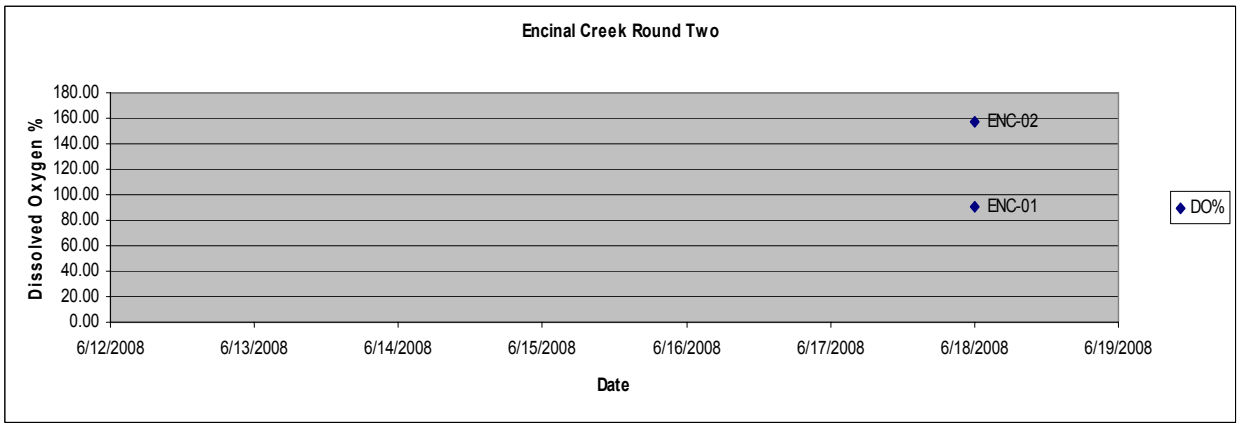

Encinal Creek Round One
Salinity
0.09
0.09
0.09
0.09
0.08
0.08
0.08
0.08
ENC-02
ENC-01
Salinity
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

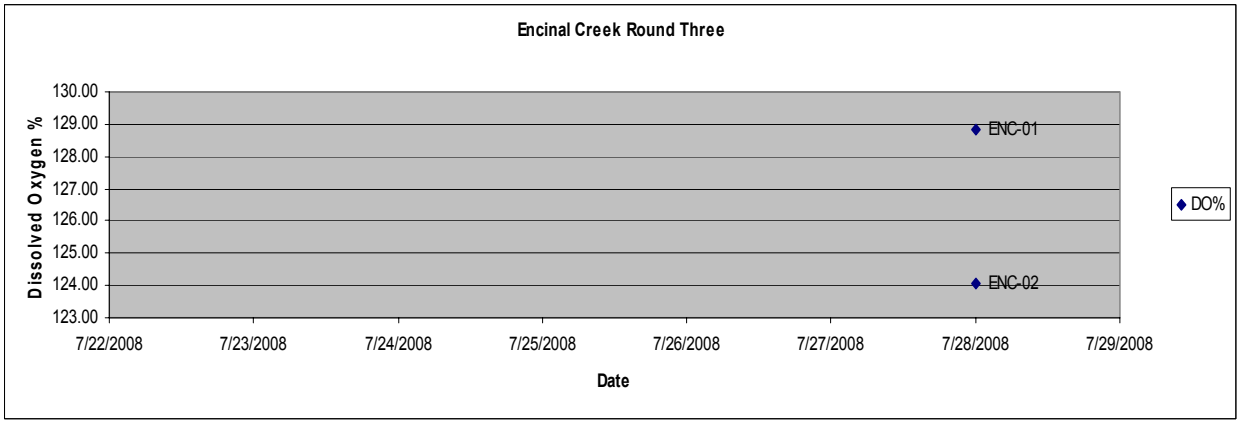

Encinal Creek Round Two
Salinity
0.09
0.09
0.09
0.09
0.08
0.08
0.08
0.08
ENC-02
ENC-01
Salinity
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

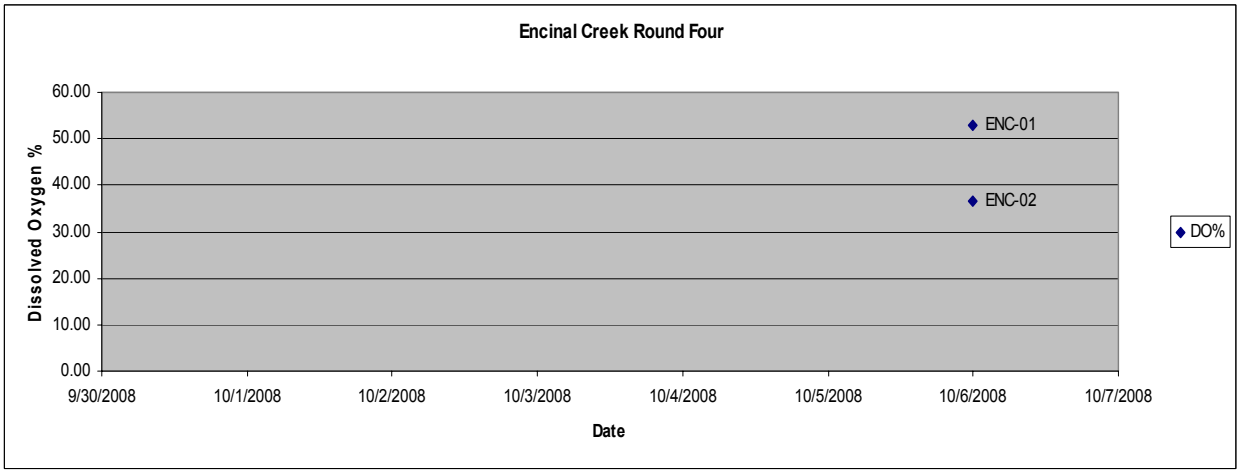

Encinal Creek Round Three
Salinity
0.090
0.080
0.070
0.060
0.050
0.040
0.030
0.020
0.010
0.000
ENC-01
ENC-02
Salinity
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

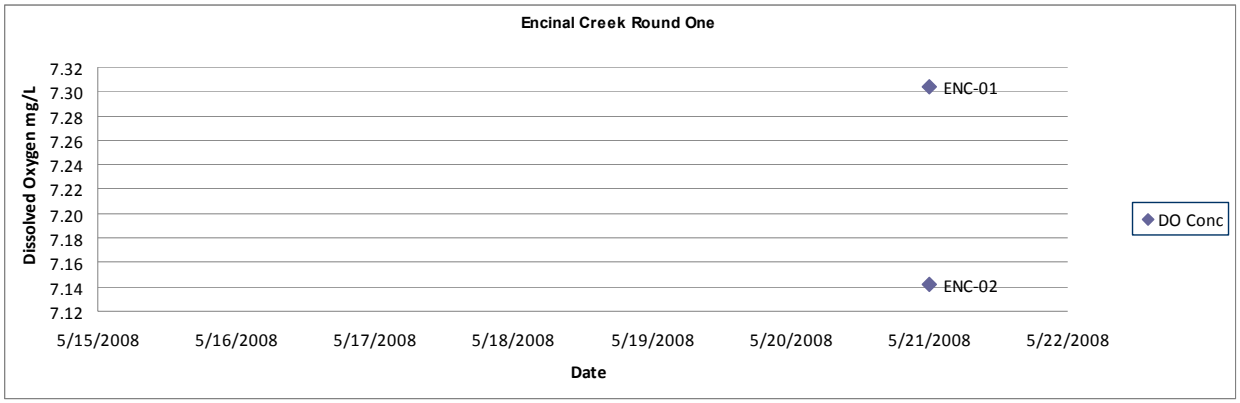

Encinal Creek Round Four
Salinity
0.12
0.10
0.08
0.06
0.04
0.02
0.00
ENC-01
ENC-02
Salinity
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

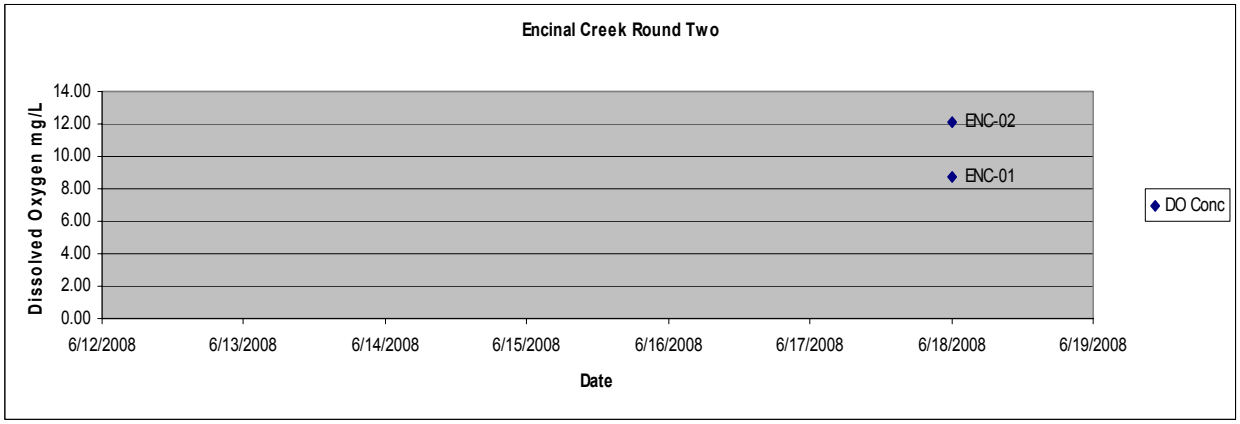

Encinal Creek Round One
Dissolved Oxygen%
70.50
70.00
69.50
69.00
68.50
68.00
67.50
67.00
ENC-02
ENC-01
DO%
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date


Encinal Creek Round Two
Dissolved Oxygen %
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ENC-02
ENC-01
DO%
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date


Encinal Creek Round Three
Dissolved Oxygen %
130.00
129.00
128.00
127.00
126.00
125.00
124.00
123.00
ENC-01
ENC-02
DO%
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date


Encinal Creek Round Four
Dissolved Oxygen %
60.00
50.00
40.00
30.00
20.00
10.00
0.00
ENC-01
ENC-02
DO%
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date


Encinal Creek Round One
Dissolved Oxygen mg/L
7.32
7.30
7.28
7.26
7.24
7.22
7.20
7.18
7.16
7.14
7.12
ENC-01
ENC-02
DO Conc
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date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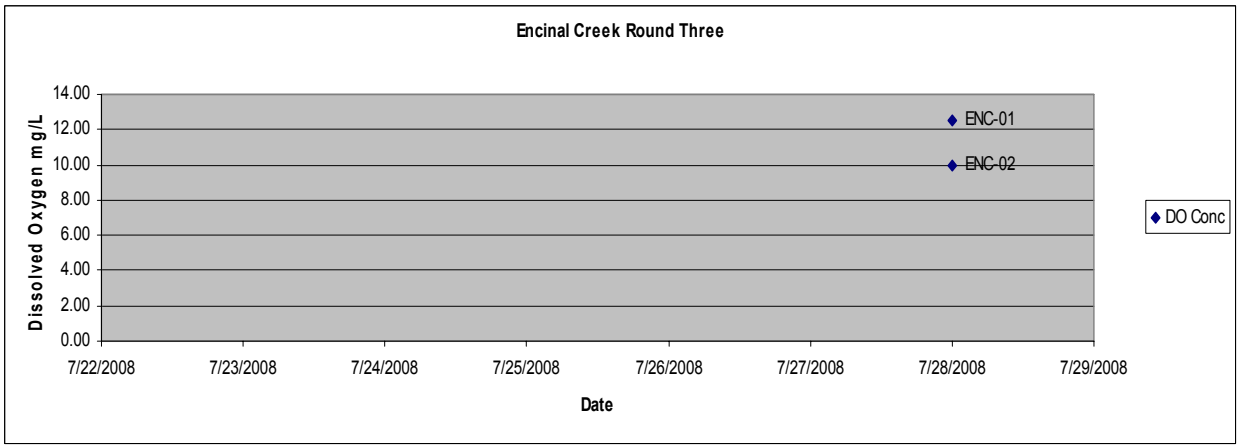
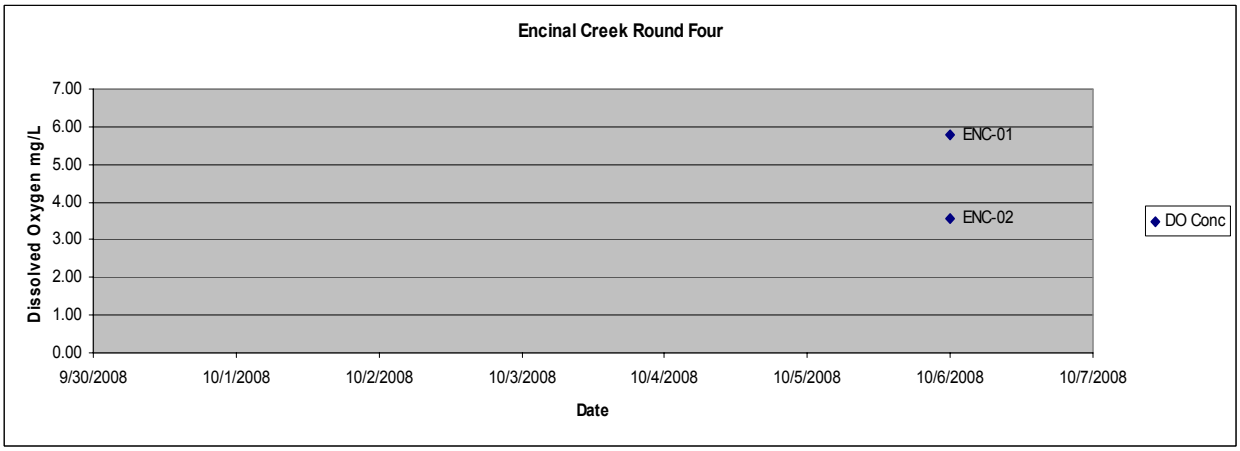
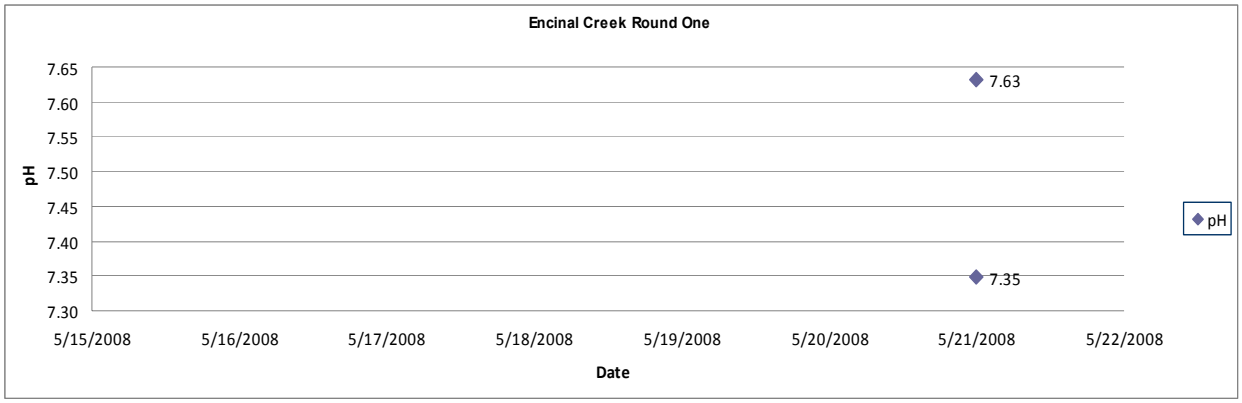
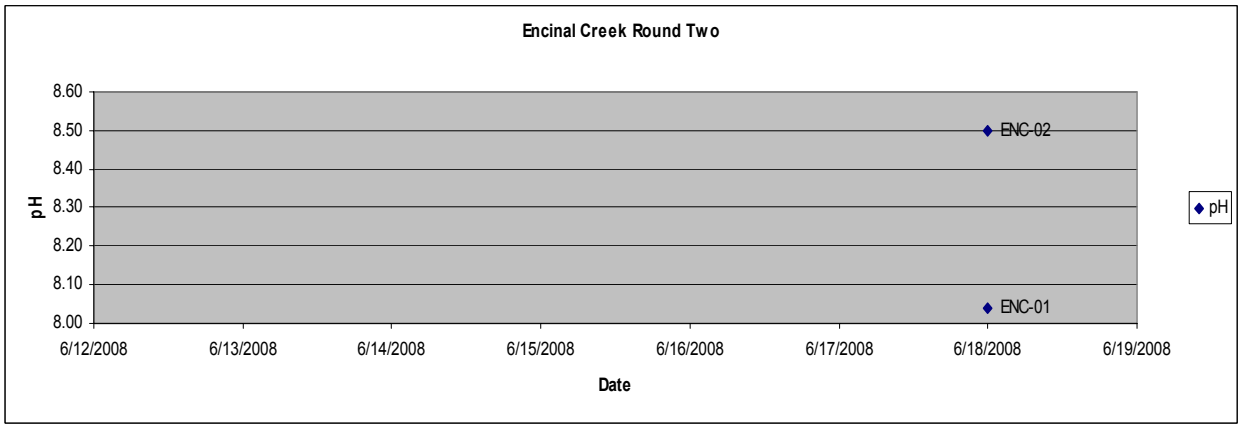
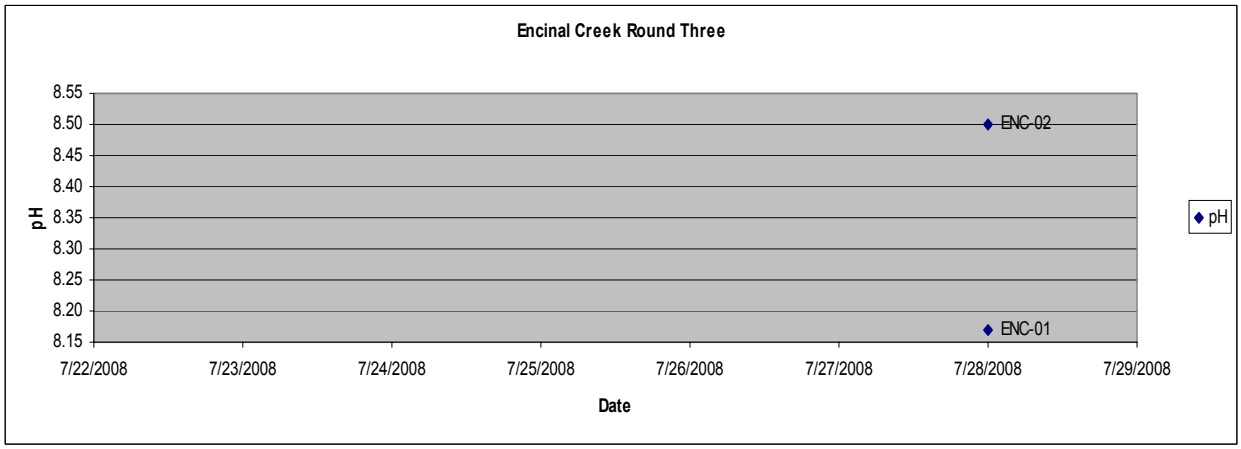
Dissolved Oxygen mg/L
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ENC-02
ENC-01
DO Conc
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

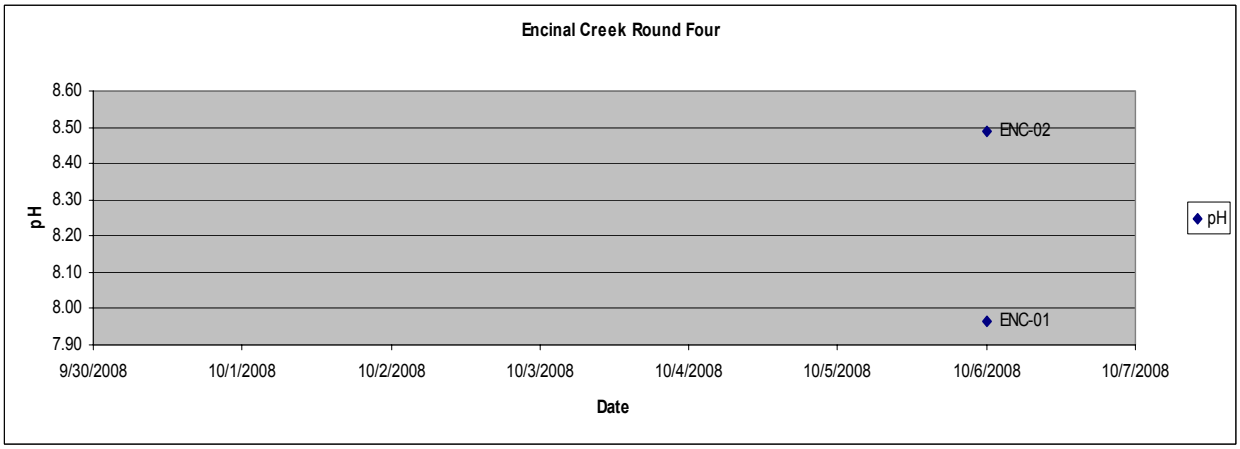

Encinal Creek Round Three
Dissolved Oxygen mg/L
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ENC-01
ENC-02
DO Conc
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

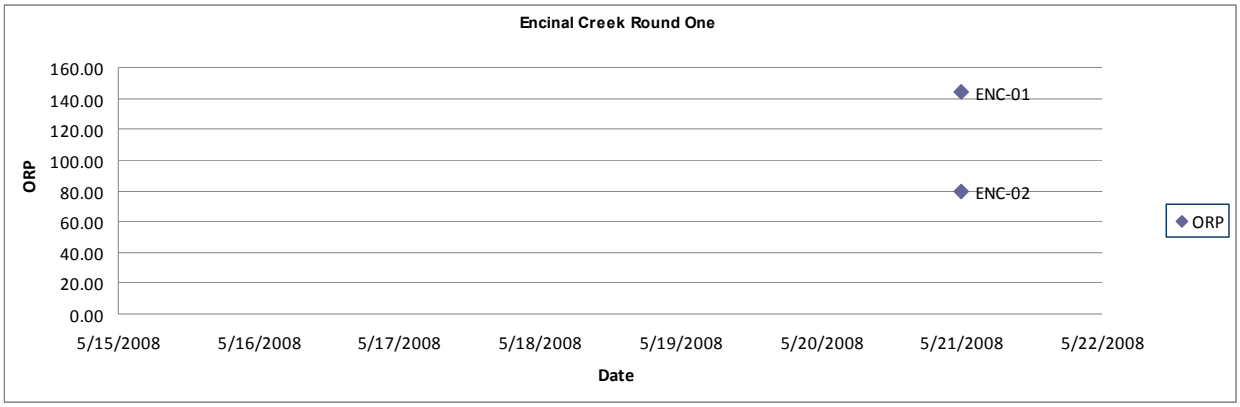

Encinal Creek Round Four
Dissolved Oxygen mg/L
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ENC-01
ENC-02
DO Conc
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

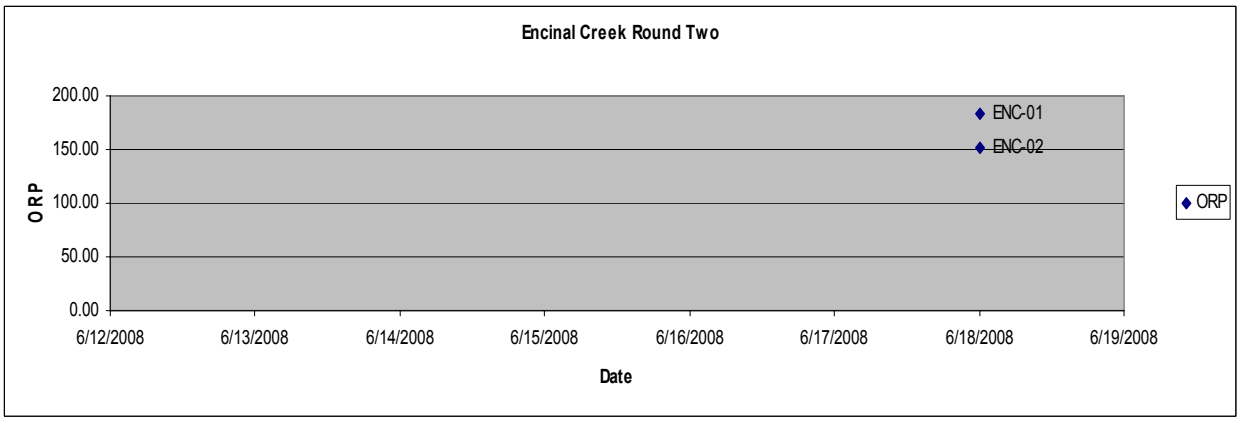

Encinal Creek Round One
7.65
7.60
7.55
7.50
7.45
7.40
7.35
7.30
pH
7.63
7.35
pH
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

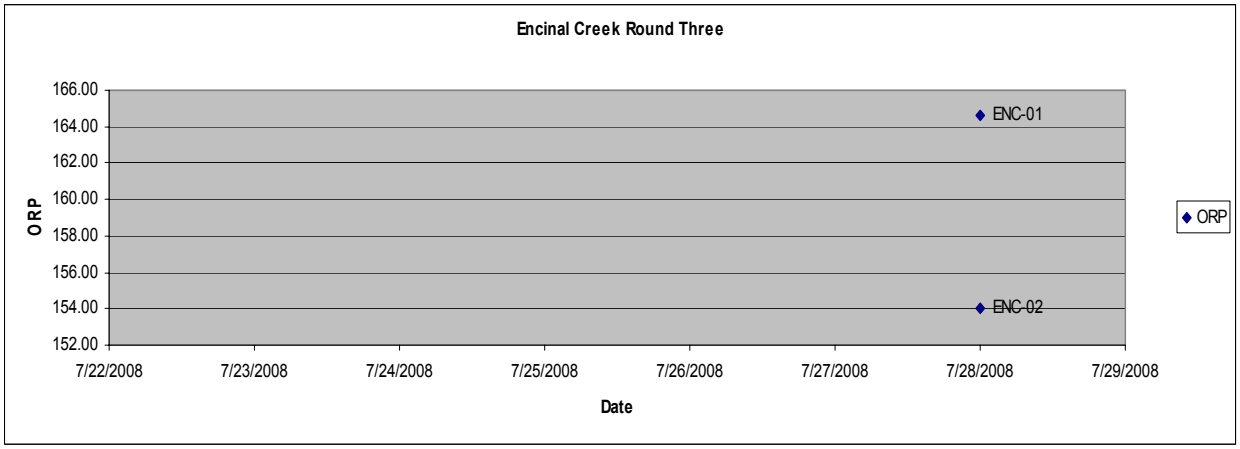

Encinal Creek Round Two
8.60
8.50
8.40
8.30
8.20
8.10
8.00
pH
ENC-02
ENC-01
pH
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

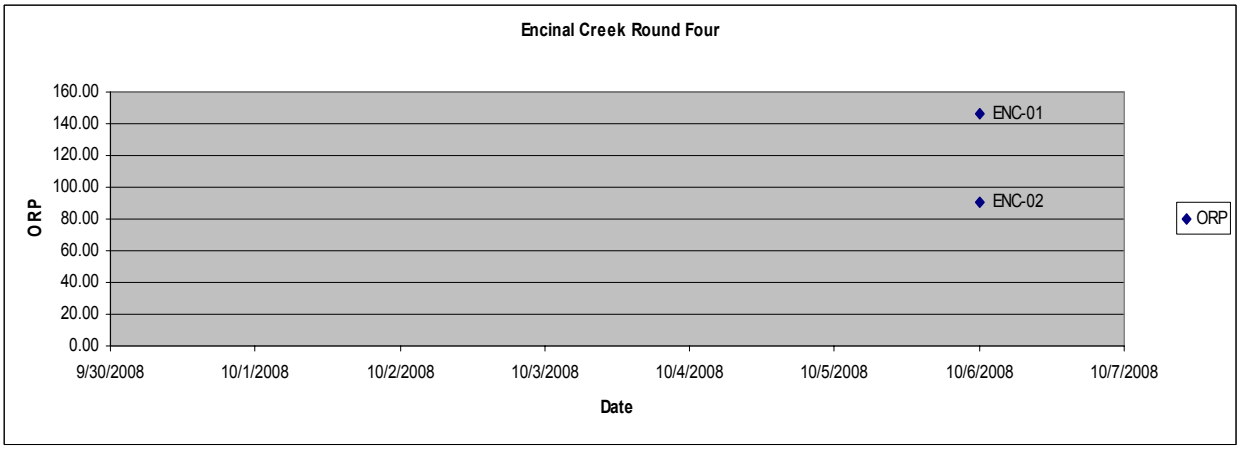

Encinal Creek Round Three
8.55
8.50
8.45
8.40
8.35
8.30
8.25
8.20
8.15
pH
ENC-02
ENC-01
pH
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

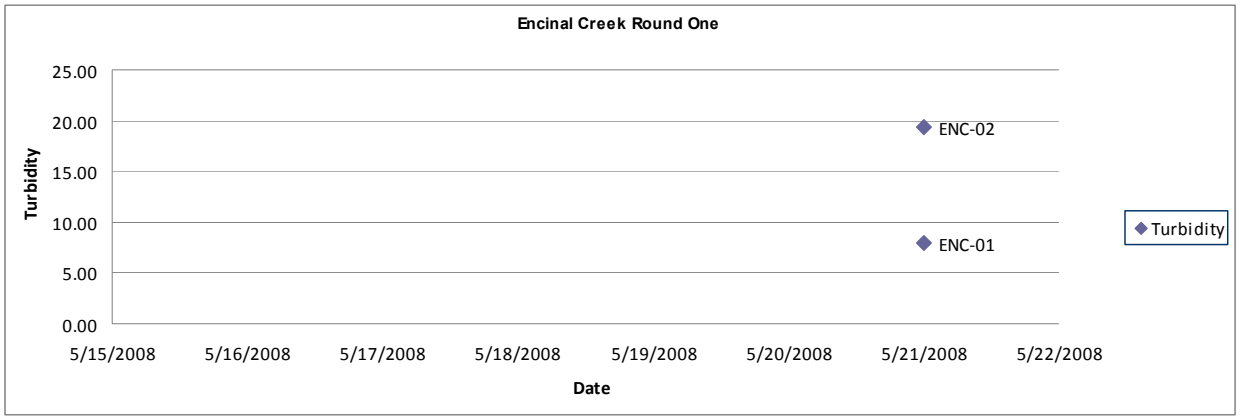

Encinal Creek Round Four
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
pH
ENC-02
ENC-01
pH
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

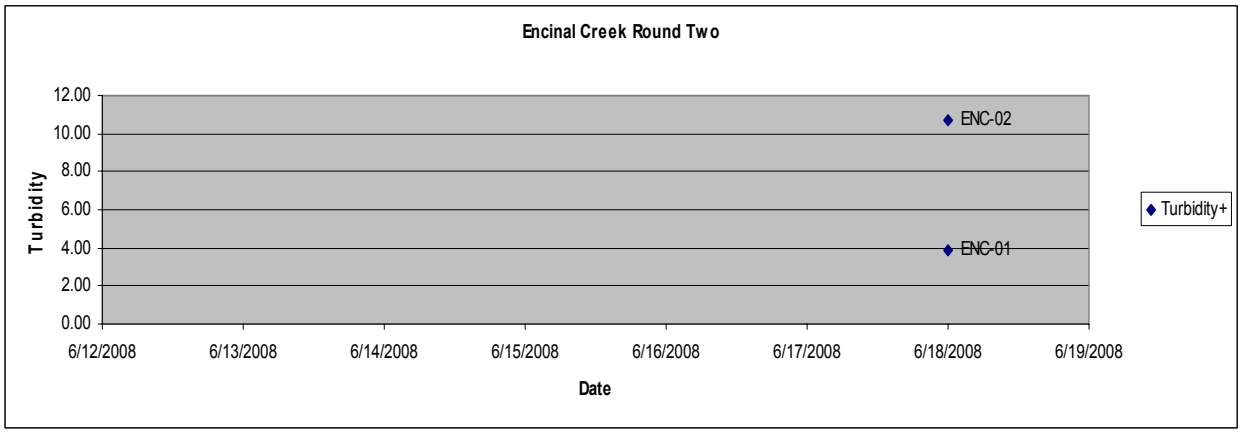

Encinal Creek Round One
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
ORP
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

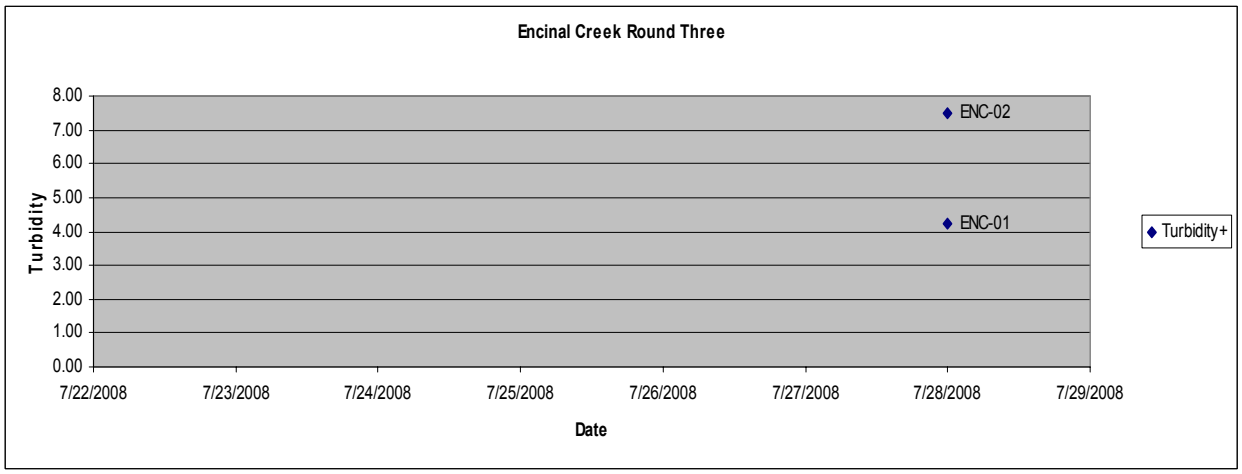

Encinal Creek Round Two
200.00
150.00
100.00
50.00
0.00
ORP
ENC-01
ENC-02
ORP
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

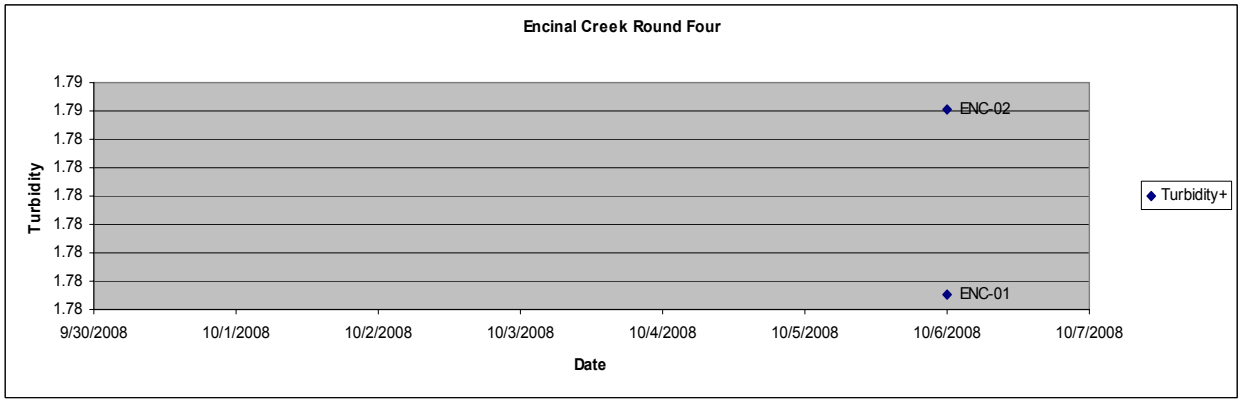

Encinal Creek Round Three
166.00
164.00
162.00
160.00
158.00
156.00
154.00
152.00
ORP
ENC-01
ENC-02
ORP
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date

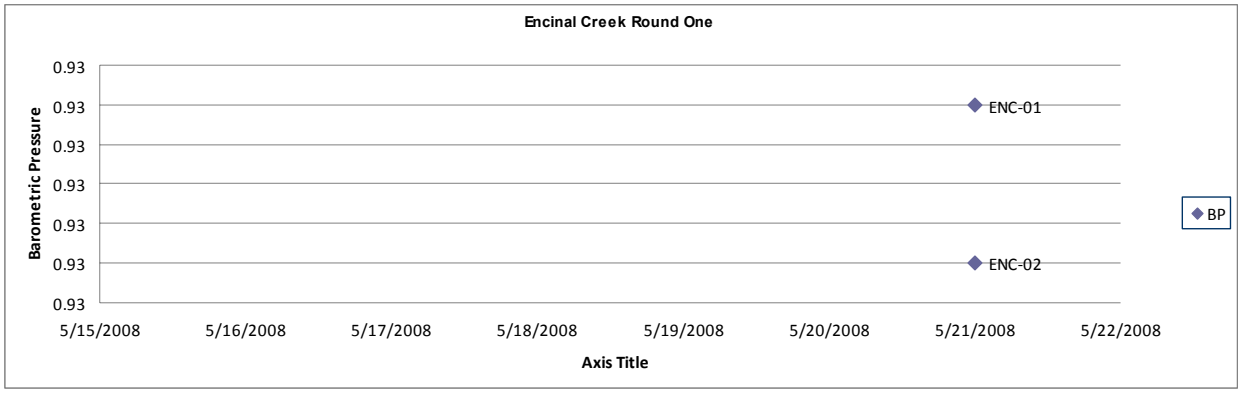

Encinal Creek Round Four
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
ORP
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

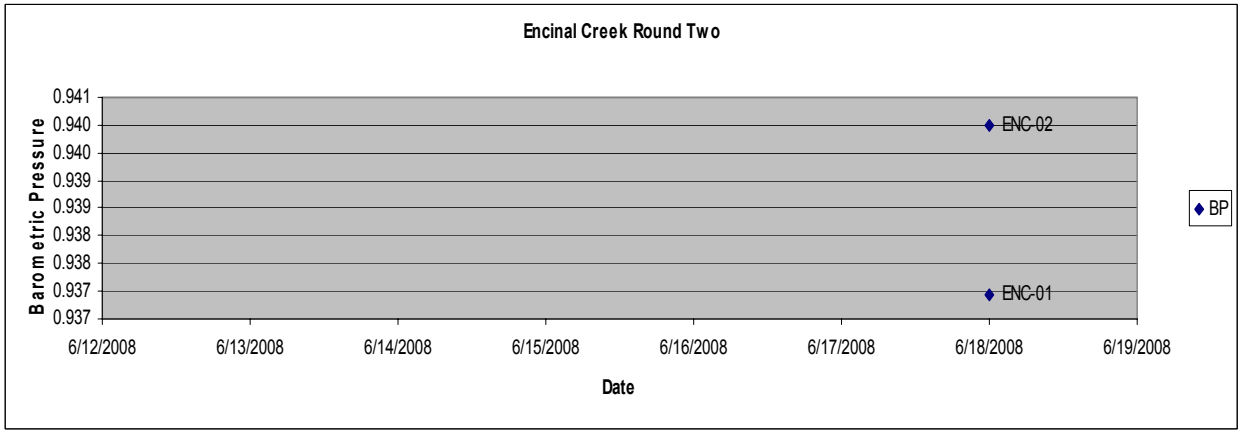

Encinal Creek Round One
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
ENC-02
ENC-01
Turbidity
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Date

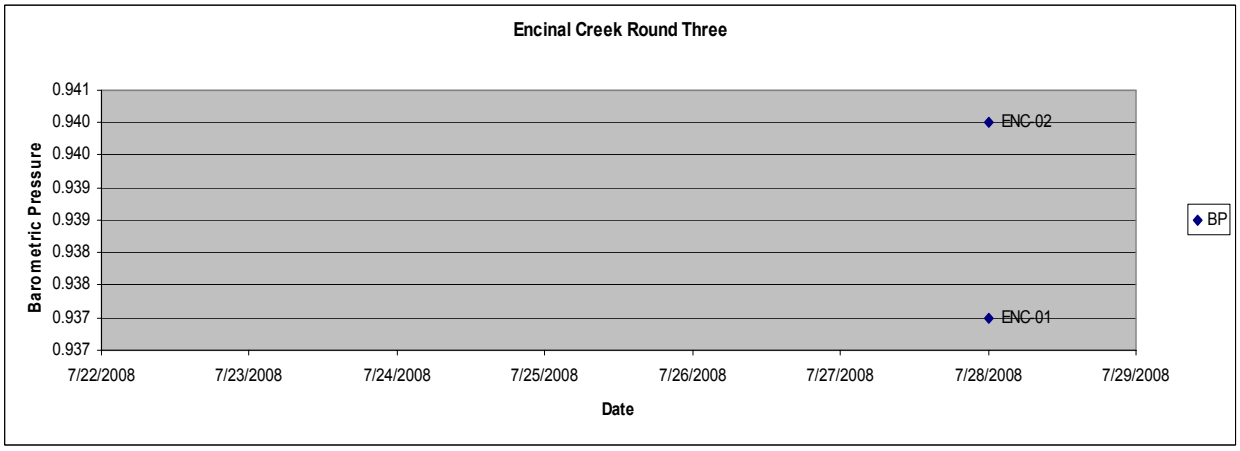

Encinal Creek Round Two
Turbidity
12.00
10.00
8.00
6.00
4.00
2.00
0.00
ENC-02
ENC-01
Turbidity+
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date

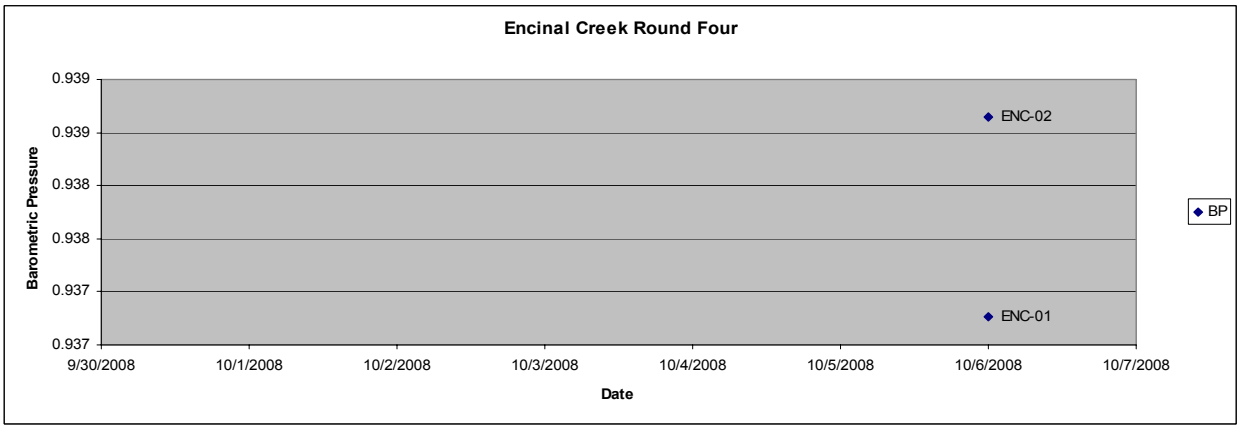

Encinal Creek Round Three
Turbidity
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
ENC-02
ENC-01
Turbidity+
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date


Encinal Creek Round Four
Turbidity
1.79
1.79
1.78
1.78
1.78
1.78
1.78
1.78
1.78
ENC-02
ENC-01
Turbidity+
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date


Encinal Creek Round One
Barometric Pressure
0.93
0.93
0.93
0.93
0.93
0.93
0.93
ENC-01
ENC-02
BP
5/15/2008
5/16/2008
5/17/2008
5/18/2008
5/19/2008
5/20/2008
5/21/2008
5/22/2008
Axis Title


Encinal Creek Round Two
Barometric Pressure
0.941
0.940
0.940
0.939
0.939
0.938
0.938
0.937
0.937
ENC-02
ENC-01
BP
6/12/2008
6/13/2008
6/14/2008
6/15/2008
6/16/2008
6/17/2008
6/18/2008
6/19/2008
Date


Encinal Creek Round Three
Barometric Pressure
0.941
0.940
0.940
0.939
0.939
0.938
0.938
0.937
0.937
ENC-02
ENC-01
BP
7/22/2008
7/23/2008
7/24/2008
7/25/2008
7/26/2008
7/27/2008
7/28/2008
7/29/2008
Date


Encinal Creek Round Four
Barometric Pressure
0.939
0.939
0.938
0.938
0.937
0.937
ENC-02
ENC-01
BP
9/30/2008
10/1/2008
10/2/2008
10/3/2008
10/4/2008
10/5/2008
10/6/2008
10/7/2008
Date

Evaportranspiration

Apart from precipitation, evapotranspiration is the next major component in the hydrologic budget. Evapotranspiration involves the process of evaporation from open bodies of water, wetlands, snow cover, and bare soil and the process of transpiration from vegetation. The principal climatic factors influencing evapotranspiration are solar radiation and wind speed. In the conterminous United States, evapotranspiration averages about 67 percent of the average annual precipitation and ranges from 40 percent of the precipitation in the Northwest and Northeast to about 100 percent of the precipitation in the Southwest.

Estimates of the mean annual evapotranspiration have been derived from hydrologic budgets for each State. These estimates indicate that statewide evapotranspiration within the United States ranges from about 10 inches per year in the Southwest to about 35 inches per year in the Southeast. However, in selected areas of the Southwest where moisture is available and solar radiation is high, evapotranspiration rates in salt cedar are estimated to be about 56 inches per year.

Seasonal trends in evapotranspiration follow the seasonal trends in air temperature-maximum rates occur during the summer months, and minimum rates during the winter months. Advanced Very High Resolution Radiometer instruments installed on polar-orbiting satellites provide relative measurements of plant vigor, density of vegetation cover, and the seasonal duration of vegetation growth. These measurements also monitor the spatial and temporal persistence of drought for large areas.

Changes in evapotranspiration during a drought depend largely on the availability of moisture at the onset of a drought and the severity and duration of a drought. Evaporation from open bodies of water during a drought increases, but transpiration by plants, particularly shallow-rooted plants, generally decreases (*U.S. Geological Survey Water-Supply Paper 2375, p. 99-104.*.).

Discussion

The 30 sites currently monitored within the Pueblo of Laguna Indian Reservation lands cover the full spectrum of environments, climates, terrains, and water quality. The locations range from an Alpine zone in the upper elevations where pine, spruce, aspen, and fur are the dominate tree types to Northern Chihuahuan Desert grasslands characterized by plateaus, rolling hills, and basin floors where the soils are relatively deep. Blue Grama, *Bouteloua gracilis*, is the dominant species here. Surface water sources within the Pueblo of Laguna lands vary greatly as well. The higher elevations are characterized by braided high velocity, cold-water streams and the low elevations are characterized by ephemeral streams called arroyos. Springs are the soul source of water on several of these surface water bodies, many of which dry up completely during the summer months. The flora and fauna associated with these zones vary with elevation, terrain, and uses. In many instances, only plants are associated with the surface water bodies, (Arroyos) and many of the springs, which are isolated dry up during the summer or reduce to shallow pools with little to no aquatic life. Evaluation of current sites monitored revealed two streams and one spring hold the possibility of supporting fish species and have enough water year round to support these aquatic ecosystems. These are the Rio Paguate, Water Canyon Creek and Dipping Vat Spring on the Rio San Jose at RSJ04. Cultural and Traditional uses of these water bodies and all water bodies on the Pueblo of Laguna Indian Reservation Lands will be denoted as a “Yes” or “No” answer and under no circumstances will details of Cultural and Traditional use be elaborated upon. Do any water bodies monitored during the Tribal Fiscal Year 2008 of the CWA § 106 Water Quality Program have Cultural and Traditional uses? Yes.

Analytical data for the Tribal Fiscal Year 2008 is not complete and may not be added in this report. Round one through Round three data from the Master Data base will be attached as an appendix, hard copy only, to this report, if data from Round 4 has been received and compiled then it will be included if not then it will be added as an addendum at a later date. The analytical data collected in round one shows major changes in water samples collected from all sites. The sites designated as Back Ground have little to not interference from up stream sources and derive flow from snowmelt and rain. It is suspected that any metal levels may be elevated due to development practices implemented by the U.S. Forest Service; this development also limits the influence of biological influences such as wildlife, aquatic species, and the environment. Additionally the New Mexico Bureau of Geology and Mineral Resources in conjunction with the U.S. Geological Survey are up-dating geological maps in the Mt. Taylor and Lobo Canyon Quadrangles. These 7.5 minute quadrangle maps overlap on to Pueblo of Laguna lands. One of the objectives of this mapping is to better understand the movement of surface water and groundwater due to the complex nature of a composite volcanic field and its interaction on the surrounding bedrock. This will help the Pueblo of Laguna better identify recharge zones and aquifer connections and the complex relationship between surface water and groundwater within Mt Taylor Volcanic field on and off reservation lands. More analytical sampling is required to determine if any problems exist in the waters of the Pueblo of Laguna. Currently assistance is being sought with the New Mexico Bureau of Geology and

Mineral Resources to obtain analytical sampling analysis on water bodies classified as important by the Pueblo of Laguna. Determinations of naturally occurring constituents are still being compiled and evaluations for additional analytical parameters for up coming years evaluated. Further study for naturally occurring and man made organic volatile and semi-volatile compound still need to be determined. This would require a substantial increase in the analytical budget and would be proposed for the surface water systems that are currently used by the Pueblo of Laguna for drinking and ceremonial use and feed the shallow alluvial aquifers where groundwater is drawn for the domestic drinking water supply system.

Turbidity has proven problematic; most locations have water that is above 50 NTU. This was remedied with the purchase of a new YSI 650 Multi-parameter probe and 6820 Multi-parameter Sonde which can read Turbidity up to 1000 NTU. Additionally physical parameters may not possible in arroyos when there is flow. This is normally a flood induced by heavy precipitation and the velocity of the water is very physically powerful. Attempts were made to collect from bridges; however, the sediment load was so great that and the particle size were slightly greater than the diameter of the collection tube that it plugged the tube.

In summary there is both physical, ambient toxicity, and analytical sample data to determine problem areas on surface water bodies across the Pueblo of Laguna reservation lands. The Rio Paguate has good quality water above the mine however, below the mine the quality drops dramatically. The level of Isotopic Uranium in the water peaked this year at 394.90 µg/L at RPG-03 and 147.28 at RPG-04 on 06/25/2008. The levels on 05/28/2008 were 327.52 µg/L at RPG-03 and 227.38 µg/L. The quantity has varied greatly as well this year with higher than normal turbidity levels during the summer months when flow is diminished. This is most likely due to the drought and this being one of the permanent streams emanating from Mt. Taylor has seen increased use by wildlife and livestock. This level impacts not only the Rio Paguate but the Rio San Jose below there convergence points and the Rio Puerco then the Rio Grande. The Rio Moquino has showed measurable levels of Isotopic Uranium all year long with a peak level of 9.93 µg/L on 05/28/2008. The Rio San Jose at RSJ-04 showed elevated levels on 06/26/2008 of 13.08 µg/L which is at a sampling location more than 15 miles downstream and diluted by two large springs and several minor ones. The quantity of water in the Water Canyon Creek has fluctuated greatly throughout the year with variability in the quality as well. The main problem with this stream system is the diversion of 100% of the flow by the Cubero Land Grant Community. Encinal Creek has also remained fairly constant throughout the year as well; the only problem is limited flow. The two points at Jack Ward Mesa have varied greatly all year, it is expected that this is due to geology and natural causes. The Rio San Jose has varied greatly as well and this is due to numerous factors. The Rio Puerco and Rio Salado vary greatly as well, however this is mostly do to the presence or absence of water. There has been very limited flow all year in the Rio Salado and it has remained dry due to 100% containment by the Juan Tafoya Land Grant Community (AKA Marquez). The numerous springs including background have not fluctuated as greatly but difference can be attributed to the drought conditions experienced this year which impact quality, flow and quantity.

Arroyo Cutting

An arroyo is a nearly vertically walled, flat floored stream channel that forms in fine, cohesive, easily eroded material. Arroyos can cut as deeply as 65 feet into the valley floor, are often wider than 165 feet, and can be hundreds of miles long. Arroyos exist throughout the western United States, but are most common in arid and semi-arid climates in the Southwest. The rapid widening and deepening of arroyos have both changed the physical environment and been a costly nuisance in the west since European settlement began in the mid 1800's.

Causes of Arroyo Formation

Three factors may cause arroyo formation, but the relative contribution of each is difficult to discern. The main factor is thought to be a change in climate that produced unusually heavy rainfall. Land-use practices, such as grazing, may have enhanced arroyo formation in the southwest during the most recent period of erosion (A.D. 1865-1915). A natural cycle of erosion and deposition caused by internal adjustments to the channel system is a third possibility (Graf, 1988; Schumm and Hadley, 1957).

Climate

Flooding caused by heavy rain may produce arroyos. Although climate records in the southwest were not systematically kept before 1900, recent studies have found evidence for unusually heavy rainfall in Tucson, Arizona during the late 1800's (Betancourt and Turner, 1993). This rainfall was caused by strong and frequent ENSO (El Nino Southern Oscillation) events, suggesting that heavy rain was a regional phenomenon. Thus, the climate of the Southwest during the most recent period of arroyo entrenchment was conducive to large floods (Hereford, 1993). Drainages may have been especially vulnerable to arroyo cutting, if unusually wet ENSO conditions occurred immediately following a period of below normal precipitation. During a dry period, the enervated vegetation would not have its normal capacity to protect the soil from rain-drop impact or to absorb and slow runoff.

Land use

With the settlement of the West came the rapid introduction of cattle, sheep, and horses. From 1870 to 1890 the number of livestock in New Mexico increased from 300,000 to 2,300,000 (Peterson, 1950). Similar increases were reported in other Western states during this time. Valley floors, which were the most dependable forage areas for the animals, were quickly overgrazed. The fragile vegetation was consumed, and the soil was compacted and left extremely susceptible to erosion. To further exacerbate the soil conditions, both humans and livestock created trails along stream channels and nearby hillsides forming small ditches, leaving the land surface susceptible to arroyo formation.

Nevertheless, earlier periods of arroyo formation predated the introduction of livestock, and thus overgrazing cannot be solely responsible. Spanish and Mexican ranchers, moreover, introduced large numbers of livestock in the 1700's without associated erosion. For these reasons, other factors such as climate change may have played a more important role in arroyo formation.

Effects of Arroyo Cutting

Swamps in the Southwest during the Last Century

Observations before 1865 describe verdant river bed marshes, known as cienegas, containing beaver ponds, fish, and tall grasses which were nourished by high water tables (Bryan, 1925). These marshes have since been drained by arroyos, altering the flora and fauna of the area by widening and deepening the original stream channel.

Decreased Agricultural Productivity

Arroyo formation can be very destructive to agriculture. As soon as arroyo cutting begins, the surrounding water table is lowered making irrigation difficult. Arroyos can quickly remove as much as 25% of their valley floor (Cooke and Reeves, 1976, p. 3), covering downstream agricultural land with unwanted flood-borne sediment. This sediment does not improve the fertility of the underlying alluvial soil because it contains large quantities of sand and gravel that originate from subsoil and deposits of soil forming materials (Cooperrider and Hendricks, 1937).

Flooding

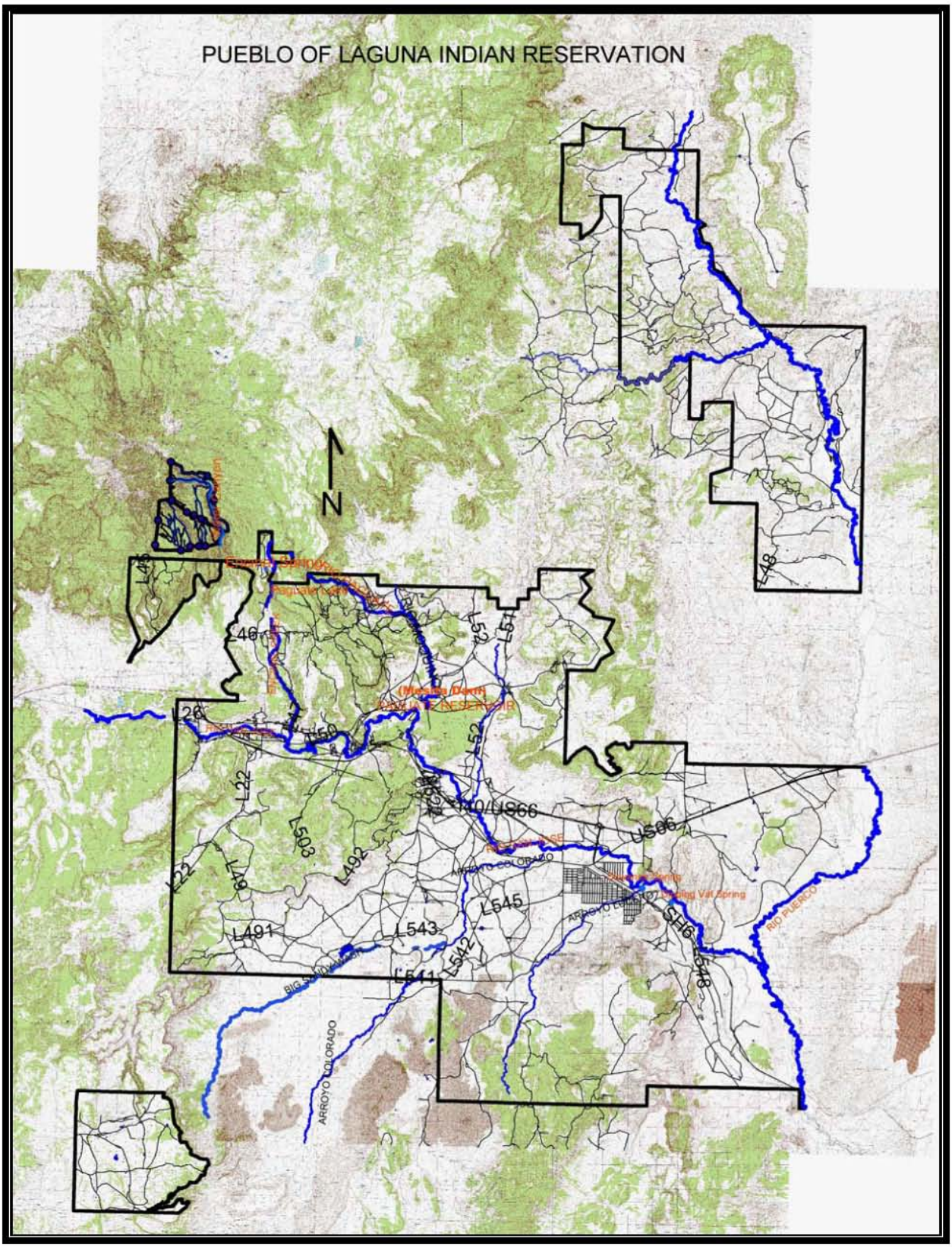
The often excessive deposits of sediment from upstream arroyo formation can decrease flood protection by reducing the natural regulatory functions of stream channels. Sediment from upstream arroyo erosion fills channels that otherwise would store flood water. Arroyos also increase flood severity by changing the geometry of the stream channel. Development of an arroyo in a previously braided or meandering drainage straightens and shortens the channel which limits flood water dispersal and increases velocity.

Displacement of People

Because of the loss of land to arroyos and the increased difficulties of farming, humans have occasionally been forced to either change their agricultural practices or to relocate. Where farming practices were depended on irrigation, problems of increasingly fluctuating and decreasingly reliable water sources, and difficulties of transferring water to fields, drove out farmers or forced a change to grazing (Gregory and Moore, 1931). Other damages include destruction to roads, railroads, bridges, culverts, fences, and irrigation works. In the late 1880's, the entrenchment of the Rio Puerco in New Mexico forced the desertion of the towns of San Ignacio, San Fernando y Blas, and San Francisco (Bryan, 1925).

Prehistoric arroyo cutting may have been one of the main factors leading to abandonment of southern Utah and northern Arizona by the Anasazi (Hereford et al., 1995).[2]

[2] USGS Rio Puerco On-line Web site http://esp.cr.usgs.gov/rio_puerco


PUEBLO OF LAGUNA INDIAN RESERVATION
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L503
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L491
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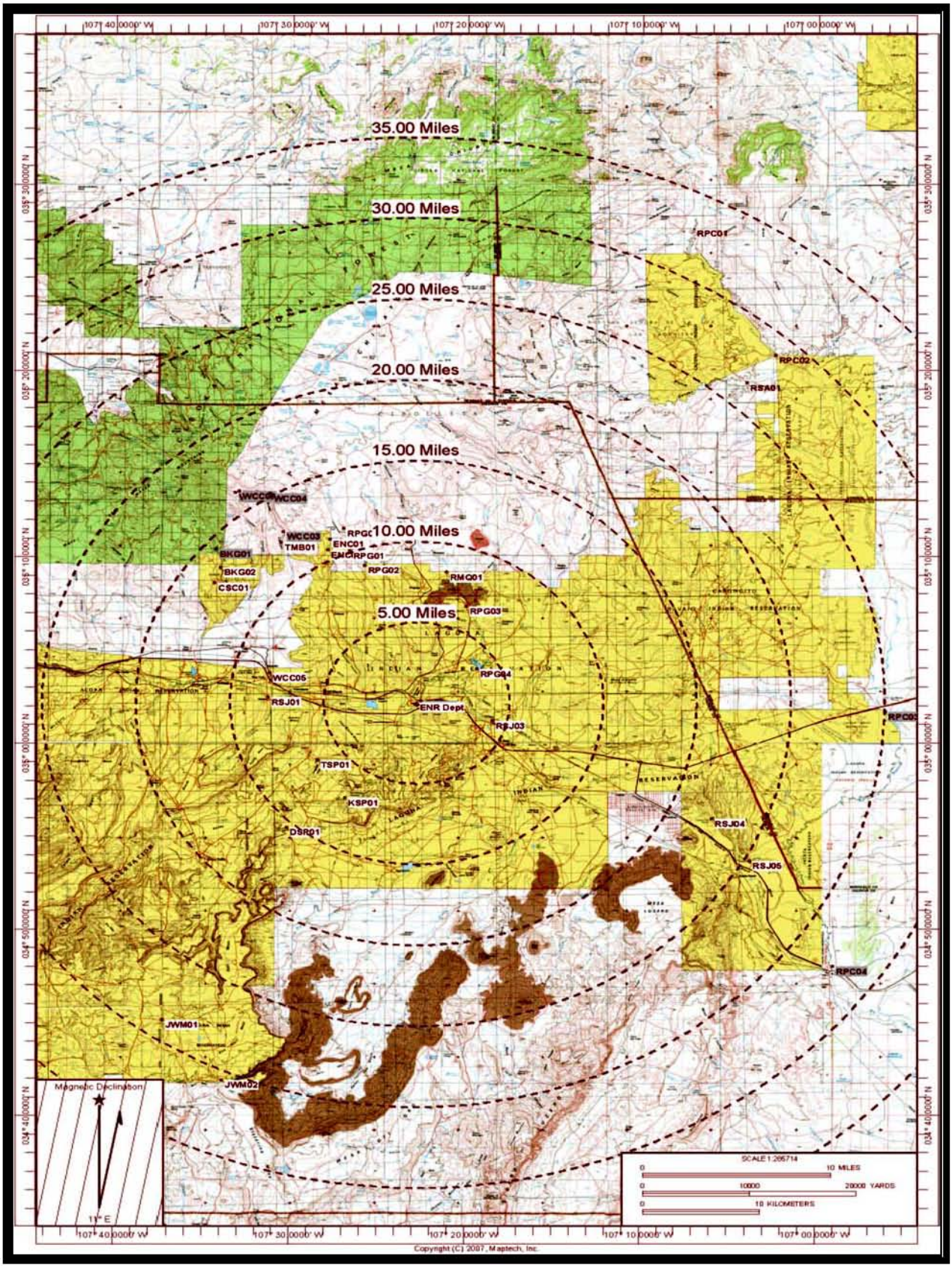
L542
L541
L548
US66
SH6
ARROYO COLORADO
BIG SANDY WASH
RIO PUERCO

Not to Scale

Tribal FY 2008 CWA § 106 Water Quality Program Sampling & Monitoring Locations



Macroinvertebrates and Fish Habitats

The Rio San Jose and the Rio Puerco watersheds, which are both sub-watersheds of the Rio Grande Basin system, receive water from sources passing through or originating on Pueblo of Laguna Indian lands. The stream systems which comprise these watersheds vary with regard to the size of the basin, elevation, seasonal flow rates, ownership and resource management schemes, and of course, aquatic bio-diversity.

There are perennial, spring-fed and snow run-off, cold-water streams which support native and introduced trout species (Genus: *Salmo)*, of New Mexico and the elements of primary production, which these trout feed on. These stream systems vary from one (foot) in diameter, to approximately 12 feet in diameter, with varying levels of stream depth and flow rates. There is also variation in the pools, riffles, eddies, as well as, available fish cover and habitat. Additionally, there have been occurrences of catfish (Genus: *Ictalurus*) and Bluegill (Genus: *Lepomis*) in the Rio Paguate and Rio San Jose stream systems.

There are also areas of the stream systems, which have become "choked" with vegetation and silt. These choked areas of the stream system are primarily upstream of the Pueblo of Laguna's external boundary fence. Within the Pueblo of Laguna's boundaries, in the Water Canyon stream system, there are a series of high elevation, small, in-line ponds, which vary in size, depth, and habitat. There are some seasonal occurrences of algal blooms in this pond series, which effects aquatic life. Inhabitants of these high-mountain ponds include, but are not limited to, mudpuppies (Genus: *Necturus*), Gastropods (snails), crayfish (Order: Decapoda), and Leopard Frogs (Genus: *Rana*), and these ponds are regularly visited by bear, deer, mountain lion, turkey, ducks and elk.

The Pueblo of Laguna's Environmental and Natural Resource Teams are presently designing a complete aquatic biodiversity inventory to be conducted as funding becomes available.

Conclusions

The Pueblo of Laguna Surface Water Quality Monitoring program has experienced set back but has met or exceeded all goals for the § 106 Clean Water Act Grant for FY 2007-2008. The water quality specialist and colleges have collected four rounds of analytical samples and attempted to collect bi-monthly physical parameter data in addition 4 rounds of Ambient Toxicity sampling data was collected and all data is attached to this report. In addition, all quarterly reports have been submitted for this grant year, with the exception of this Year End Report. The result of the analytical sampling and physical parameter monitoring is indicating great diversity within the waters of the Pueblo of Laguna. Variations in surface water bodies with hydrologic links to groundwater in many cases are becoming evident, which has been suspected but not confirmed.

As discussed in the introduction section the hydrogeology of the Pueblo of Laguna Reservation lands is unique and complex. Pristine conditions are no longer possible due to the extensive mining that occurred in the Grants Mineral Belt. Contamination from mining activities, population centers, National Laboratories, highways, detonation of nuclear weapons within the state of New Mexico, etc., have wide reaching effects and directly impact the air quality which in turn affects meteoric waters which are part of the hydrologic cycle. The first atomic bombs detonated were within the State of New Mexico, the first at Los Alamos National Laboratory and the second at the Trinity Site on the White Sands Missile Range. Much of the uranium needed for these weapons was mined from Pueblo lands and the effects of which are still being discovered.

The use of surface water by the Pueblo of Laguna people had not changed much since New Mexico became a State in 1912. These uses include irrigation of farmland, livestock watering, drinking water supplies, and cultural and traditional uses. Introduction of drinking water and waste water systems by the Indian Health Service in the 1960's have had dramatic effects on the limited, high quality water supplies on Pueblo lands. Demand for drinking water has grown logarithmically since its introduction with similar detrimental effects on source areas. Impacts from septic and sewage lagoons is not fully know but is expected to have been negative. Demands for water in the semi-arid climate of the southwest are growing both on and off the reservation. Large metropolitan areas demands for clean drinking water have exceeded the capability of the source supply and these areas are now looking towards Indian lands to fulfill their needs, with no regard to the needs of the Tribes for the same resource. It is extremely important for Tribes, specifically the Pueblo of Laguna to protect and determine the quality and quantity of its waters both surface and subsurface. It is also important to understand the impact of contaminants on the hydrologic cycle, and how these contaminants will influence human health and the environment.

The Pueblo of Laguna is in the beginning stages of this process and will continue to assess the surface waters within its boundaries to protect the health of its people, culture and society for future needs for all life.

This concludes all activities reportable for FY 2008.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Date: _____

Reviewed by: _____

Printed Name: Barbara Cywinska-Bernacik

Date: _____

Project Official: _____

Printed Name: John E. Antonio

Title: Governor

Date: _____

Appendix A

Quarterly Reports

First Quarter Progress Report

Pueblo of Laguna
Environmental and Natural Resources Department

CWA § 106 Water Quality Program

October 2007 – December 2007

Assistance Agreement No. I-96650101-0

27000187

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- All data from the four rounds of sampling collected during the previous year, along with physical parameter data collected utilizing the YSI Multiparameter Display System (MDS) with Model 6820 multi-probe compact sonde, have been compiled and archived. All analytical results were entered into the Master Data Base.

- The CWA § 106 Water Quality Program Year-End Report is in the final stages of completion and signed by Pueblo of Laguna Governor John E. Antonio and submitted in the next quarter to Region VI for approval.

- A revised version of the QAPP has been submitted to Region VI for approval.

- Training is an on going process and will be included in work activities as needed for refresher and improving job performance. Training maybe done in-house, obtained through the Bureau of Indian Affairs (BIA), Indian Heath Service (IHS), OETA, EPA etc., or other provider on a no-cost basis for current staff and new staff as added.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Collection of analytical and physical parameter data was not feasible during the first quarter of the new fiscal year. This issue is addressed in the revisions to the QAPP submitted for approval.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- No new data has been found from any federal agencies. As a point of fact, the water uses and sources vary greatly between tribes. In fact, its now known that, in most cases, this information is not relevant or viable to the needs or uses by the Pueblo of Laguna.

- Assistance to the CWA § 106 program is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties and vice versa.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. The Environmental Technician position currently is unfilled and being considered for re-advertisement through the Pueblo of Laguna Human Resource department as a full time employee. When filled the Technician position, the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and new land acquisitions as they arise. Off-reservation sources of water that affect the Pueblo of Laguna are also considered and coordinated with State of New Mexico Environment department on these areas. These coordination efforts will be on a case-by-case basis. Training on the Multi-Parameter Probe started and will continue with each of the rounds of sampling and as the QAPP revised.

- As part of the Tribal Re-organization, programs are not permanent and can be moved to new offices, which maybe created to better server the growing needs of the Pueblo of Laguna. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect GPS/GIS data on the sites and process the data. Assistance from

Natural Resources Program has been sought from available staff as well in areas where program interest and objectives overlap or the responsibility has been split. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- All analytical data received from the laboratory has been reviewed and entered into the Master Data Base. All associated Physical Parameter data have been archived and site location maps have been up-dated to reflect current conditions.

This concludes all activities reportable for the first Quarter of FY 2008.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: John E. Antonio

Title: Governor

Date: 3-13-08

Second Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

January 2008 – March 2008

Assistance Agreement No. I-96650101-0

27000191

Objective 1: Maintain and Continue to Build Surface Water Quality Program

Sub Objectives:

1.1 Provide Administrative/Technical Support for Water Quality Program

1.2 Build, Maintain and Expand Technical Reference Library

1.3 Build Analytical/Physical Parameter Data Base

1.4 Discussion

Related Activities completed during this quarter:

Many activities have occurred during the second quarter of this grant period. These include the completion and submission of the FY 2007 Year End Report AKA 305B TAR Report, the update and submission of the Quality Assurance Project Plan (QAPP) and approval QTRAK #08-132, completion and submission of the § 106 of the Clean Water Act Grant application for funding, collection and shipment of the first round of Ambient Toxicity Samples to the U.S. EPA Houston Lab for analysis. Additional activities include the purchase of the Enviro Data Software for better data base management.

Discussion:

As stated above many activities have occurred during the second quarter of this grant year. In addition to the aforementioned activities, the Water Quality program along with the other environmental programs hosted the March Inter-Tribal Resource Advisory Committee (IRAC) for the first time at the new Rt. 66 Hotel and Casino on behalf of the Pueblo of Laguna. The environmental programs used the opportunity to present the programs structure and functions to the participants; a copy of the sign-in sheets are attached to this report. This was also an excellent opportunity for doing outreach education to other Tribes and the State of New Mexico, which the entire Environmental & Natural Resources Department utilized.

The QAPP during this quarter was revised, submitted and approved by the U.S. EPA Region 6 so that project activities can proceed. The process utilized for revision and suggested by Mr. Don Johnson, Region 6 Quality Assurance Manager proved successful in minimizing the amount of time from submission and approval. Major revision to this QAPP, QTRAK #08-132, were done in the previous year and only minor changes were needed which also helped in this swift approval.

The grant application for funding for FY 09 was completed and submitted during this quarter and is pending negotiation/approval for the requested amount. A major change for the program was the seeking to wave the Tribal Indirect Cost Rate, which required a council resolution. This action will allow for 100% of the grant funding to be utilized on program activities and staffing needs. A copy of this resolution is attached to this report.

The first rounds of Ambient Toxicity Samples were collected during this quarter. The location and sample types vary from year to year. These decisions are made at the U.S. EPA Region 6 level with consultation from the Water Quality Program. Sediment and water are the standard media collected, packaged and shipped to the Region 6 Houston Laboratory for analysis. A copy of the collection schedule is attached to this report. It needs to be noted that while the Water Quality

program staff collect and ship the Ambient Toxicity Samples they are a separate function from the § 106 CWA program activities. These activities are separate from the activities identified in the § 106 CWA work plan but are identified in the § 106 CWA work plan narrative. These activities are split into to two functions, collection and analysis. Program staff utilize § 106 CWA funds in the collection, preparation and shipment of these samples, however EPA provides the analysis through the Region 6 Laboratory. These are allowable costs under the § 106 CWA grant and are part of the over all assessment of the Pueblo of Laguna's Surface Water Quality Monitoring program.

Work on the Technical Reference Library is an ongoing process and is in dire need of additional space. Office space is at a premium and is vital that documents housed there be readily available when needed. Whenever possible large new documents added are stored electronically to save space, however, it is not cost effective or feasible to convert old documents to electronic format. This process is only expected to grow but is not affecting space at a critical level yet.

The Enviro Data software is required for the maintenance and development of the master database. It became apparent last quarter during the development of the Year End Report that a more effective means of maintaining the database was required. Queries for data proved to be a labor-intensive task, which left little to no time for other data QA. The software is custom built to the need and specifications set for by the Pueblo of Laguna Surface Water Quality Program and have the capability to grow for use by the reminder of the Environmental programs. The investment of time to set up the parameters for data storage will require more training but will be beneficial in the end for the program; data can be retrieved with ease and compared to the baseline, which is still under development, as well as manipulated for inclusion in reports etc.

Objective 2: Develop Program Design for Water Quality Monitoring

Sub Objectives:

2.1 Update Quality Assurance Project Plan

2.2 Discussion

Related Activities Completed during this quarter:

The QAPP as stated above, was updated, submitted and approved by QTRAK #08-132 for the start of program activities under the 2008/2009 sampling rounds.

Discussion:

The QAPP only required minor changes from the major revision done in 2006. These were addressed and with the suggestions made by Mr. Don Johnson, the process went very smoothly. Minor changes are only expected for the next year, some of which have all ready been discussed with the Ms. Nikole Witt the program officer. These include the addition of Staff from the Office of Environmental and Technical Assistance (OETA) to serve as the Quality Control/Quality Assurance (QA/QC) officer. Mr. Boyd Nystedt has been designated as the QA/QC person for the Surface Water Quality Monitoring program. A bio with Mr. Nystedt's qualifications will be obtained and included as well as his signature on the signature page of the QAPP.

Objective 3: Implement Basic Water Quality Monitoring Program

Sub Objectives:

3.1 Conduct Field Data Collection-Physical Parameters

3.2 Conduct Field Data Collection-Analytical Parameters

3.3 Discussion

Related Activities Completed during this quarter:

No physical or analytical data collection except for Ambient Toxicity have occurred during this quarter.

Discussion

Field activities are tentatively scheduled to begin this month barring weather and the hiring of the Environmental Technician is expected to begin by the third week of April. Interviews tentatively scheduled for Monday April 14, 2008 from the applicant pool advertised and developed by the Pueblo of Laguna Human Resource department are hoped to provide a qualified individual, if not the position will be requested to be re-advertised to a larger pool. The weather is the other factor for not entering the field. High winds with blowing dust in the lower elevations and blowing snow in the higher have stalled all efforts for an early start to the sampling season.

Once the Environmental Technician is hired and orientation has been, completed fieldwork can begin on the four rounds of sampling for this year along with the remainder of the Ambient Toxicity sampling.

Conclusion and Summary:

This concludes all activities reportable for the first Quarter of FY 2008.

Submitted by: Curtis L. Francisco

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Reviewed by: Barbara Cywinska-Bernacik

Printed Name: Barbara Cywinska-Bernacik

Title: Enviro. Program Manager

Date: 4/14/08

Inter-Tribal Resource Advisory Committee
(IRAC) Meeting Hosted by
Pueblo of Laguna

	Name	Pueblo/Tribe/Organization	Phone Number	Email Address	Lunch
1	Danny Wells	Jicarilla Apache	(575) 759-7421	d.wellsepotech@yahoo.com	
2	Cordell Tecube	Jicarilla EPO	(575) 759-7421	cltecube@yahoo.com	
3	Boyd Nystedt	ENLPC/OETA	(505) 692-7073	bnystedt99@gmail.com	✓
4	Curtis L Francisco	Pueblo of Laguna	(505) 552-7546	[illegible]	
5	Rebecca Neri Zagal	NM ONET	505-243-8087	REBECCA.NERIZAGAL@STATE.NM.US	
6	Jim Bala	NM OURT	505-243-8087	JIM.BALA@STATE.NM.US	
7					
8	Amy Garcia	Pueblo of Laguna - Env Dept	505 552 7546 x14	agarcia@lagunatribe.org	
9	[illegible]	[illegible]	[illegible]	[illegible]	
10	Emery Ayuantita	Pueblo of Zuni Env Prog	505-782-2484	[illegible]	
11	Mars Chalan	Cochiti Pueblo	505-465-3111	mars_chalan@pueblodecochiti.org	✓
12	Alisha Antonio	Laguna Natural Resources	(505) 552-7512	aantonio@lagunatribe.org	
13	[illegible]	Laguna Nat Res	552-7512	[illegible]	
14	Sabin Chavez	Laguna Nalemp Office	552-7114	SMCHAVEZ@LAGUNATRIBE.ORG	✓
15	Vernon Valdez	Laguna Nalemp	552 7114	vvaldez@lagunatribe.org	
16	Chuck Schultz	Laguna ENRD	552-7512	cschultz@lagunatribe.org	✓
17	Barbara Bernauk	Laguna Environm	552-7534	bbernauk@lagunatribe.org	
18	Albert Riley	Laguna Council	552-6654		
19	John Antonio	Laguna Pueblo	552 6654	jantonio@lagunatribe.org	

Inter-Tribal Resource Advisory Committee (IRAC) Meeting Hosted by Pueblo of Laguna

	Name	Pueblo/Tribe/Organization	Phone Number	Email Address	Lunch
20	Duke Sire	Picuris Pueblo Enviro.	505-597-0110	sireduke@gmail.com	✓
21	WAYNE H. YAZZA	Picuris	575-580-0110	[illegible]	✓
22	ALEX PUGLISI	PUEBLO OF SANDIA	771-5080	apuglisi@sandiapueblo.nsn.us	X
23	Allen Elwood	Pueblo of Sandia	771-5083	aelwood@sandiapueblo.nsn.us	X
24	Neil Weber	Pueblo de San Ildefonso	455-4119	nweber@sanipueblo.org	✓
25	DINO CHAVARRIA	SANTA CLARA PUEBLO	505 753 7326	dchavarria@santaclarapueblo.org	✓
26	Adrian Garcia	Santa Clara Pueblo	505-753-7326	agarcia@santaclarapueblo.org	✓
27	Jeremy Yepa	Santa Clara Pueblo	505 753 7326	jyepa@santaclarapueblo.org	✓
28	Brian Suazo	Santa Clara Pueblo	505-753-7326	bsuazo@santaclarapueblo.org	✓
29	Milton Bluehouse	NMED	505-827-0990	milton.bluehouse@state.nm.us	✓
30	Jacqynthia Johnson	Pueblo of Acoma	505-552-5186	jrjohnson@pueblooffacoma.org	✓
31	Laura Peña	Santo Ana Pueblo (one)	505-771-6711	LPena@santaana.org	✓
32	Deborah Goss	Santa Ana Pueblo	505-771-6711	dgoss@santaana.org	✓
33	Denise Livingston	Pueblo of Tesuque	505 955 7746	dlivingston@pueblooftesuque	—
34	Robert Gomez	Pueblo of Taos	575.751.4601	rgomez@taospueblo.com	X
35	Steve Romero	Pueblo of Nambe	505 455 4420	[illegible]	✓
36	Marvin Sarracino	Pueblo of Laguna	505 552-6011	msarracino@lagunatribe.org	✓
37	Elroy Drake	Navajo Nation	928 871 7056	elroy-drake@yahoo	✓
38	Judy Tenorio	Pueblo of San Felipe	505-867-3351	jtenorio@sifpueblo.com	✓

4/14/2008

Page 6

Pueblo of Laguna
Environmental & Natural Resources
Surface Water Monitoring Program

27000196

Inter-Tribal Resource Advisory Committee
(IRAC) Meeting Hosted by
Pueblo of Laguna

	Name	Pueblo/Tribe/Organization	Phone Number	Email Address	Lunch
39	[illegible]	San Felipe	771-2596		
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PUEBLO OF LAGUNA
P.O. BOX 194
LAGUNA, NEW MEXICO 87026

(505) 552-6598
(505) 552-6654
(505) 552-6655

Office of:
The Governor
The Secretary
The Treasurer

PUEBLO OF LAGUNA

Resolution No. 08-08

Re: Approval of Waiver of Indirect Cost for the EPA CWA Section 106 Grant

At a duly called meeting of the Pueblo of Laguna Tribal Council held on the 11th day of March, 2008, the following resolution was adopted.

WHEREAS, the Pueblo of Laguna has a negotiated Indirect Cost rate of 39.62 % and is required to charge this rate on contracts; and

WHEREAS, the Pueblo of Laguna has an EPA CWA Section 106 grant application for the period October 1, 2008 to September 30, 2009; and

WHEREAS, the EPA CWA Section 106 base funding level have decreased during the last two years and the IDC rate has risen to the current rate of 39.62%; and

WHEREAS, inflation has increased during this same period creating a diminished cash amount available for direct contract dollars; and

WHEREAS, the Environmental Department is requesting a waiver of IDC charges to this grant period so that direct program operations are not adversely impacted by the high IDC rate and to allow more direct funding to assist in meeting the proposed scope of work and all grant requirements; and

WHEREAS, the finance staff has reviewed the grant application summary form which include the waiver of IDC and has identified the Tribal Overhead Budget as the source to offset the shortfall due to the waiver of IDC.

NOW, THEREFORE, BE IT RESOLVED, that the Tribal Council approves the waiver of IDC for the EPA CWA Section 106 grant and funding period of October 1, 2008 to September 30, 2009.

BE IT FURTHER RESOLVED, that the Treasurer and CFO are directed and authorized to charge the amount of IDC waived under this grant to the Tribal Overhead Budget.

Resolution No. 08-08

BE IT FURTHER RESOVED, that the Governor is directed and authorized to take all actions necessary to submit the application and to carry out the scope of work as approved by the funding source.

Governor

Richard D Rucker, Sr
Council Member

Council Member

ATTEST:

Josephine L. Cochran
Tribal Secretary

CERTIFICATION

The foregoing resolution was enacted upon by the Pueblo of Laguna Tribal Council on the 17th day of March, 2008, by a vote of 19 for and 0 opposed, at a duly called meeting at which a quorum of the Council was present.

Governor

ATTEST:

Josephine L. Cochran
Tribal Secretary

2008 Ambient Toxicity Testing Schedule for the Pueblo of Laguna

Location	Water Samples				Sediment Samples				Number of Samples per location
	Round 1	Round 2	Round 3	Round 4	Round 1	Round 2	Round 3	Round 4	
RPG-03	1	1	1	1	1		1		6
Date	3/10/2008	5/5/2008	7/7/2008	8/4/2008	3/10/2008		7/7/2008		
RPG-04	1	1	1	1	1		1		6
Date	3/10/2008	5/5/2008	7/7/2008	8/4/2008	3/10/2008		7/7/2008		
RSJ-04	1	1	1	1	1		1		6
Date	3/24/2008	5/5/2008	7/21/2008	8/4/2008	3/24/2008		7/21/2008		
Total Number of Samples per Year									18

Third Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

April 2008 to June 2008

Assistance Agreement No. I-96650101-0

27000201

Objective 1: Maintain and Continue to Build Surface Water Quality Program

Sub Objectives:

1.1 Provide Administrative/Technical Support for Water Quality Program

1.2 Build, Maintain and Expand Technical Reference Library

1.3 Build Analytical/Physical Parameter Data Base

1.4 Discussion

Related Activities completed during this quarter:

Many activities have occurred during the third quarter of this grant period. These include the completion and resubmission of the § 106 of the Clean Water Act Grant application for funding in the amount of $110,000.00, collection and shipment of the second round of Ambient Toxicity Samples to the U.S. EPA Houston Lab for analysis, completion of 2 rounds of analytical sampling and physical parameter data collection. Additional activities include the hiring of an Environmental Technician to assist with fieldwork on a full time basis and attendance at the 8th National Tribal Conference on Environmental Management in Billings, Montana.

Discussion:

As stated above many activities have occurred during the third quarter of this grant year.

The start of analytical sample collection and physical parameter data collection rounds with the assistance of the new Environmental Technician Dorothy N. Beecher. Ms Beecher is also a Laguna Tribal Member from the village of Encinal and is finishing her Associates Degree from Central New Mexico Community College, and has 15 years of varied work experience. Late in the quarter, two interns from the I-TEST program from Santa Fe Indian School started there 5 week summer work experience with the Environmental Program, Surface Water Quality. These interns are Mr. Scott Martinez and Ms. Kristin Siow, both are Laguna Tribal members, Scott is a senior and Kristin is a junior. The interns will be with the program for 5 weeks before returning to school.

The grant application for funding for FY 09 was completed and resubmitted during this quarter per negotiation/approval for the requested amount of $110,000.00.

The second rounds of Ambient Toxicity Samples were collected during this quarter. The number of samples varies from year to year but includes water and sediment on locations determined by the POL Water Quality Program. These allocations of laboratory space and sample quantity are made at the U.S. EPA Region 6 level with consultation from the Water Quality Program. Sediment and water are the standard media collected, packaged and shipped to the Region 6 Houston Laboratory for analysis. It needs to be noted that while the Water Quality program staff collect and ship the Ambient Toxicity Samples they are a separate function from the § 106 CWA program activities. These activities are separate from the activities identified in the § 106 CWA work plan but are identified in the § 106 CWA work plan narrative. These activities are split into to two functions, collection and analysis. Program staff utilize § 106 CWA funds in the collection, preparation and shipment of these samples, however EPA provides the analysis through the

Region 6 Laboratory. These are allowable costs under the § 106 CWA grant and are part of the over all assessment of the Pueblo of Laguna's Surface Water Quality Monitoring program.

Work on the Technical Reference Library is an ongoing process and is in dire need of additional space. Office space is at a premium and is vital that documents housed there be readily available when needed. Whenever possible large new documents added are stored electronically to save space, however, it is not cost effective or feasible to convert old documents to electronic format. This process is only expected to grow but is not affecting space at a critical level yet. Leaks in the roof of the building have damaged or destroyed some documents now that the monsoon season has arrived; prior to this, the building was nearly set on fire by the shorting out of one of the cooling units on the roof. The Environmental program for the Pueblo of Laguna is housed in the old Indian Health Clinic here at Laguna, which has many problems due to age and other factors.

The Enviro Data software is required for the maintenance and development of the master database. It became apparent last quarter during the development of the Year End Report that a more effective means of maintaining the database was required. Queries for data proved to be a labor-intensive task, which left little to no time for other data QA. The software is custom built to the need and specifications set for by the Pueblo of Laguna Surface Water Quality Program and have the capability to be utilized use by the other Environmental programs. The investment of time to set up the parameters for data storage will require more training but will be beneficial in the end for the program; data can be retrieved with ease and compared to the baseline, which is still under development, as well as manipulated for inclusion in reports etc.

<u>Objective 2:</u> Develop Program Design for Water Quality Monitoring

Sub Objectives:

2.1 Update Quality Assurance Project Plan

2.2 Discussion

Related Activities Completed during this quarter:

There is no new activity on the QAPP since approved for this sampling year.

Discussion:

Minor changes are only expected for the next year, some of which have all ready been discussed with the Ms. Nikole Witt the program officer. These include the addition of Staff from the Office of Environmental and Technical Assistance (OETA) to serve as the Quality Control/Quality Assurance (QA/QC) officer. Mr. Boyd Nystedt has been designated as the QA/QC person for the Surface Water Quality Monitoring program. A bio with Mr. Nystedt's qualifications will be obtained and included as well as his signature on the signature page of the QAPP.

<u>Objective 3:</u> Implement Basic Water Quality Monitoring Program

Sub Objectives:

3.1 Conduct Field Data Collection-Physical Parameters

3.2 Conduct Field Data Collection-Analytical Parameters

3.3 Discussion

Related Activities Completed during this quarter:

2 rounds of physical or analytical data collection have been completed and the second Ambient Toxicity sample collection and shipment have occurred during this quarter.

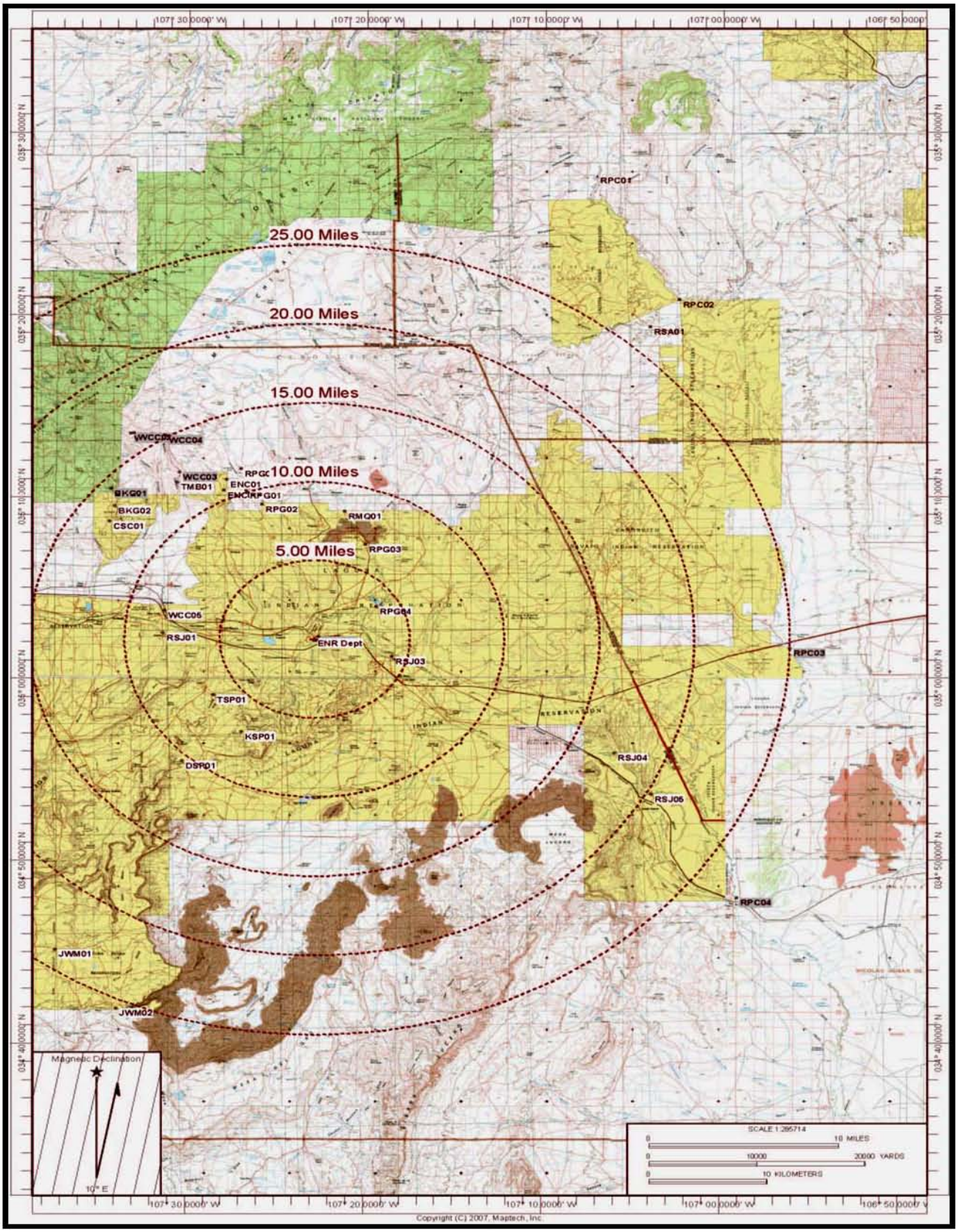
Discussion

Field activities begin in late April with a temporary worker until the hiring of the Environmental Technician in early May. The Environmental Technician had been discussed in a previous section. The weather is the major factor potentially delaying entry into the field. High winds with blowing dust in the lower elevations and now torrential rain may cause delays. The higher elevations were still getting snow as late as June, which caused some problems. Weather forecast models are predicting an early Monsoon season for the area, and in conjunction with the early fire season flooding has become a real problem. This is proven problematic to protection the health and safety of the field staff. Flooding is not always detectible until you reach a location; heavy rain up stream can cause debris and mud flows that were not visible upon crossing an arroyo but can bar or impair field work.

This photo show the site RPC-04 on the Rio Puerco, July 09, 2008 at 0848hrs with very little flow

This photo shows the same stream, Rio Puerco at RPC-03 July 09, 2008 at 1138 hrs.

The change in flow occurred during the time it took to drive from one location to the next and there was no rain encountered that day in the field. If the field staff had to cross the steam to reach the upstream location, there would have been no way to return. All caution were taken while in the field but this does not prevent the weather from changing conditions from great distances. The next figure shows the sampling locations for the 2008 sampling season and the short between RPC-04 and RPC-03


25.00 Miles
20.00 Miles
15.00 Miles
10.00 Miles
5.00 Miles
RPC01
RPC02
RSA01
WCC04
WCC03
TMB01
ENC01
BKG01
BKG02
CSC01
RPG02
RMQ01
RPG03
RPG04
WCC05
RSJ01
ENR Dept
RSJ03
RPC03
TSP01
KSP01
DSP01
RSJ04
RSJ05
RPC04
JWM01
JWM02
Magnetic Declination
10° E
SCALE 1:285714
10 MILES
10000
20000 YARDS
10 KILOMETERS
Copyright (C) 2007, Maptech, Inc.

Conclusion and Summary:

This concludes all activities reportable for the third Quarter of FY 2008.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Reviewed by: _____

Printed Name: Barbara Cywinska-Bernacik

Title: Enviro. Program Manager

Date: Thursday, July 24, 2008

Appendix B

Round One Data

Appendix C

Round Two Data

Appendix D

Round Three Data

Appendix E

Round Four Data

Year End Program Report FY 07
SURFACE WATER MONITORING PROGRAM

P.O. Box 194
Laguna, New Mexico

January 21, 2008

27000213

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Introduction

This is report is the culmination of the four rounds of sampling, three quarterly reports and the efforts of work done for the Pueblo of Laguna FY 2007, U.S. Environmental Protection Agency-Region VI FY 2007, year in the Clean Water Act § 106 Surface Water Quality Monitoring Program.

The Pueblo of Laguna (KA-WAIKA) is a federally recognized Indian Tribe located in West-Central New Mexico on the Colorado Plateau. The Pueblo is one of the 19 federally recognized Pueblos in the state. The name of the Laguna Pueblo People is derived from the Spanish word for Lake (Lagoon). As well, the name in the Keresan language is KA-WAIKA-MAH and the literal translation is "people from the lake" or "people of the lake". The Laguna People have always been farmers both dry land and irrigation, and livestock tenders but most of all, we prize the human attribute of thought. KA-WAIKA was the first of the Pueblos to adopt a written Constitution in 1908. This constitution was replaced under the Indian Reorganization Act of 1934, revised in 1958, and amended once again in 1984.

Laguna Reservation lands comprise approximately 550,000 acres in Trust and approximately 150,000 acres of State and Bureau of Land Management tracts for a total of nearly 700,000 total, situated within four New Mexican counties; Cibola, Valencia, Bernalillo and Sandoval**.** There are six main villages within the reservation boundaries: Seama (Tse-ah-mah) (the western-most), Paguate (Gwee-stchgee), Encinal (Buu-nee-guy-ah), Paraje (Tse-muu-nah), Laguna (Ka-waika), and Mesita (Haa-tsah) (the eastern-most). There are also several sub-divisions and scattered homes between the main villages. "The Village of Laguna is, and shall continue to be, the Capital of the Pueblo of Laguna",[1] which is located approximately 55 miles west of Albuquerque on Interstate-40.

The lithological setting of the Pueblo of Laguna Indian reservation is distinctive and the landscapes are commonly a complex response to variations in rock types and to primary and secondary structures within the units. Secondary structures are heavily influenced by diastrophic and exogenic processes. The deformation, uplift, doming and at times intense lateral deformation produce large-scale secondary structures that respond to geomorpholoigical processes in complex variations which create our distinctive terrain. Lithological controls over landforms produce a large number of variations and these variations may be associated with a wide range of discrete regions that can be identified from distinctive outcrops of a few square meters to uniformativity over hundreds of square kilometers. It is important of recognize some of the major geomorphic features associated with arenaceous, argillaceous, calcareous, igneous, and metamorphic rocks. These will impact the rate of weathering which are related to the rates at which weathered material is removed from its location of break-up to deposition. Weathering is an unfixed mix of both chemical and mechanical processes. All these factors impact fluid movements. A liquid is

[1] Pueblo of Laguna, Constitution of the Pueblo of Laguna, June 6, 1984, page4

transported thorough open channels where the flow is confined and although the depth, velocity, and flow in the channel can be measured the study can be rendered hazardous in arid and semi arid climates. Uplift mechanisms can be categorized for purposes of simplicity as eustatic, isostatic, tectonic and orogenic. These mechanisms are all factors in the development of drainage basins and stream channels. Denudation chronology, direct observation and measurement, mathematical simulations and application of the ergodic hypothesis are some of the methods used to try to visualize the long-term evolution of the landforms. Morphgenetics are important to consider regarding questions concerning climatic geomorphology. The morphometrics portions are greatly impacted by climatic influences. These influenced may either be directly related through precipitation intensity or indirectly through vegetation. The morphogenetic region in which the Pueblo of Laguna is located is classified as Semi-Arid. The geomorphic processes associated with this region are listed as follows:

- Frost Weathering (minimal except at higher latitudes)
- Mechanical Weathering (minimal to moderate, especially thermal and salt)
- Chemical Weathering (minimal to moderate)
- Mass Wasting (moderate but infrequent)
- Fluvial Processes (Maximum but episodic in the form of sheet wash, gullying and ephemeral stream action giving high overall erosion rates)
- Glacial Scour (nil)
- Wind Action (Moderate to Maximum)

The morphological features associates with this region are listed as follows:

- Pediments (1˚ to 4˚)
- Cliffs and angular talus slopes (25˚ to 35˚)
- Inselbergs
- Integrated ephemeral stream systems
- Arroyos
- Badlands
- Alluvial fan
- Local dunes

The following diagram was first demonstrated by Hjulström, which was elaborated by Sundborg (1956) which relates critical velocity to the sediment size at which erosion of sedimentary particles will begin for both wind and water.

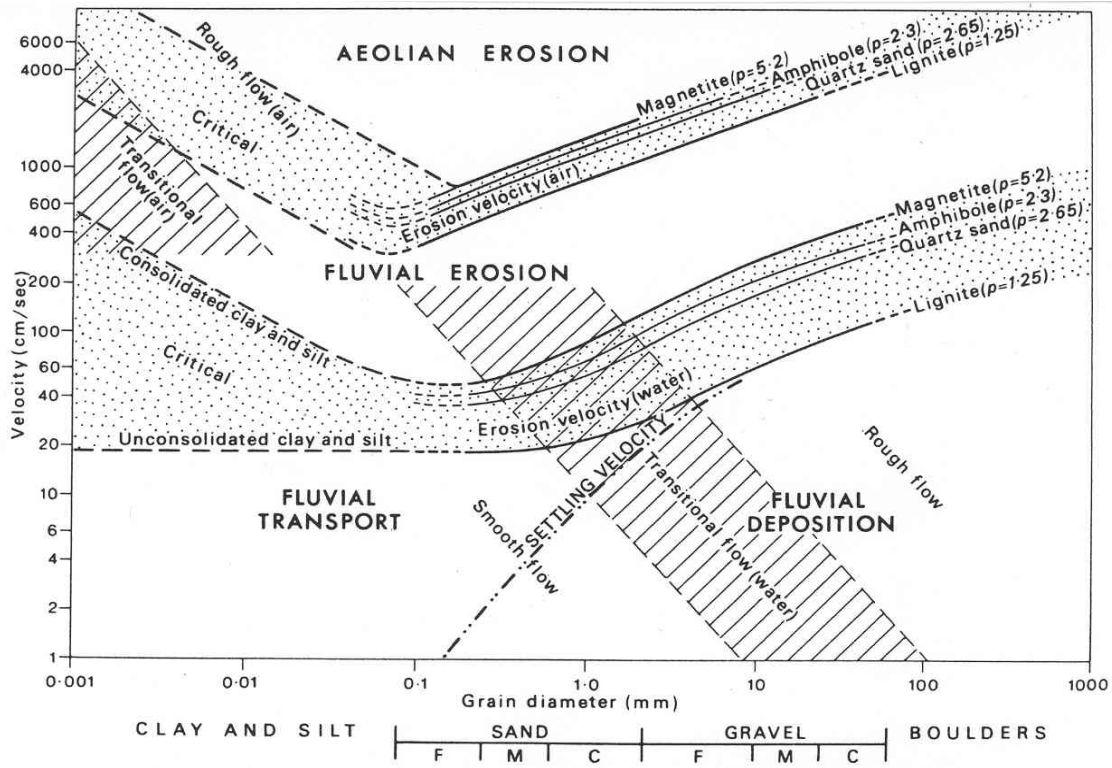


Figure 12.14 Curves showing relations of grain size to critical fluvial and aeolian erosion velocity for uniform materials of differing densities. The critical fluvial erosion velocity refers to a height of 1 m above the river bed. The two critical zones around these curves and the settling velocity curve for particles in water delimit the four regimes of fluvial deposition, fluvial transport, fluvial erosion and aeolian erosion.
Source: Sundborg, 1956, figure 16, p. 197.

Potable and non-potable water is in very limited supply at the POL, making it a highly valuable resource. Drinking water comes from its shallow surficial aquifers, drinking water wells are screened in the shallow alluvial aquifers along surface water pathways. Therefore, the POL's drinking water aquifers and supply system is vulnerable to contamination from surface sources. There are two primary watersheds that drain the POL lands: the Rio Puerco and the Rio San Jose. The Rio San Jose drains from the west towards the east, joining up with the Rio Puerco, which drains from the north towards the south. The Rio Puerco then goes on to a confluence with the Rio Grande. Together, the Rio San Jose and the Rio Puerco form a part of the Rio Grande basin. The Rio Puerco is one of the main tributaries of the Rio Grande, entering the river near Bernardo, New Mexico. It supplies more than 70% of the suspended sediment entering the Rio Grande above Elephant Butte reservoir. The Pueblo's lands are in the eastern and central portions of these watersheds.

The U.S. EPA's Index of Watershed Indicators classifies the POL's watersheds as having "More Serious Problems – Low Vulnerability to Pollutant Stressors", and assigns the watersheds a score of 5 on a scale of 1-10. The problems stem primarily from erosion, loss of riparian vegetation, intrusion of non-native species (i.e. Salt Cedar) and high sediment loads. However, there are a few possibilities for the discharge of pollutants. There have been no fish advisories for these watersheds. A uranium mine on

the Pueblo has been mostly reclaimed. However, discharges from this mine, as well as from similar mines and mills upstream of the POL, could have affected the Pueblo's watersheds. Currently, there are two regulated point source effluent dischargers, one on the Rio San Jose at the Dancing Eagle Casino and on the Rio Puerco at the Route 66 Casino. There is always the likelihood of spills and accidental releases on the U.S. Interstate Highway 40 and Railroad systems, which bisect the POL's lands.

Physical and Analytical Parameters Locations

The Pueblo of Laguna Water Quality Specialist, Environmental Director, Environmental Technician and Partners for Success Summer hire collected three rounds of analytical samples and monthly physical parameter data for 30 sites on the POL lands. The locations are summarized in the following table.

No.	Site Name	Site ID	Latitude	Longitude	Analytical Method	Classification	Area of the Reservation
1.0	Rio San Jose #1	RSJ01	35°03'15.26"	107°32'39.40"	Fecal/E. Coli, Total Nitrogen, Total Phosphrous	Existing	Reservation Proper
2.0	Rio San Jose #2	RSJ02	35°03'25.50"	107°32'39.60"	Fecal/E. Coli, Total Nitrogen, Total Phosphrous	Existing	Reservation Proper
3.0	Water Canyon #5	WCC05	35°03'45.56"	107°31'22.80"	Fecal/E. Coli, Total Nitrogen, Total Phosphrous	Existing	Reservation Proper
4.0	Rio Paguate #2	RPG02	35°10'30.46"	107°26'52.83"	Fecal/E. Coli, Total Nitrogen, Total Phosphrous	Existing	Paguate Purchase
5.0	Rio Moquino #1	RMQ01	35°09'11.81"	107°21'18.57"	Isotipic Uranium, Fecal/E. Coli, Total Nitrogen, Total Phosphorous	Existing	Paguate Purchase
6.0	Rio Paguate #3	RPG03	35°07'08.70"	107°19'58.93"	Isotipic Uranium, Fecal/E. Coli, Total Nitrogen, Total Phosphorous	Existing	Paguate Purchase
7.0	Rio Paguate #4	RPG04	35°04'04.25"	107°19'37.11"	Isotipic Uranium, Fecal/E. Coli, Total Nitrogen, Total Phosphorous	Existing	Paguate Purchase
8.0	Rio San Jose #4	RSJ04	34°55'58.24"	107°06'16.86"	Isotopic Uranium, Fecal/E. Coli, Total Nitrogen, Total Phosphorous	Existing	Sedillo Grant
9.0	Rio Puerco #2	RPC02	35°20'50.87"	107°02'32.91"	Physical Parameters	Existing	Montano Grant
10.0	Background #1	BKG01	35°10'52.45"	107°34'12.36"	Physical Parameters	Relocated	Seco Canyon
11.0	Background #2	BKG02	35°10'28.10"	107°34'21.80"	Physical Parameters	Relocated	Seco Canyon
12.0	Encinal #2	ENC02	35°10'52.96"	107°28'00.76"	Physical Parameters	Existing	Paguate Purchase
13.0	Rio San Jose #3	RSJ03	35°01'13.29"	107°18'35.99"	Physical Parameters	Existing	Reservation Proper
14.0	Timber Creek	TMB01	35°10'05.65"	107°31'48.73"	Physical Parameters	Existing	Mt. Taylor Ranch
15.0	Water Canyon #1	WCC01	35°13'34.52"	107°32'58.55"	Physical Parameters	Existing	Mt. Taylor Ranch
16.0	Water Canyon #3	WCC03	35°12'39.56"	107°31'12.89"	Physical Parameters	Existing	Mt. Taylor Ranch
17.0	Rio Puerco #1	RPC01	35°27'39.07"	107°07'06.43"	Physical Parameters	Existing	Sanchez/Major's Ranch
18.0	Rio Puerco #3	RPC03	35°01'38.98"	106°56'26.92"	Physical Parameters	Existing	Sedillo Grant
19.0	Seco Canyon #1	CSC01	35°10'07.40"	107°34'12.90"	Physical Parameters	Existing	Seco Canyon
20.0	Dripping Spring	DSP01	34°55'26.80"	107°30'19.46"	Physical Parameters	Existing	Reservation Proper
21.0	Encinal #1	ENC01	35°11'14.21"	107°28'56.90"	Physical Parameters	Existing	Paguate Purchase
22.0	Rio San Jose #5	RSJ05	34°53'38.52"	107°04'11.34"	Physical Parameters	Existing	Reservation Proper
23.0	Turquoise Spring	TSP01	34°59'07.47"	107°28'30.83"	Physical Parameters	Existing	Reservation Proper
24.0	Water Canyon #2	WCC02	35°13'19.28"	107°31'14.13"	Physical Parameters	Existing	Mt. Taylor Ranch
25.0	Water Canyon #4	WCC04	35°13'25.92"	107°31'20.25"	Physical Parameters	Existing	Reservation Proper
26.0	Rio Puerco #4	RPC04	34°34'58.92"	106°59'27.93"	Physical Parameters	Existing	Sedillo Grant
27.0	Kemp Santiago Spring	KSP01	34°57'04.20"	107°27'06.03"	Physical Parameters	Existing	Reservation Proper
28.0	Jack Wards #1	JWM01	34°45'08.35"	107°34'23.27"	Physical Parameters	Existing	Jack Wards Mesa
29.0	Jack Wards #2	JWM02	34°41'54.21"	107°33'59.26"	Physical Parameters	Existing	Jack Wards Mesa
30.0	Rio Salado #1	RSA01	35°19'23.29"	107°04'13.10"	Physical Parameters	Existing	Armjilo Ranch

BKG-01

BKG-02

CSC-01

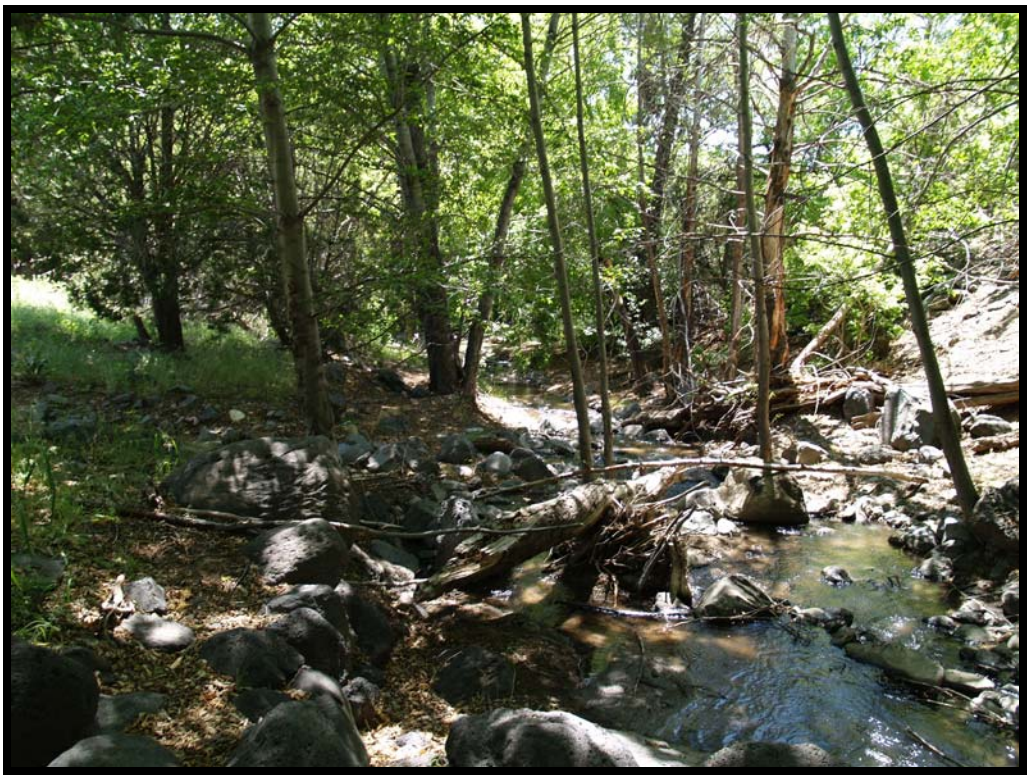
DSP-01

ENC-01

ENC-02

RMQ-01

RPG-02



RPG-03

RPG-04

RSJ-01

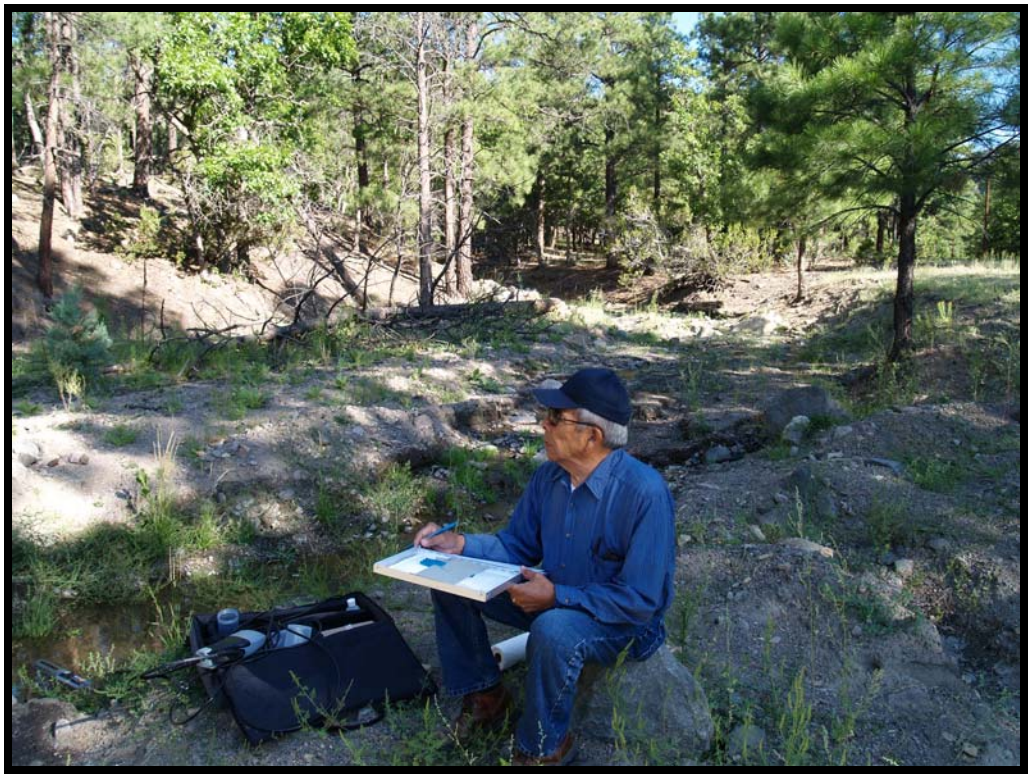
RSJ-02

RSJ-03

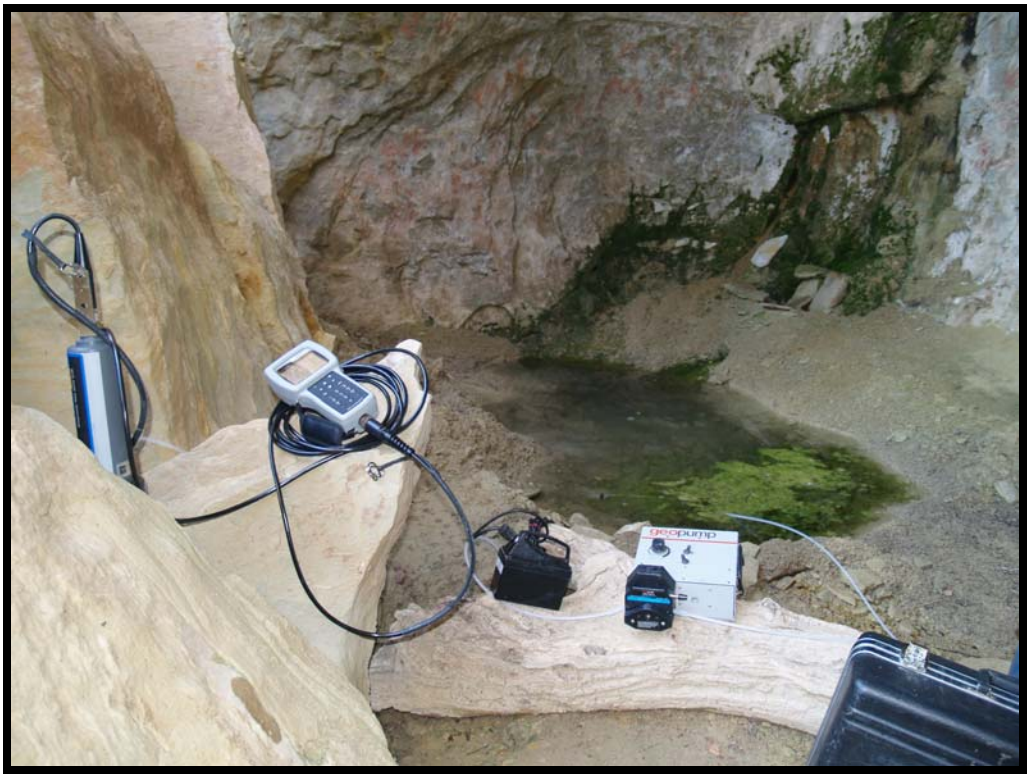
RSJ-04

RSJ-05

TMB-01



TSP-02



KSP-01

WCC-01

WCC-02

WCC-03

WCC-04

WCC-05

RSA-01

RPC-01

RPC-02

RPC-03

RPC-04

JWM-01

JWM-02

Methodology

Analytical Sample Collection

The methodology used by the POL staff in collection and physical parameter monitoring include the following:

1. Peristaltic Pump with poly and silicone tubing
2. YSI 650 Multiprobe system with 6820 Multiparameter Sonde
3. YSI 6160 Flow Cell
4. Coolers for sample collection
5. Ice for sample preservation and drink/food ice chest cooling
6. Pruning sheers and various hand tools
7. 5 lb sledge hammer
8. 4 wheel drive vehicle

An analytical laboratory was contracted for the analytical portions, which include the following:

- Isotopic Uranium (U^{238}, U^{235} and U^{234})
- Total Nitrogen which includes
  - Ammonia
  - Total Kjehdahl Nitrogen
  - NO_2 (Nitrite) and NO_3 (Nitrate)
- Total Phosphorous
- Fecal/E. Coli

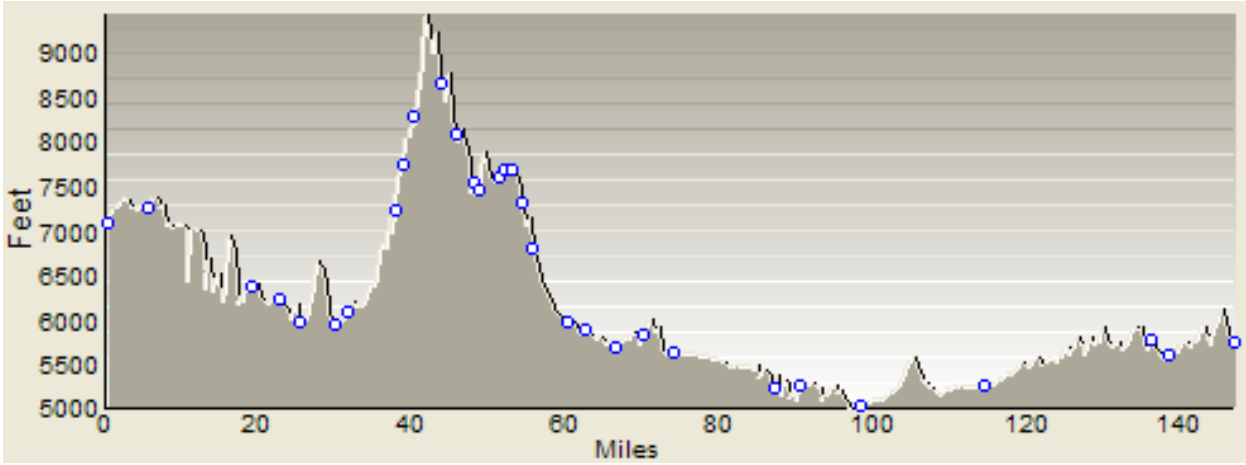
The laboratory was tasked with providing all sample containers, preservatives, coolers chains-of-custody forms and receipt of samples by the laboratory was done on Pueblo land. The sampling procedures identified in the Quality Assurance Project Plan (QAPP) approved February 2007 were followed with the exception of submerging the sample container in the water body. As can be observed from the previous site photographs it is not possible to submerge a sample container in most water bodies present on the Pueblo of Laguna Indian lands. Dipping of samples using a sterile disposable container was not appropriate. This action disturbed the sediment in the bed of the stream; therefore, a peristaltic pump was used in the collection of all surface water samples. The use of the peristaltic pump also allowed for the use of an inline 0.45 micron filter where required for field filtering which is consistent with procedures outlined in the QAPP. All samples collected for this year are for inorganic analysis therefore the use of the poly tubing will not affect the data, however as time progress and different analysis are required, Teflon tubing will be used which will not affect semi volatile or volatile organic analysis.

Physical Parameters

Surface water will be monitored for the following parameters:

- Flow rate, noted as presence or absence of water with detectable flow
- Dissolved Oxygen in percent and mg/L,
- Atmospheric pressure in Atmospheres,
- Temperature in degrees C,
- pH,
- Specific Conductance in mS/cm,
- Conductance in mS/cm,
- Resistivity in KOhm/cm,
- Oxidation Reduction Potential in mV,
- TDS in g/L
- Salinity in ppt
- Turbidity in NTU,

All attempted have been made to monitor locations on a bi-monthly basis, which has proved to be difficult given sample location dispersion, weather conditions and distance to each location. Sample collection for physical data parameters and/or analytical has proven to be non-feasible during late fall, winter and early spring months. The locations at high elevations are inaccessible due to snow and most water is frozen. The lower elevation locations are only accessible during later afternoon thawing but limited daylight make the return trip in the dark and dangerous. The following graphic show the elevation of all 30 sampling locations in feet above sea level the miles were from point to point on the map. Since the locations are not in a straight liner progression it was not possible to map them in this fashion, nor was it possible to map them in actual miles from point to point road miles. The sample location map is located in the Discussion section of this report.



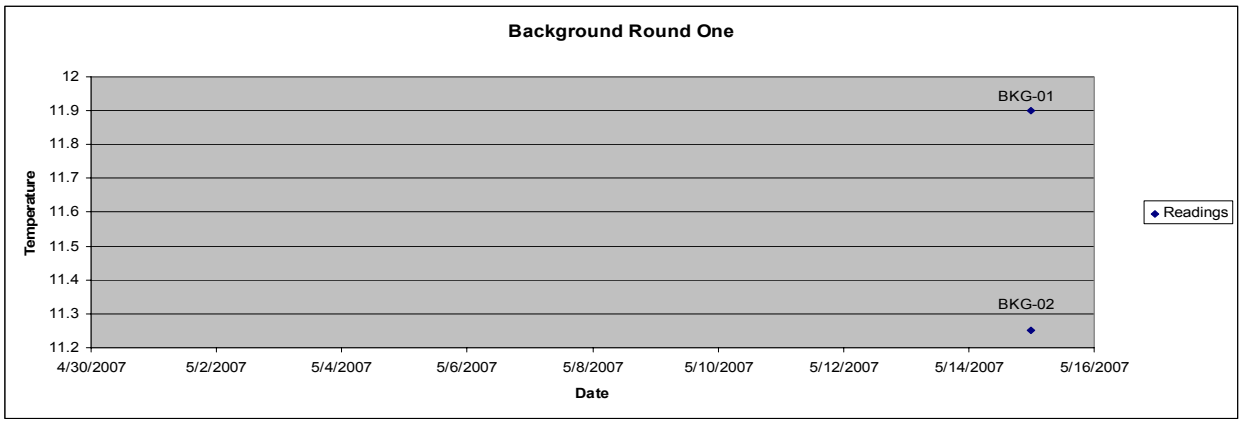
This location specific data takes into consideration areas where sewage lagoons are located close to

surface water bodies and where the potential for impact is greatest. Data from suspect locations will not be included in the “background” database. Background location had been chosen in areas where very limited impact from human activity is possible and wildlife and geologic setting are the defining factors.

Physical parameter data collection as identified in the QAPP, is to be collected on a bi-monthly basis, however this has proven to be problematic. Many locations are not accessible at all times and those with cultural/religious uses are not accessible during these types of functions. Weather is a major factor in determining access to a location. Hot summer days and high evapotransporation rates diminish flow in shallow surface water bodies to damp soil in many of the locations; however, these locations are important and are retained as locations. These conditions are noted and recorded in the logbook and noted in the Quarterly Progress Reports.

When ever possible physical parameters and analytical sample collection are combined to save time and improve field efficiency.

Background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11.8
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11.6
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11.3
11.2
BKG-01
BKG-02
4/30/2007
5/2/2007
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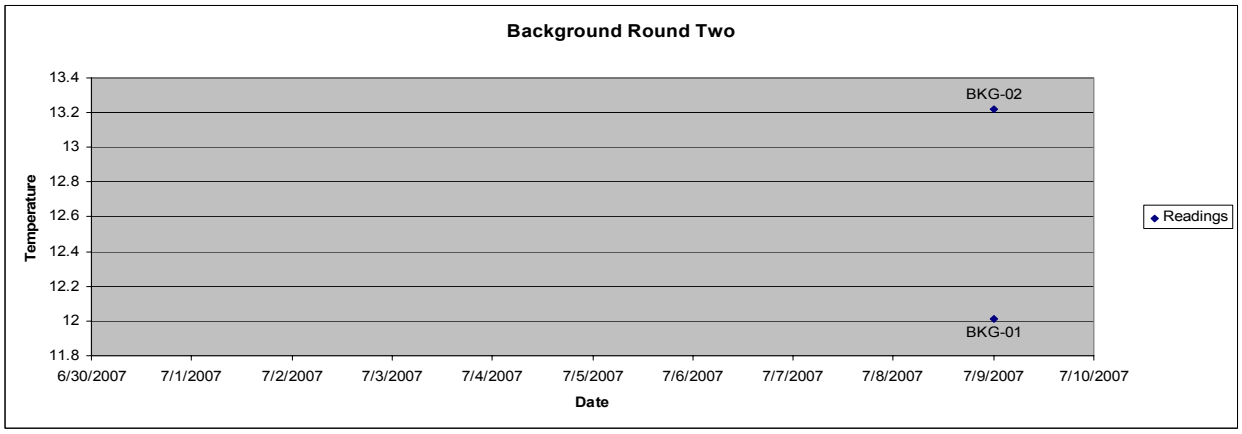
Date
Readings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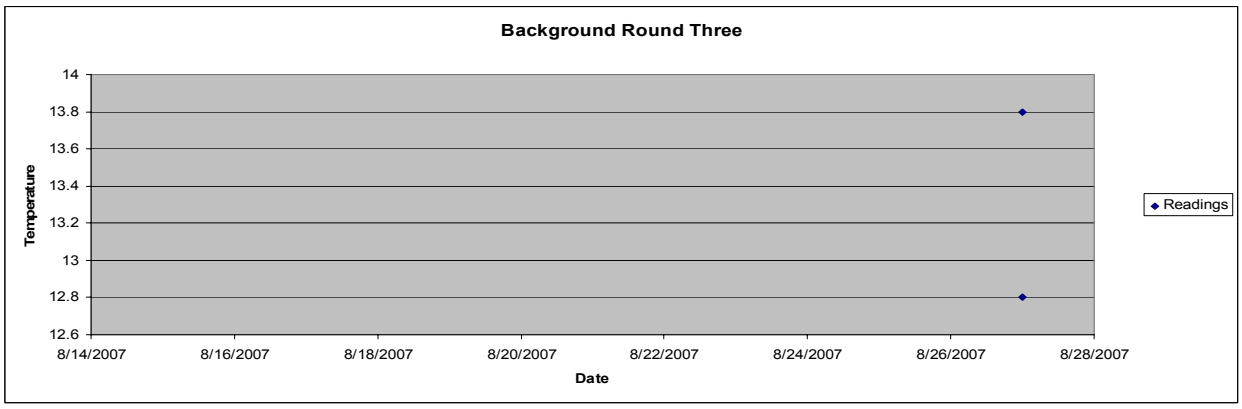
Date
Readings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13.8
13.6
13.4
13.2
13
12.8
12.6
8/14/2007
8/16/2007
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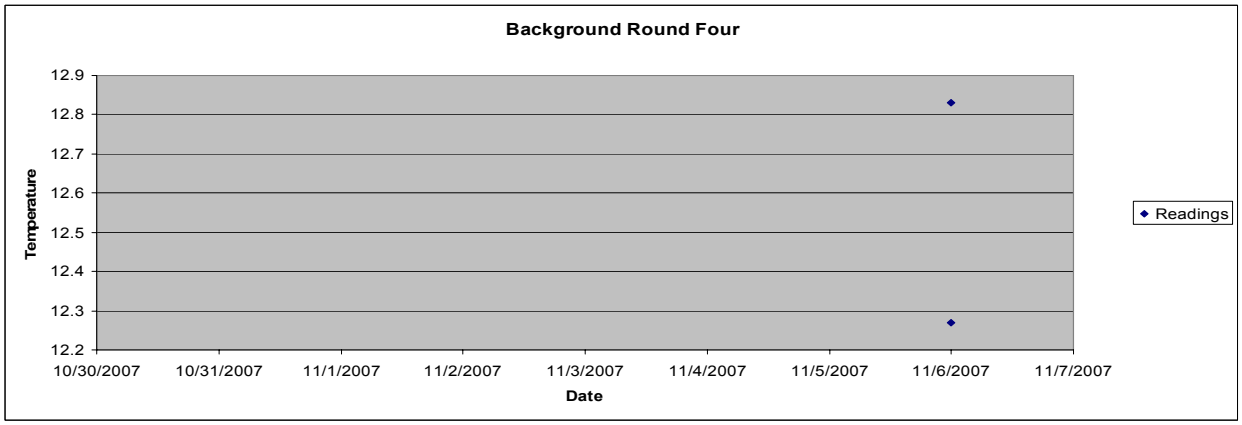
Date
Readings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Temperature
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12.8
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12.6
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12.3
12.2
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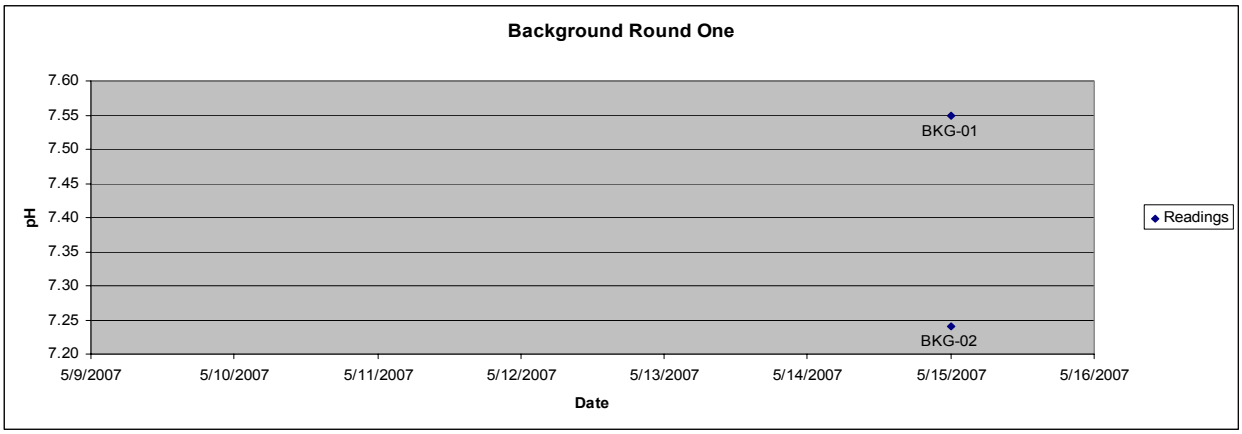
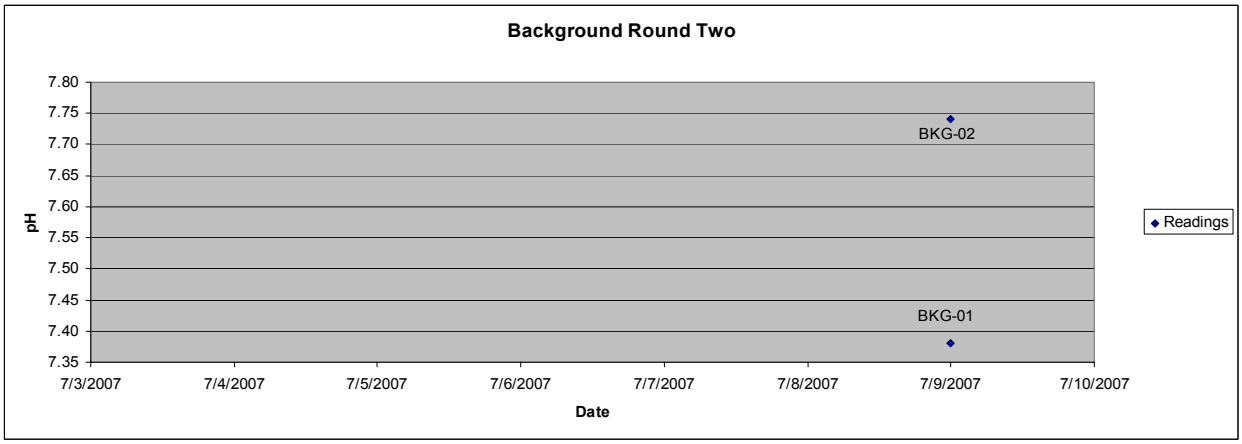
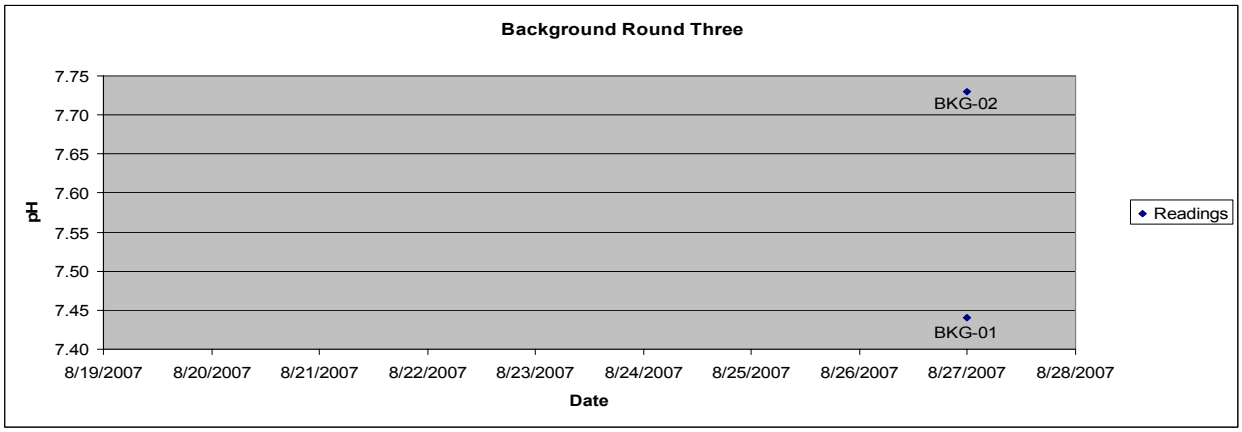
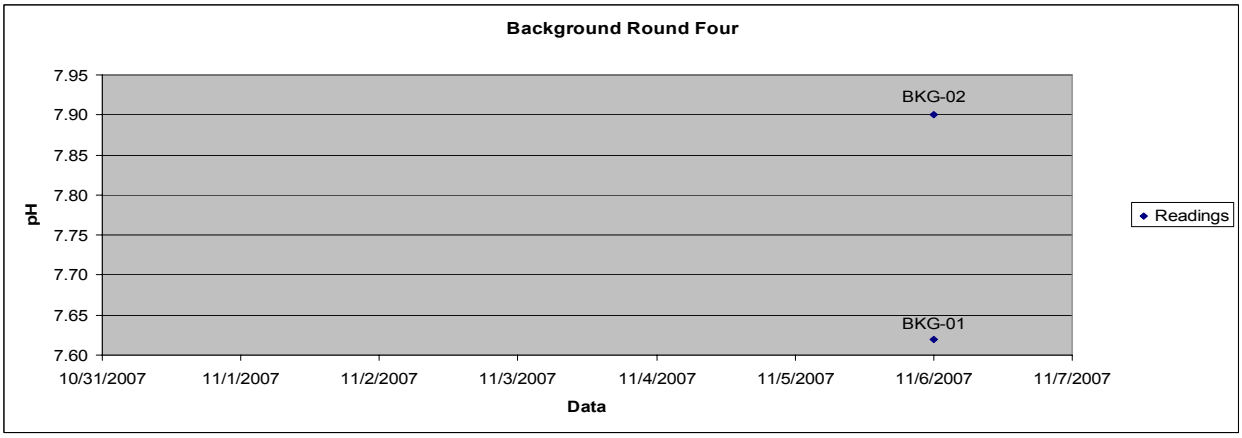
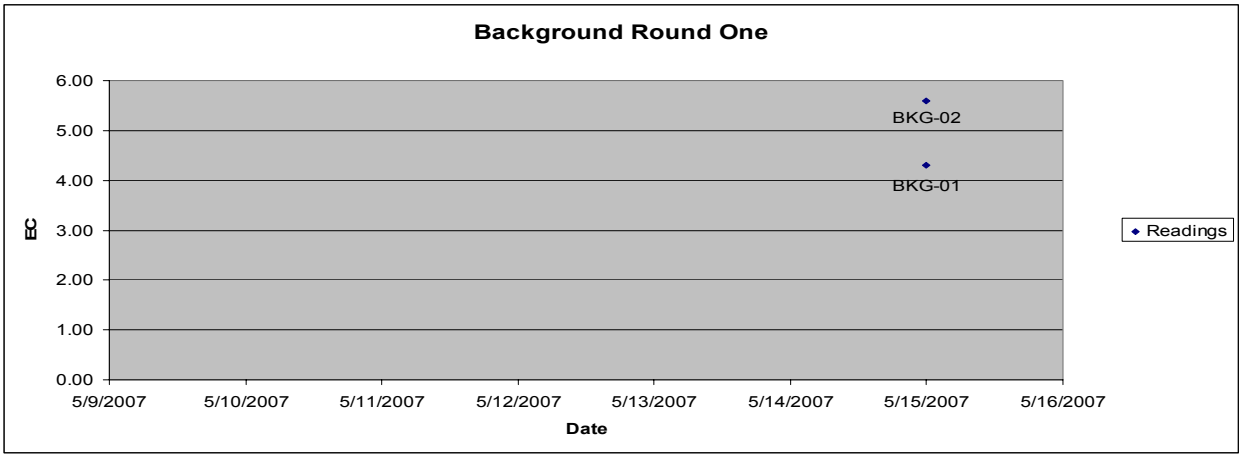
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date
Readings

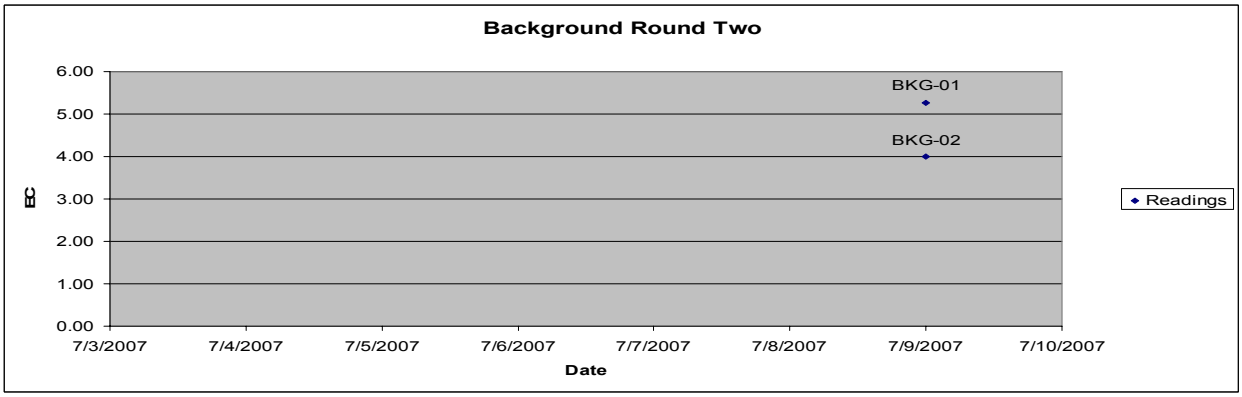

Background Round One
7.60
7.55
7.50
7.45
7.40
7.35
7.30
7.25
7.20
pH
BKG-01
BKG-02
Readings
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date

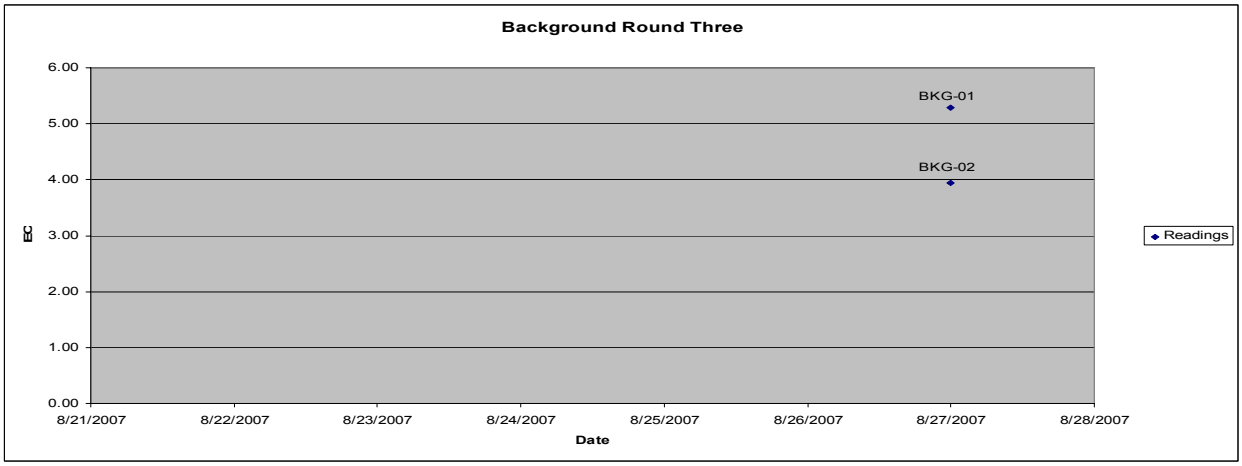

Background Round Two
7.80
7.75
7.70
7.65
7.60
7.55
7.50
7.45
7.40
7.35
pH
BKG-02
BKG-01
Readings
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date

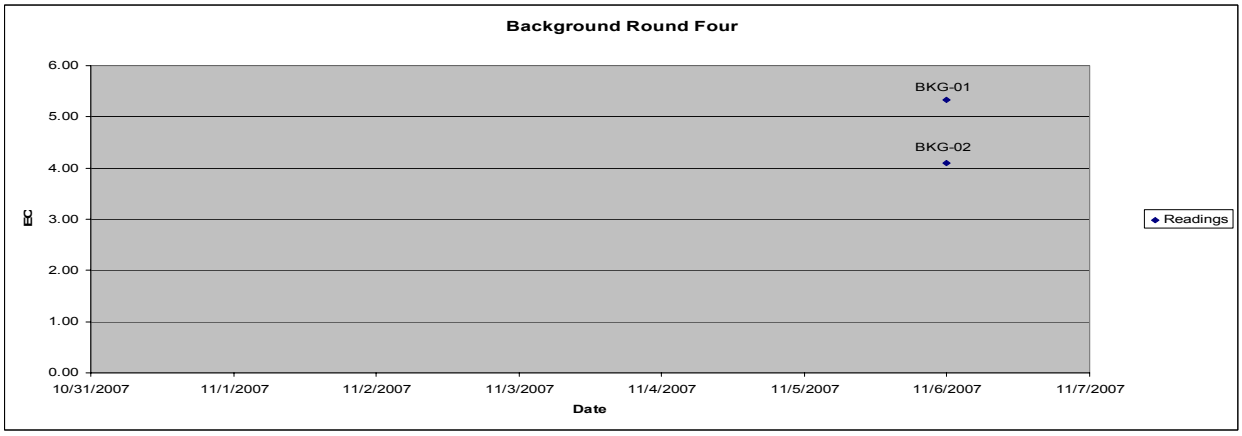

Background Round Three
7.75
7.70
7.65
7.60
7.55
7.50
7.45
7.40
pH
BKG-02
BKG-01
Readings
8/19/2007
8/20/2007
8/21/2007
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
Date

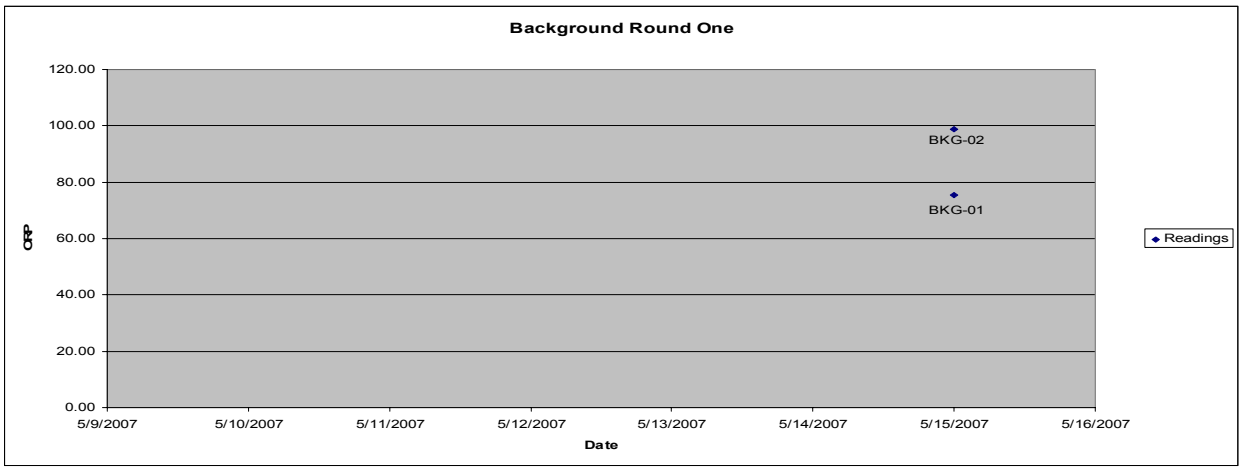

Background Round Four
7.95
7.90
7.85
7.80
7.75
7.70
7.65
7.60
pH
BKG-02
BKG-01
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Data

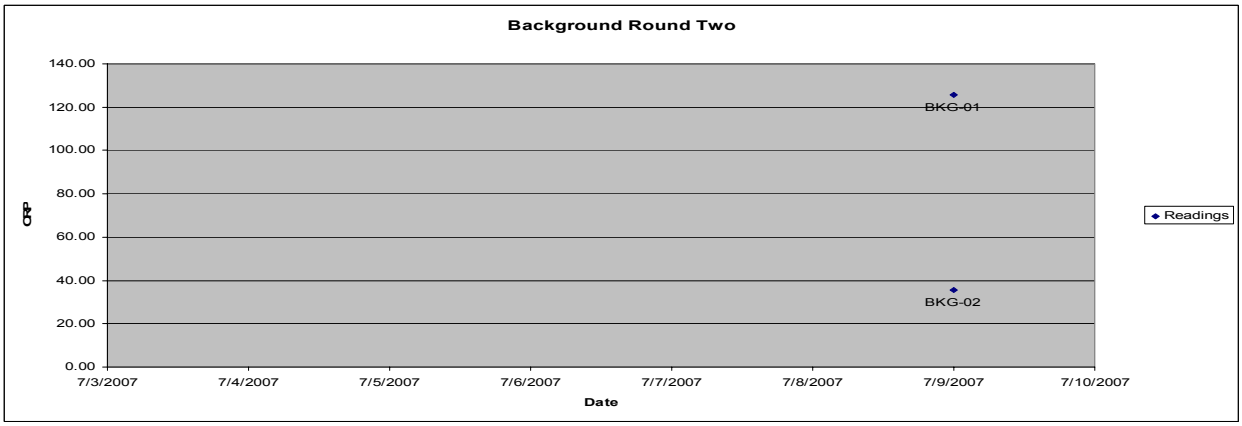

Background Round One
6.00
5.00
4.00
3.00
2.00
1.00
0.00
EC
BKG-02
BKG-01
Readings
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date

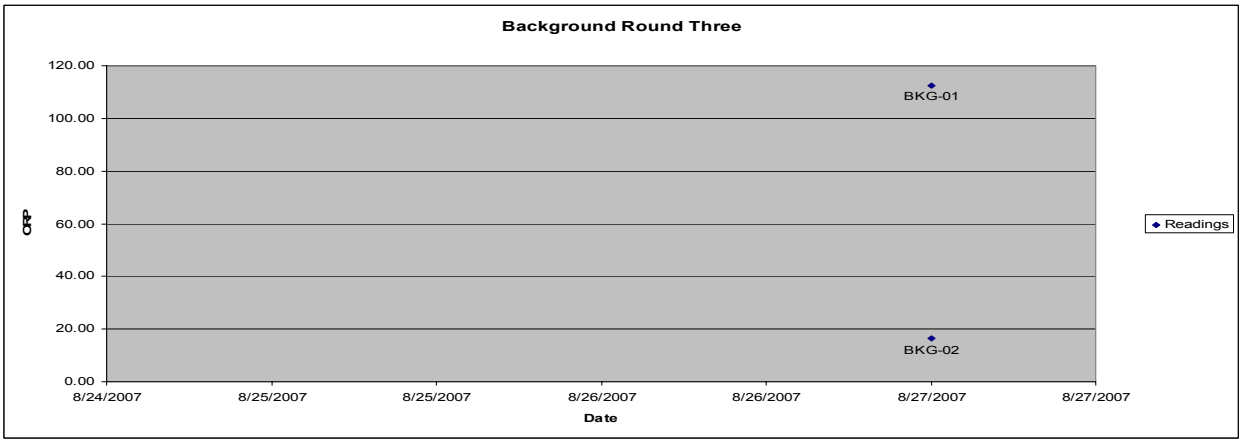

Background Round Two
6.00
5.00
4.00
3.00
2.00
1.00
0.00
EC
BKG-01
BKG-02
Readings
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date

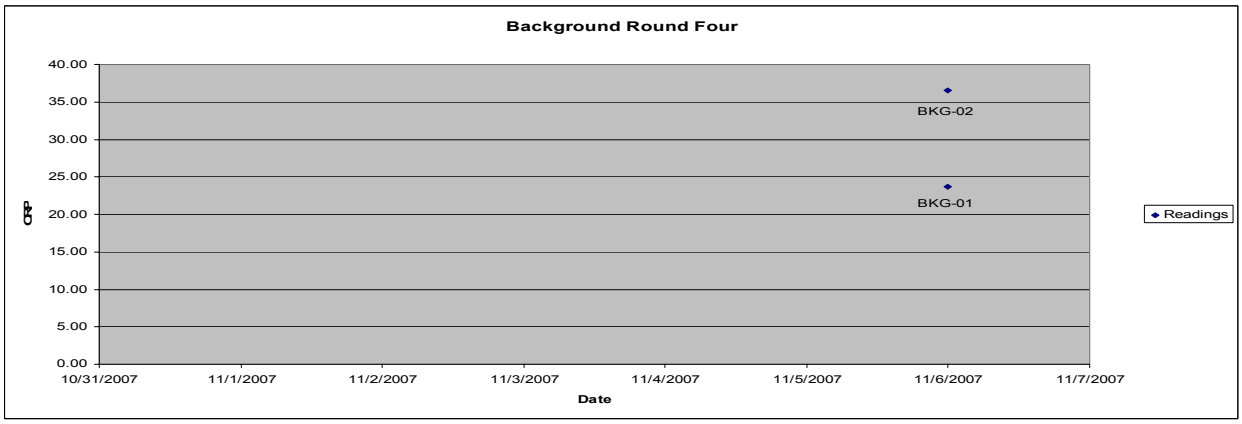

Background Round Three
6.00
5.00
4.00
3.00
2.00
1.00
0.00
EC
BKG-01
BKG-02
Readings
8/21/2007
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
Date

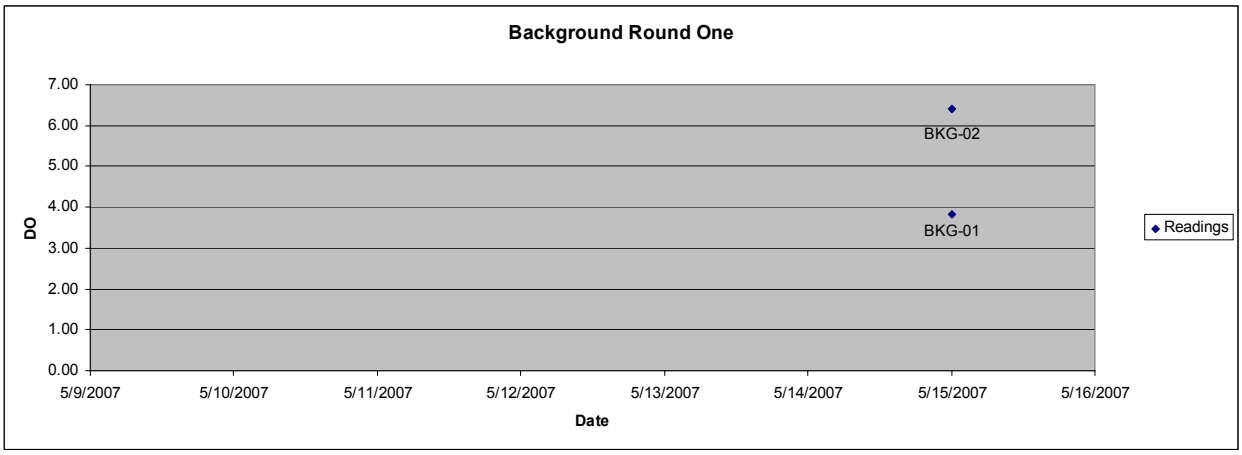

Background Round Four
6.00
5.00
4.00
3.00
2.00
1.00
0.00
EC
BKG-01
BKG-02
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date

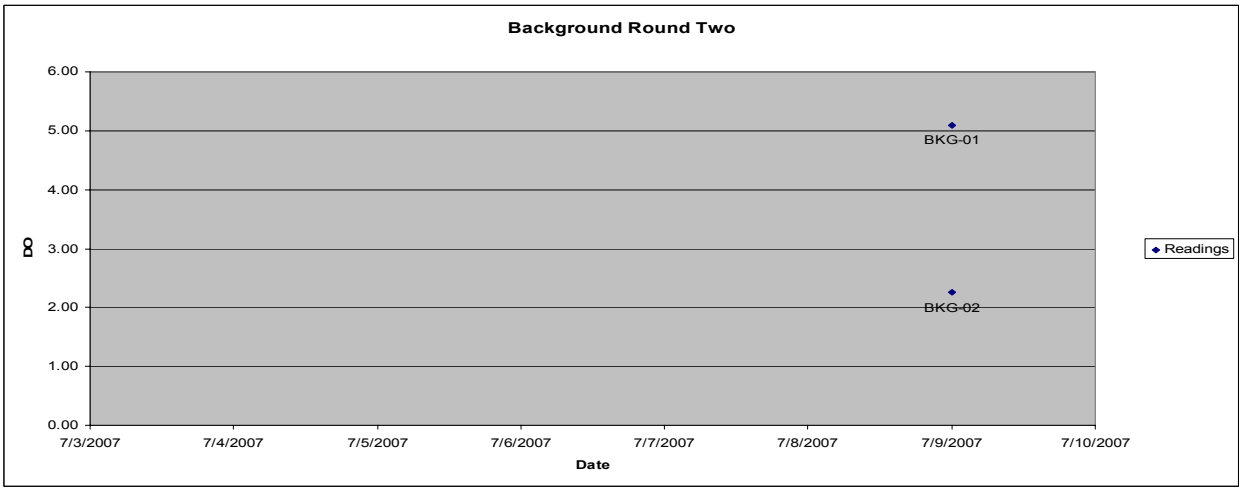

Background Round One
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
BKG-02
BKG-01
Readings
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date

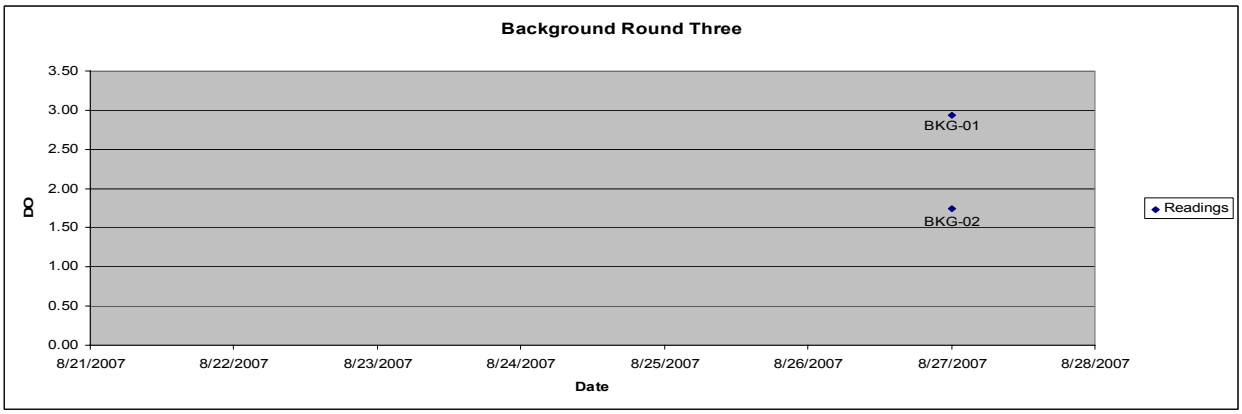

Background Round Two
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
BKG-01
BKG-02
Readings
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date

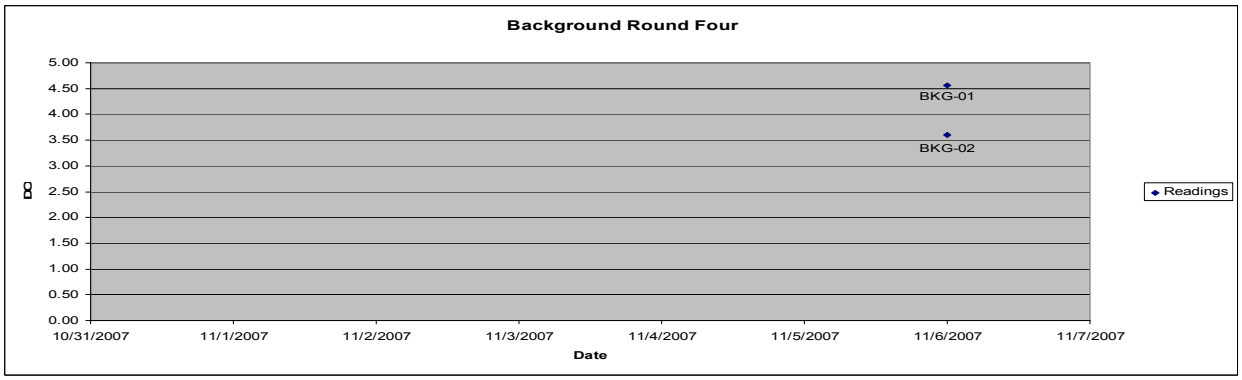

Background Round Three
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
BKG-01
BKG-02
Readings
8/24/2007
8/25/2007
8/25/2007
8/26/2007
8/26/2007
8/27/2007
8/27/2007
Date

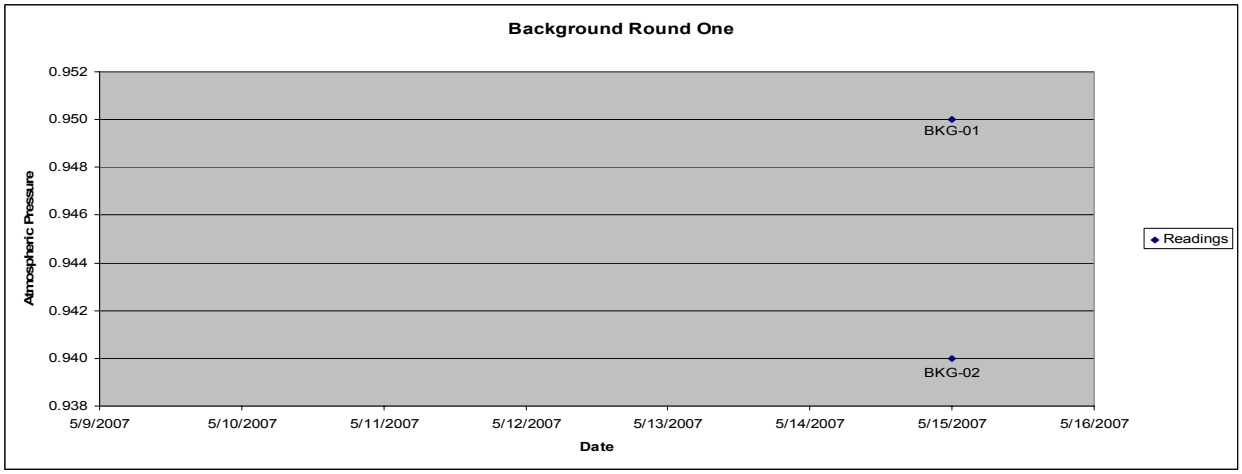

Background Round Four
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
ORP
BKG-02
BKG-01
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date

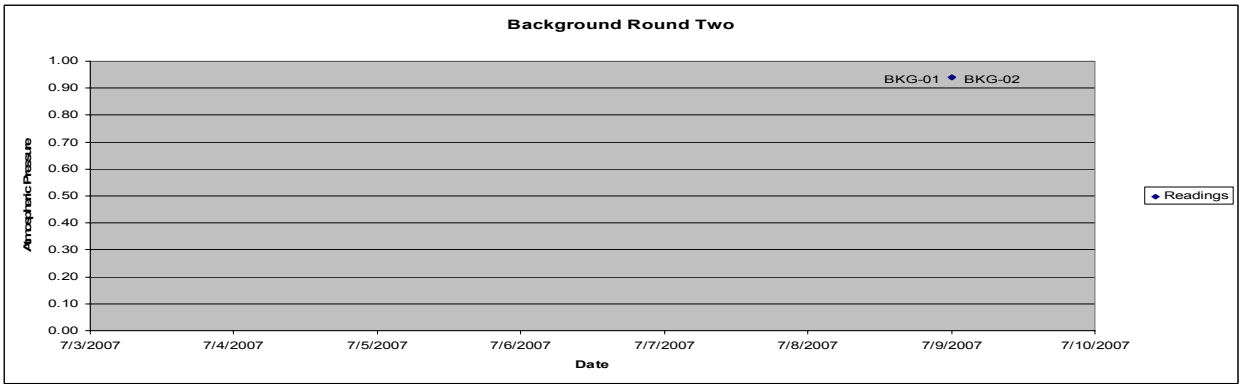

Background Round One
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DO
BKG-02
BKG-01
Readings
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date

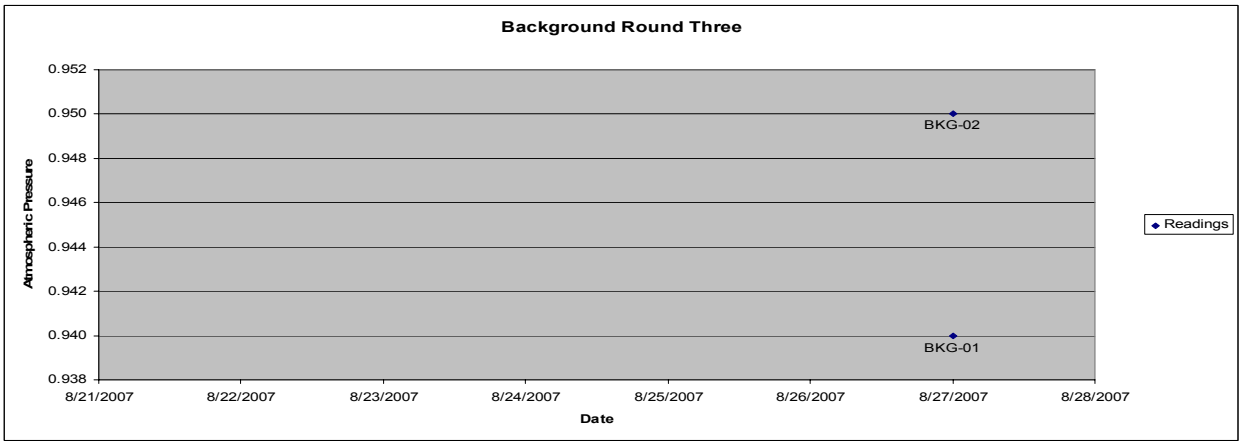

Background Round Two
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DO
BKG-01
BKG-02
Readings
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date

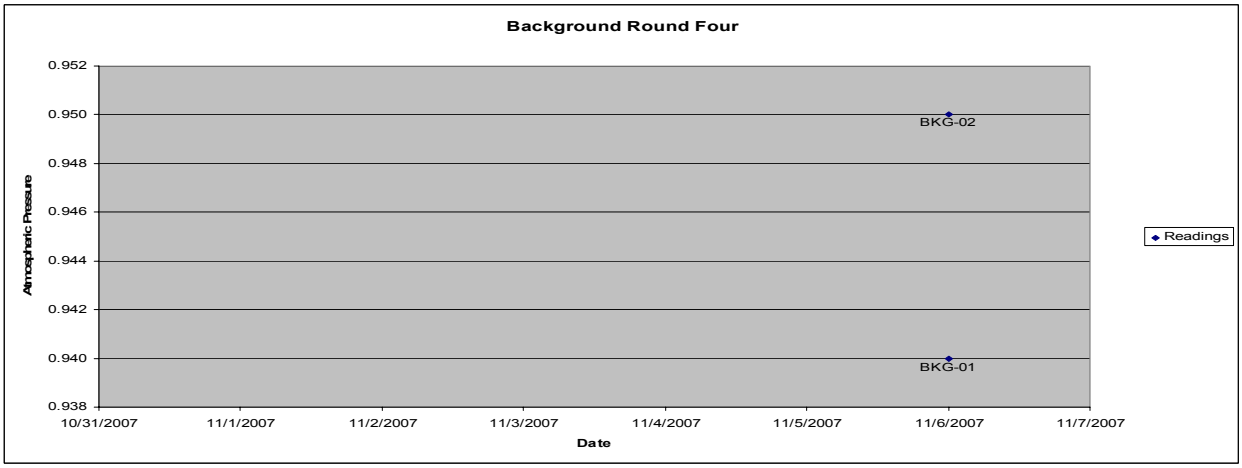

Background Round Three
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
DO
BKG-01
BKG-02
Readings
8/21/2007
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
Date

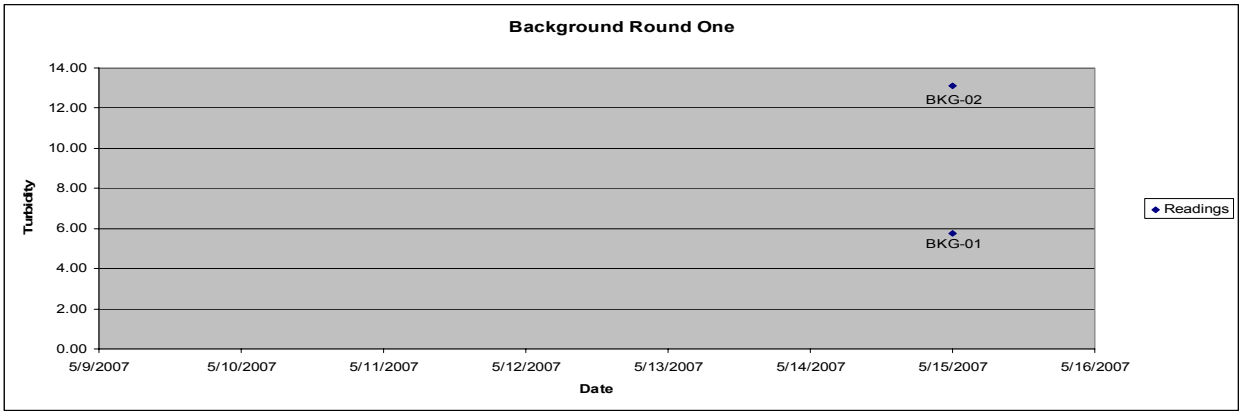

Background Round Four
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
DO
BKG-01
BKG-02
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date

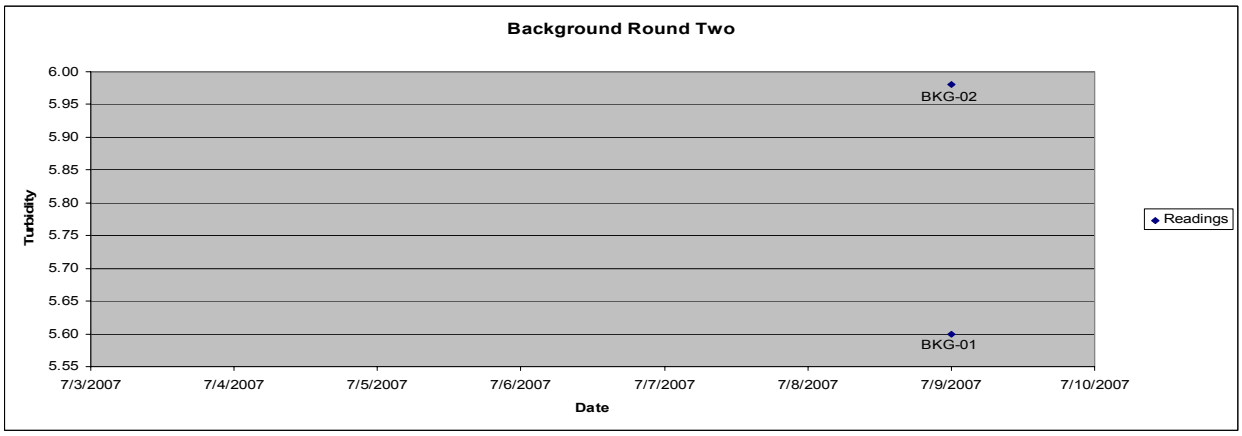

Background Round One
Atmospheric Pressure
0.952
0.950
0.948
0.946
0.944
0.942
0.940
0.938
BKG-01
BKG-02
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date
Readings

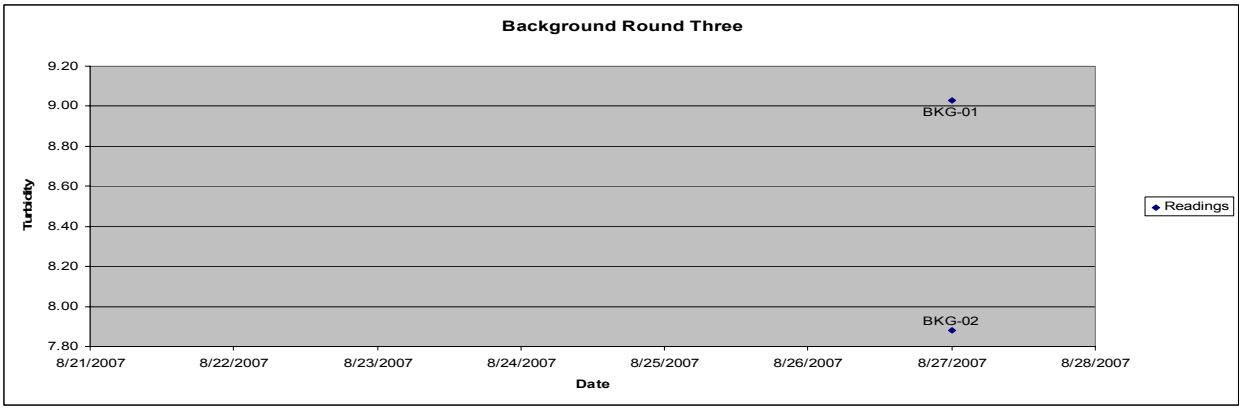

Background Round Two
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
BKG-01
BKG-02
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date
Readings

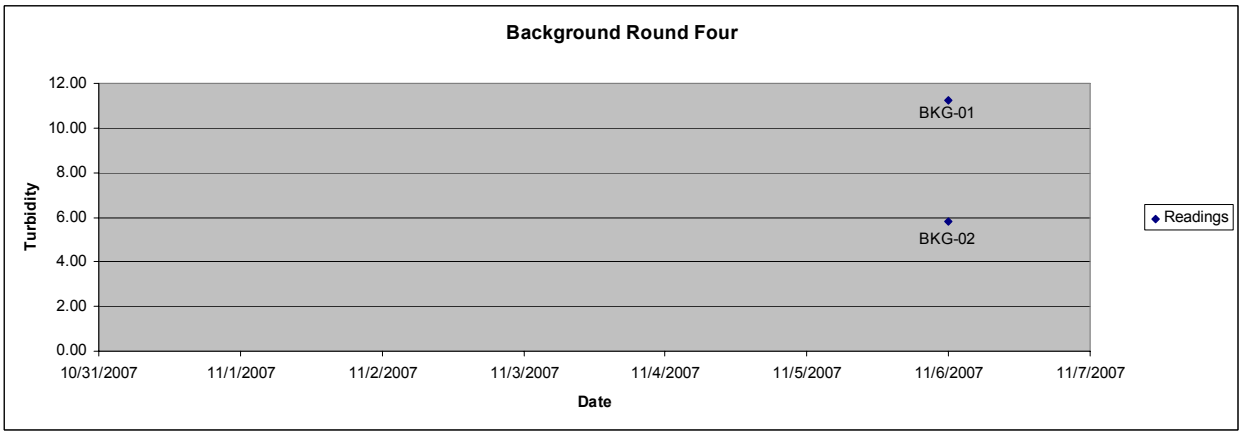

Background Round Three
Atmospheric Pressure
0.952
0.950
0.948
0.946
0.944
0.942
0.940
0.938
BKG-02
BKG-01
8/21/2007
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
Date
Readings


Background Round Four
Atmospheric Pressure
0.952
0.950
0.948
0.946
0.944
0.942
0.940
0.938
BKG-02
BKG-01
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date
Readings

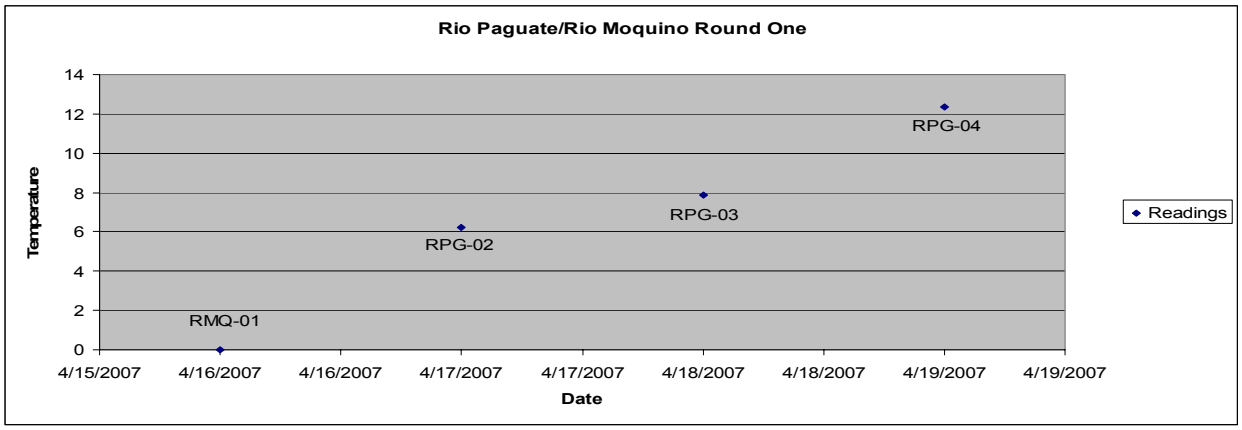

Background Round One
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Turbidity
BKG-02
BKG-01
Readings
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
5/16/2007
Date

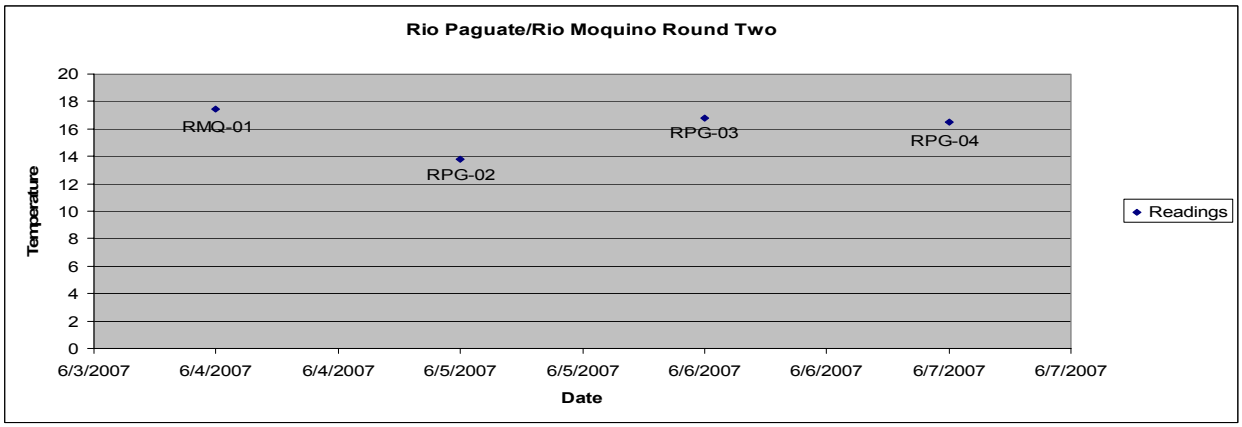

Background Round Two
6.00
5.95
5.90
5.85
5.80
5.75
5.70
5.65
5.60
5.55
Turbidity
BKG-02
BKG-01
Readings
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
Date

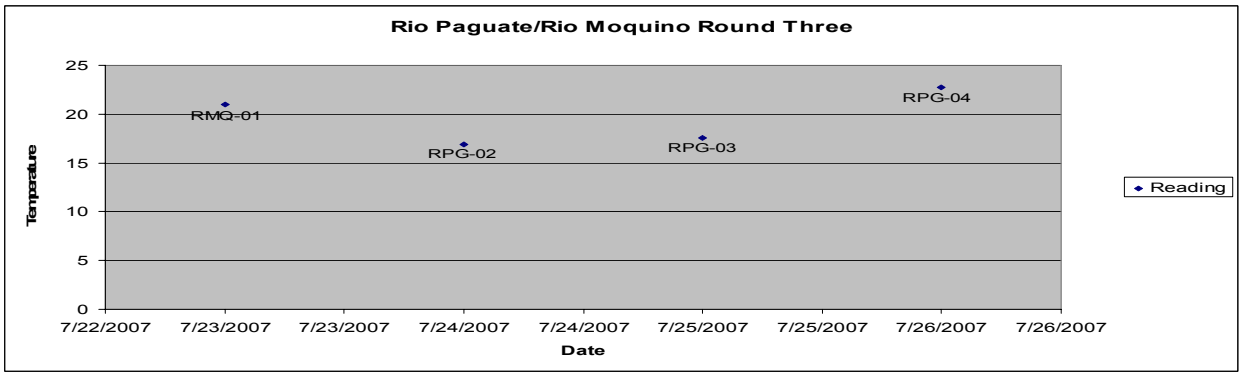

Background Round Three
9.20
9.00
8.80
8.60
8.40
8.20
8.00
7.80
Turbidity
BKG-01
BKG-02
Readings
8/21/2007
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
Date

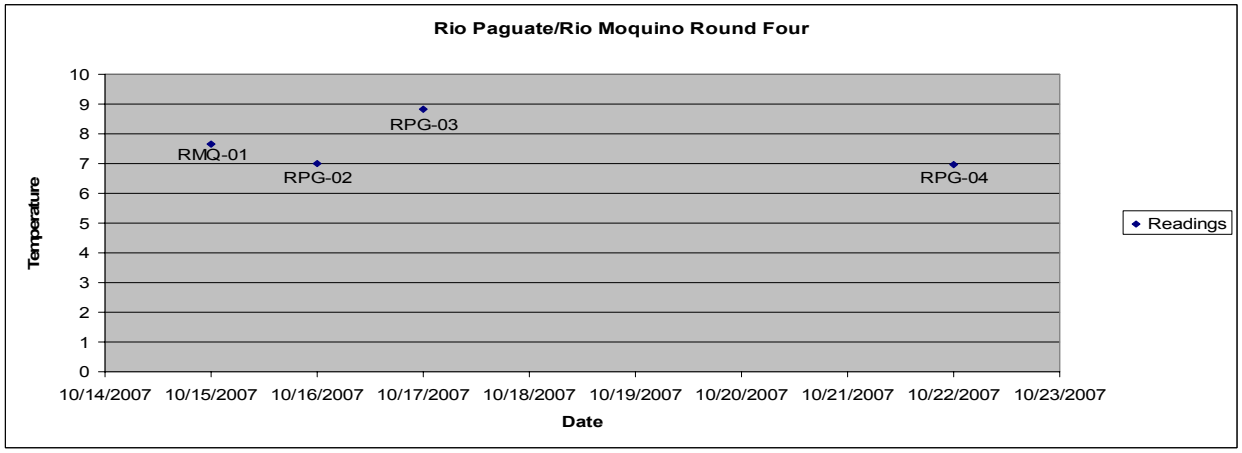

Background Round Four
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Turbidity
BKG-01
BKG-02
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
Date

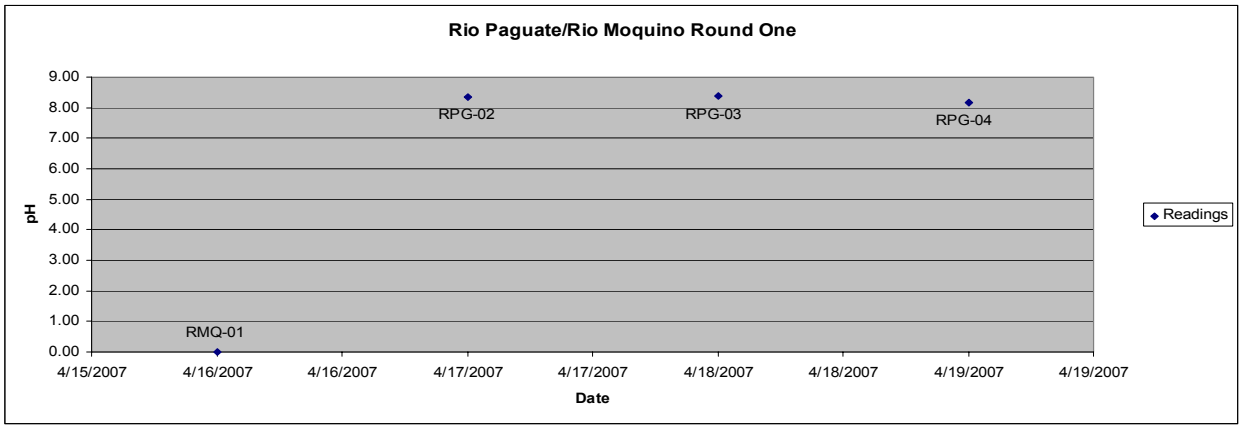
Rio Paguate/Rio Moquino

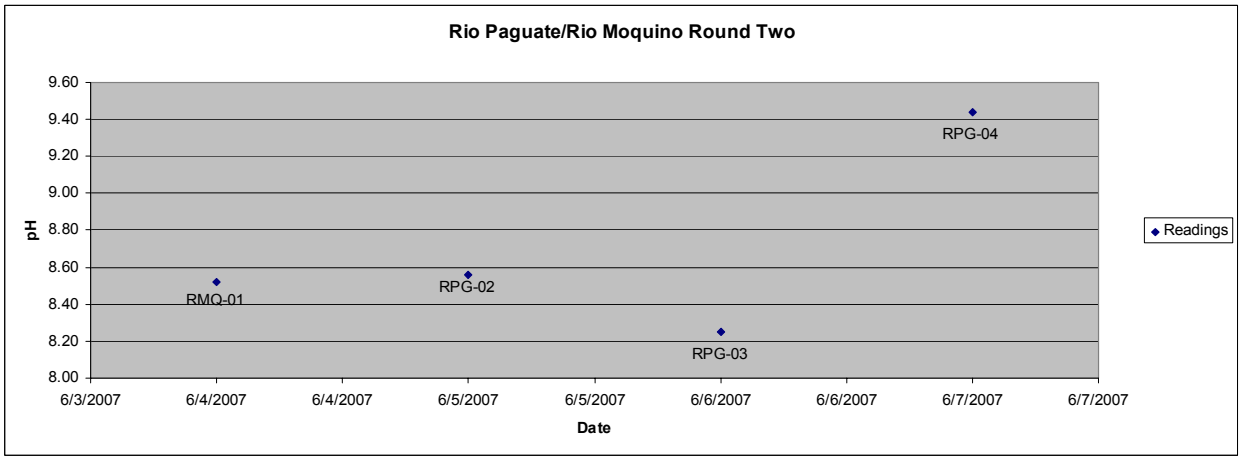


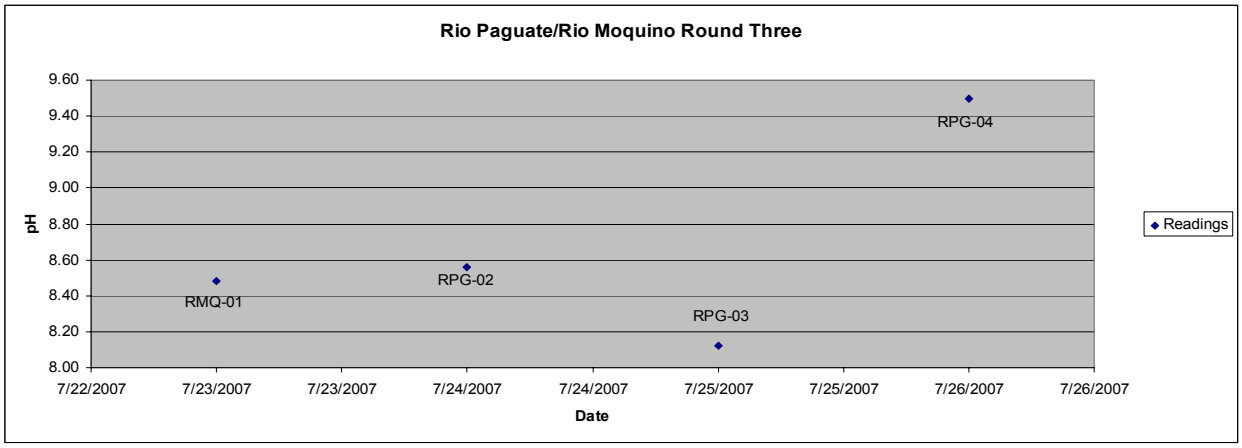


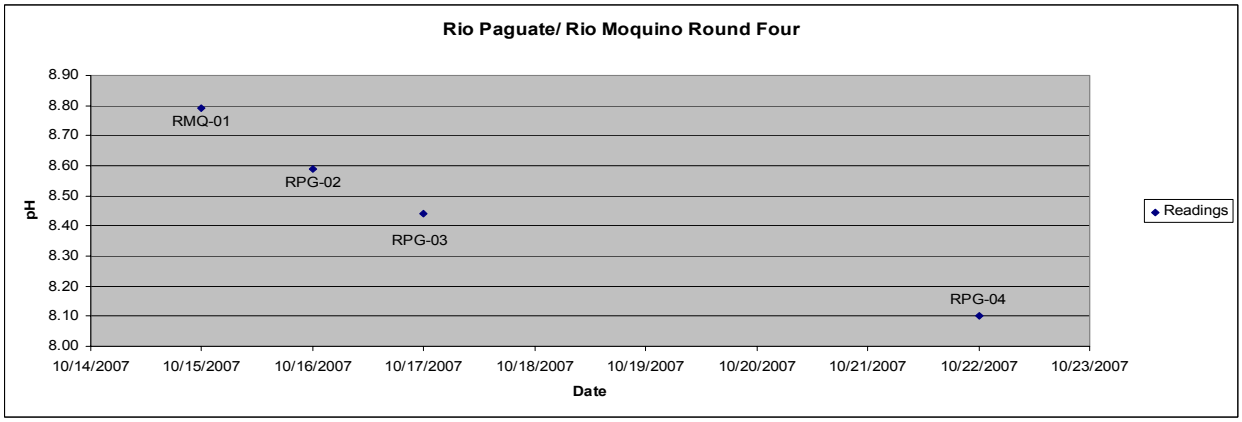


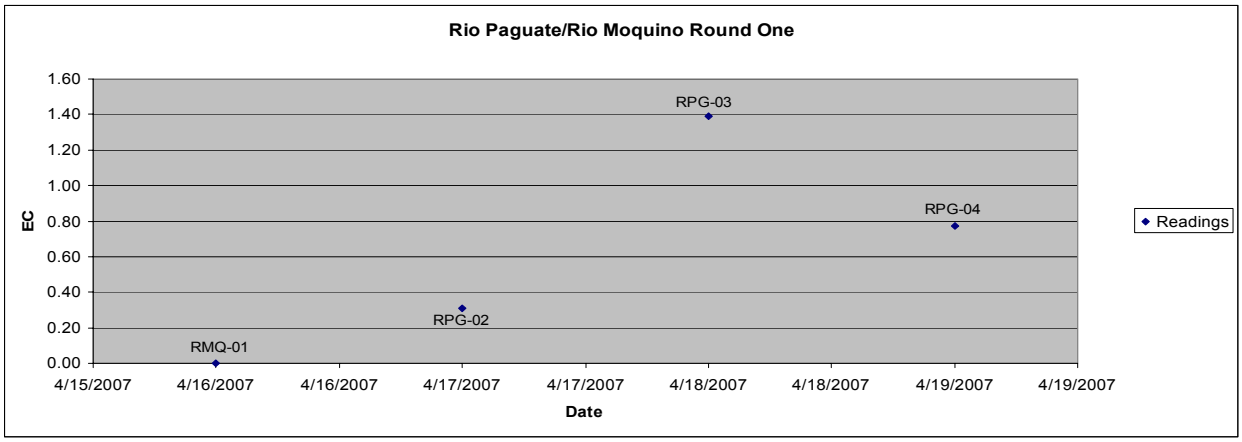


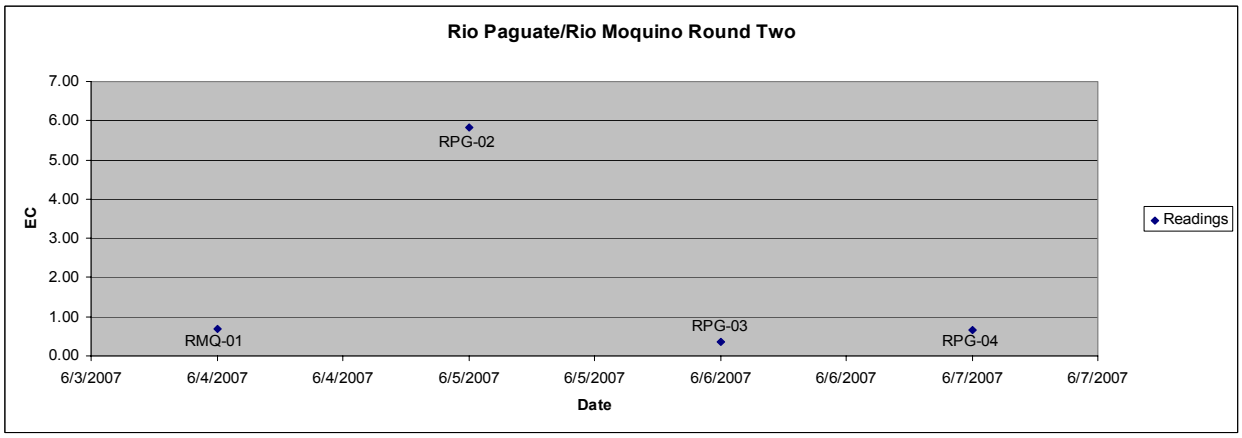

Rio Paguate/Rio Moquino Round One
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
RPG-02
RPG-03
RPG-04
RMQ-01
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007
Date
Readings

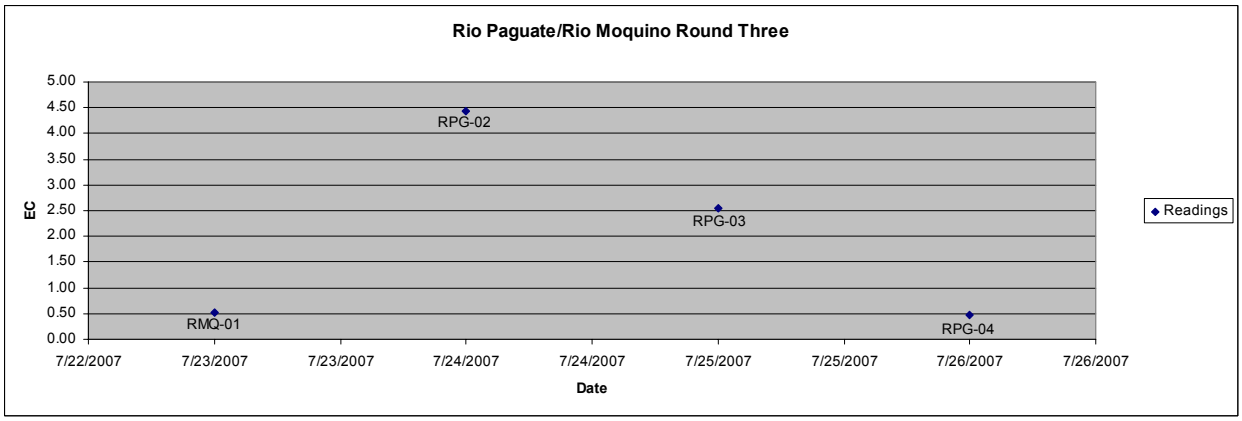

Rio Paguate/Rio Moquino Round Two
9.60
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
pH
RPG-04
RMQ-01
RPG-02
RPG-03
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007
Date
Readings

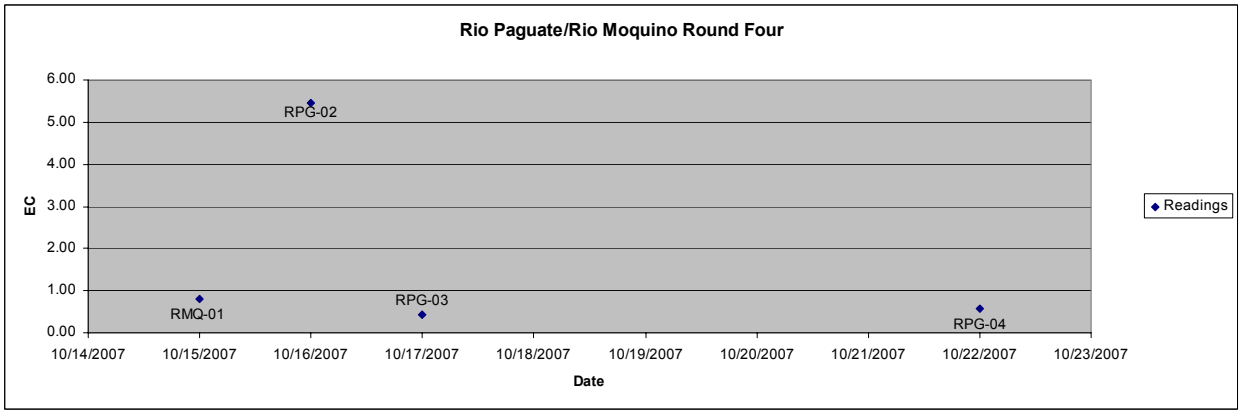

Rio Paguate/Rio Moquino Round Three
9.60
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
pH
RPG-04
RPG-02
RMQ-01
RPG-03
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007
Date
Readings

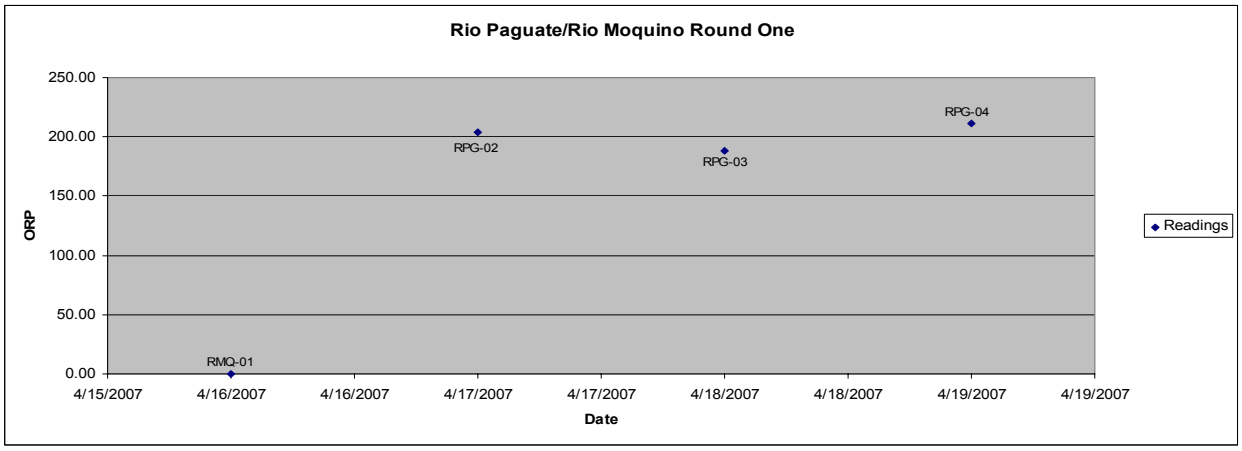

Rio Paguate/ Rio Moquino Round Four
8.90
8.80
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
pH
RMQ-01
RPG-02
RPG-03
RPG-04
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007
Date
Readings

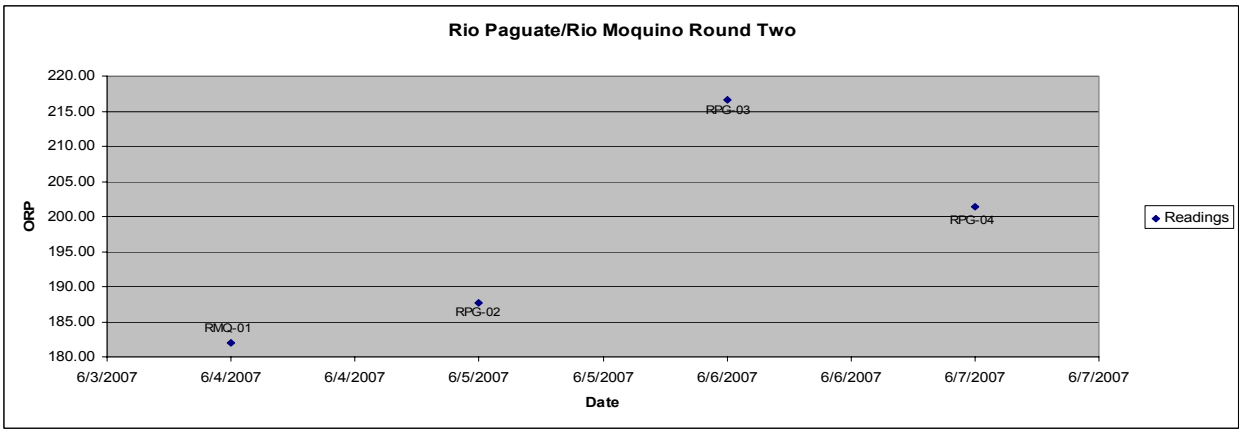

Rio Paguate/Rio Moquino Round One
EC
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPG-03
RPG-04
RPG-02
RMQ-01
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007
Date
Readings

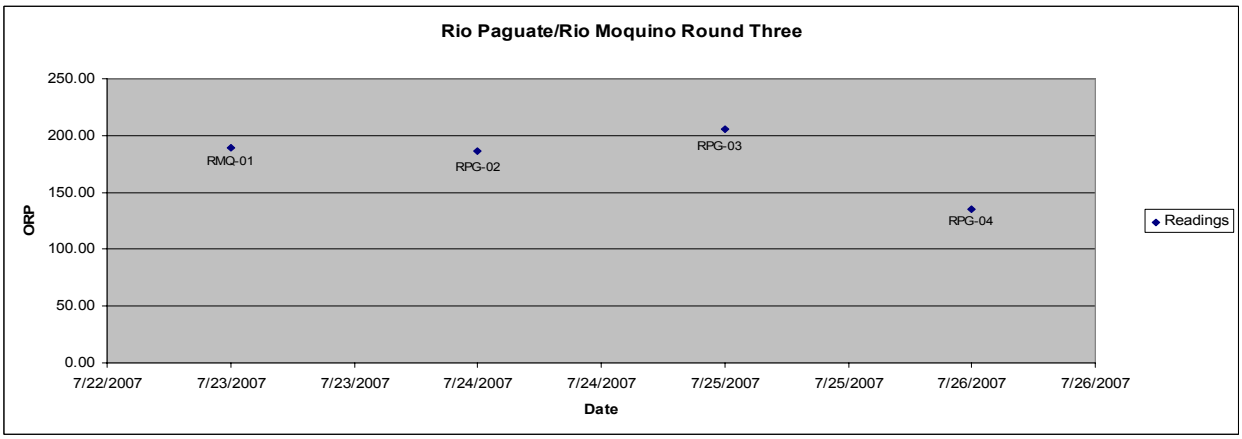

Rio Paguate/Rio Moquino Round Two
EC
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RPG-02
RMQ-01
RPG-03
RPG-04
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007
Date
Readings

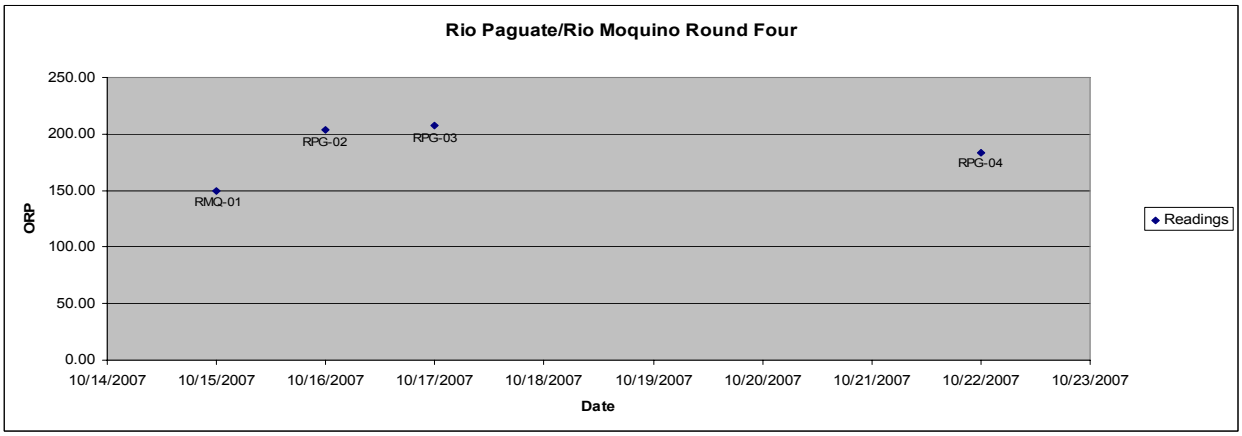

Rio Paguate/Rio Moquino Round Three
EC
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
RPG-02
RPG-03
RMQ-01
RPG-04
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007
Date
Readings

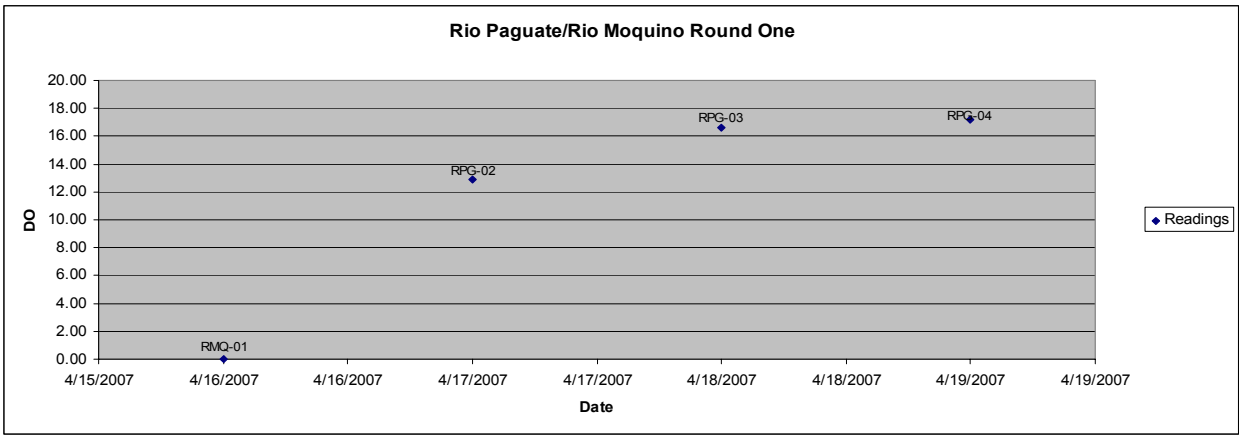

Rio Paguate/Rio Moquino Round Four
EC
6.00
5.00
4.00
3.00
2.00
1.00
0.00
RPG-02
RMQ-01
RPG-03
RPG-04
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007
Date
Readings

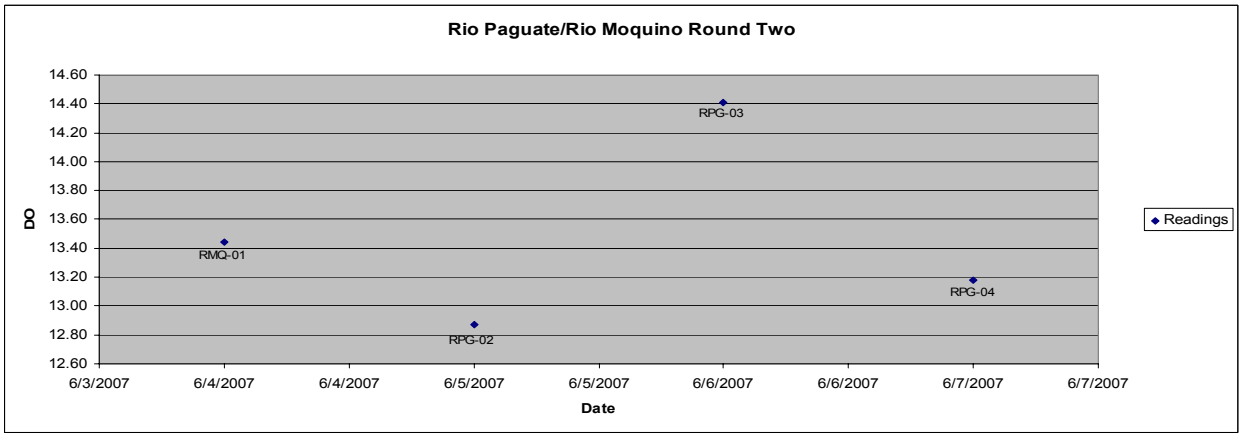

Rio Paguate/Rio Moquino Round One
250.00
200.00
150.00
100.00
50.00
0.00
ORP
RMQ-01
RPG-02
RPG-03
RPG-04
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007
Date
Readings

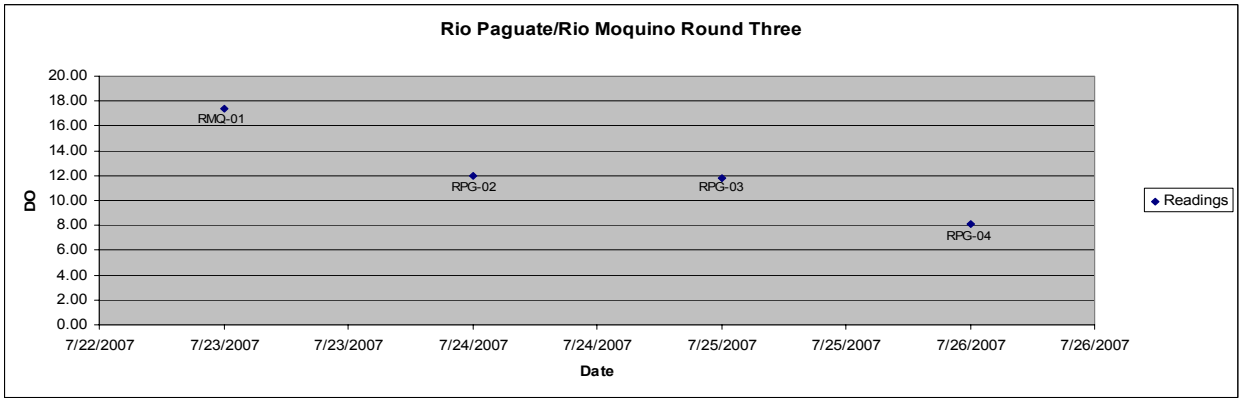

Rio Paguate/Rio Moquino Round Two
220.00
215.00
210.00
205.00
200.00
195.00
190.00
185.00
180.00
ORP
RMQ-01
RPG-02
RPG-03
RPG-04
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007
Date
Readings

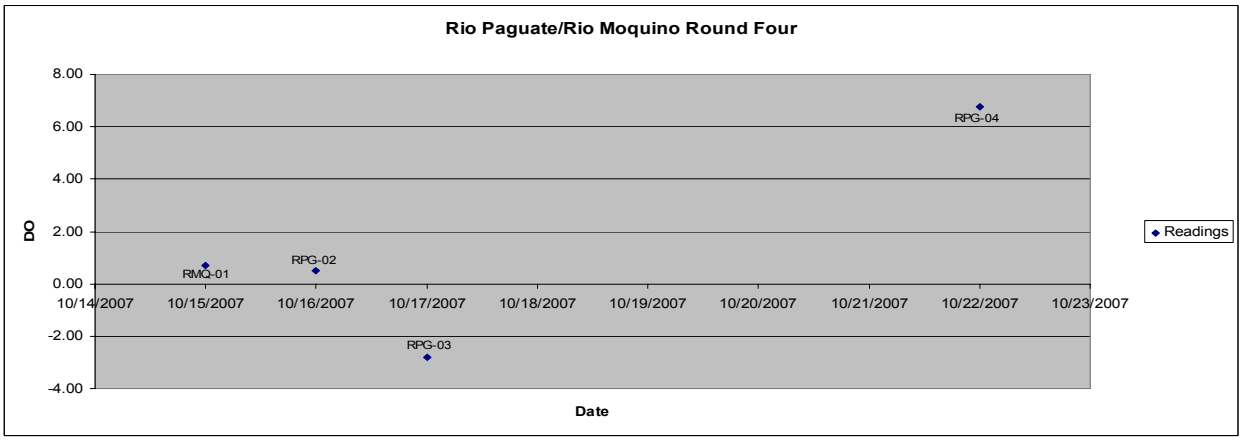

Rio Paguate/Rio Moquino Round Three
250.00
200.00
150.00
100.00
50.00
0.00
ORP
RMQ-01
RPG-02
RPG-03
RPG-04
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007
Date
Readings

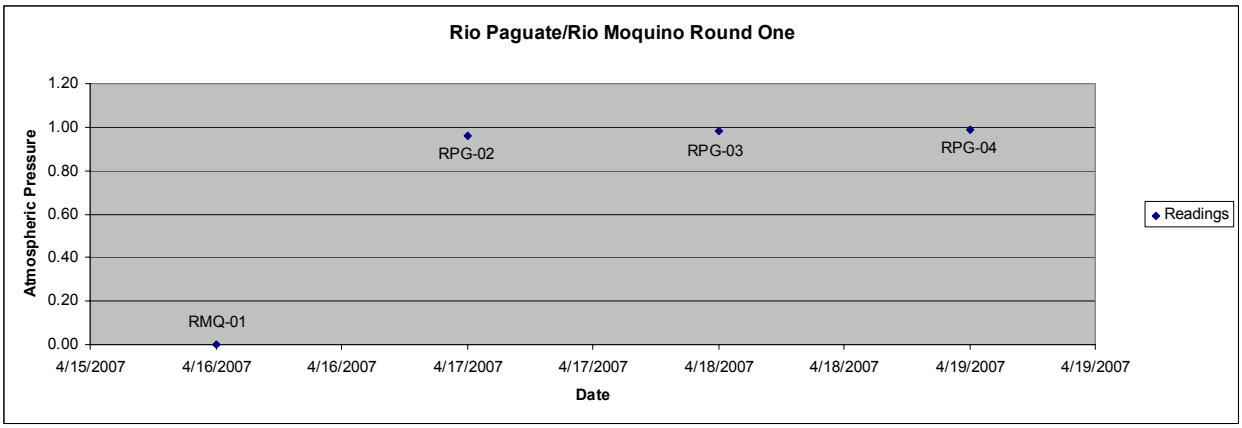

Rio Paguate/Rio Moquino Round Four
250.00
200.00
150.00
100.00
50.00
0.00
ORP
RMQ-01
RPG-02
RPG-03
RPG-04
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007
Date
Readings

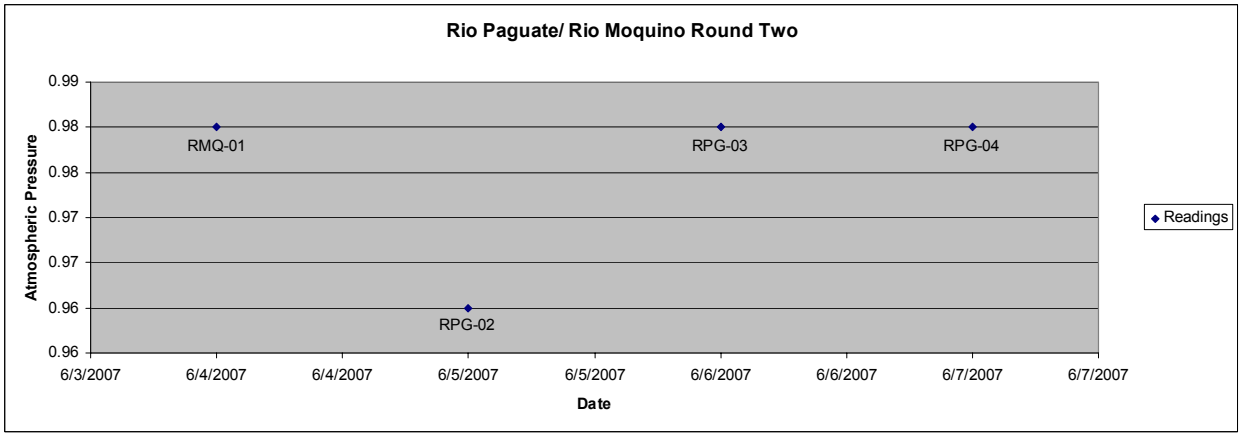

Rio Paguate/Rio Moquino Round One
DO
Date
Readings
RMQ-01
RPG-02
RPG-03
RPG-04
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007

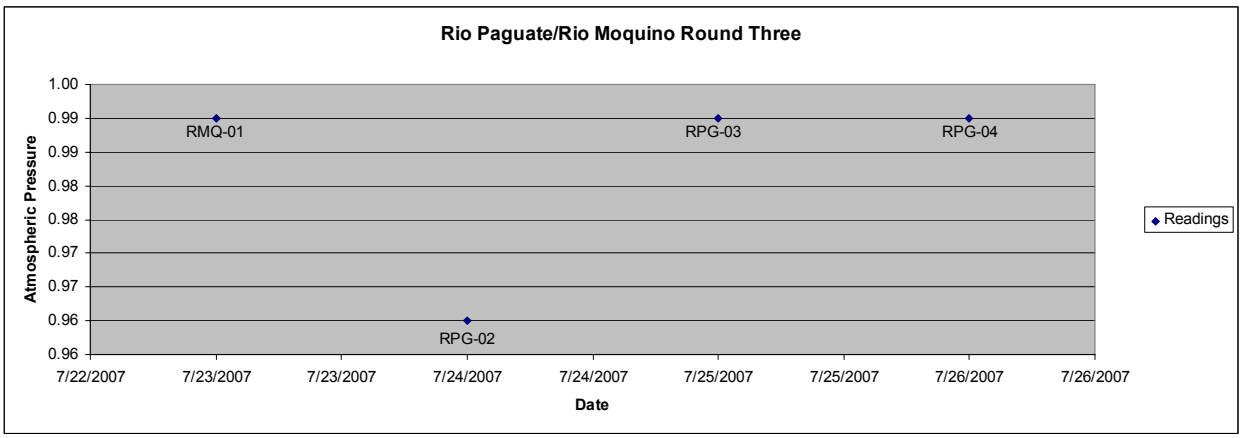

Rio Paguate/Rio Moquino Round Two
DO
Date
Readings
RMQ-01
RPG-02
RPG-03
RPG-04
14.60
14.40
14.20
14.00
13.80
13.60
13.40
13.20
13.00
12.80
12.60
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007

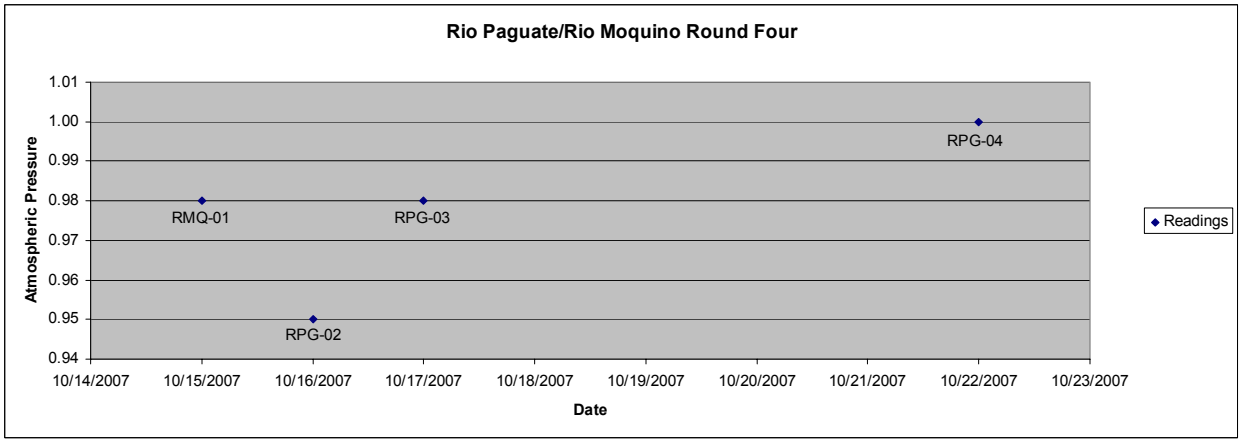

Rio Paguate/Rio Moquino Round Three
DO
Date
Readings
RMQ-01
RPG-02
RPG-03
RPG-04
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007

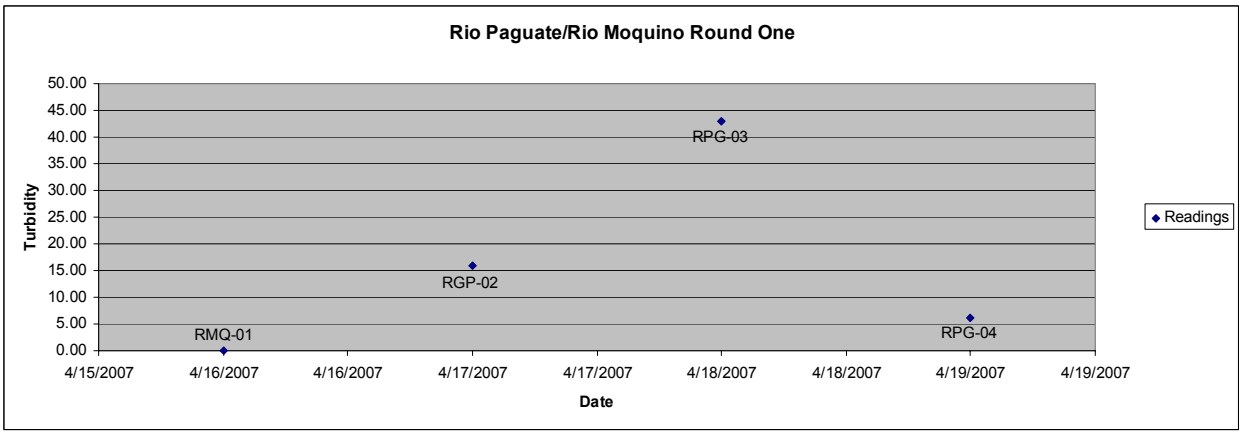

Rio Paguate/Rio Moquino Round Four
DO
Date
Readings
RMQ-01
RPG-02
RPG-03
RPG-04
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007

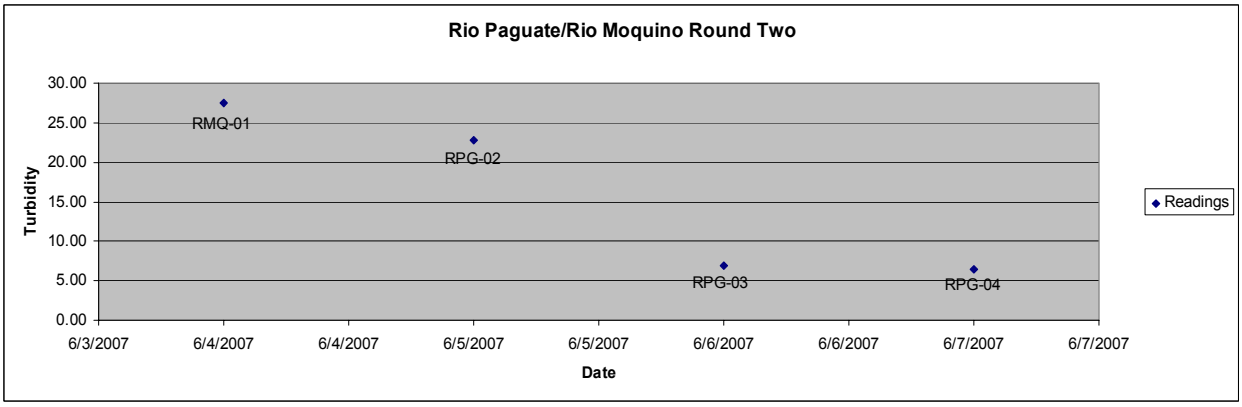

Rio Paguate/Rio Moquino Round One
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007
Date
Readings

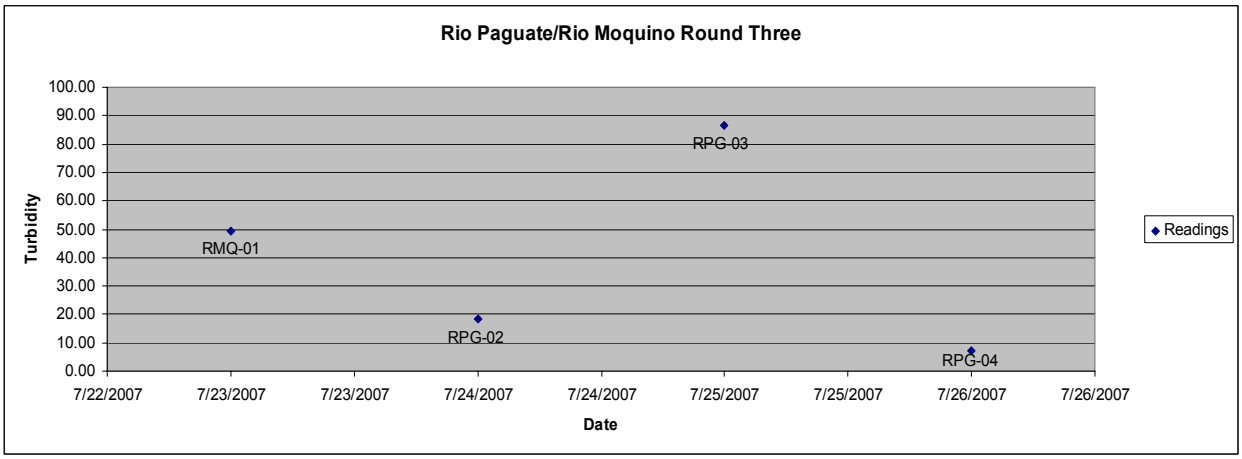

Rio Paguate/ Rio Moquino Round Two
Atmospheric Pressure
0.99
0.98
0.98
0.97
0.97
0.96
0.96
RMQ-01
RPG-02
RPG-03
RPG-04
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007
Date
Readings

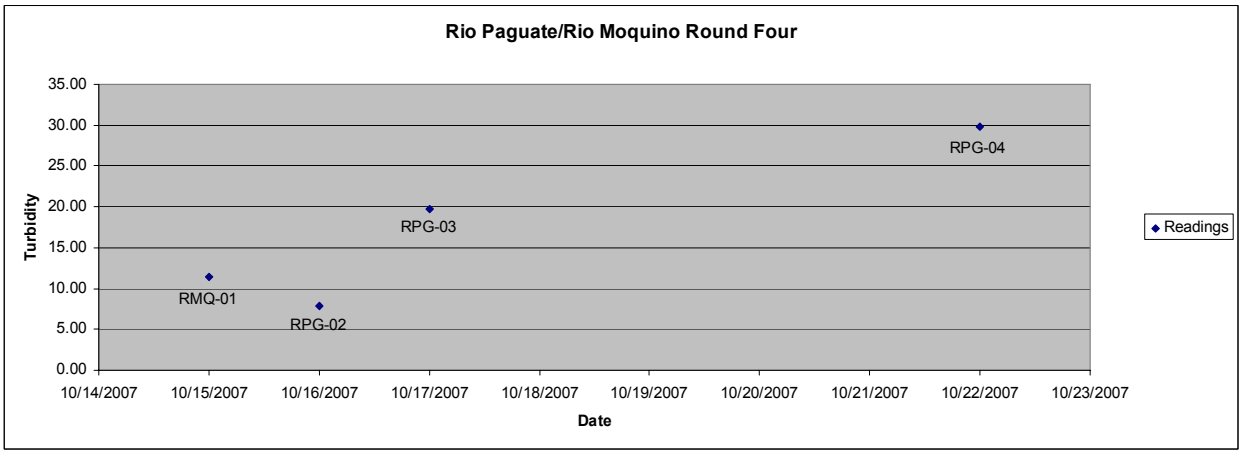

Rio Paguate/Rio Moquino Round Three
Atmospheric Pressure
1.00
0.99
0.99
0.98
0.98
0.97
0.97
0.96
0.96
RMQ-01
RPG-02
RPG-03
RPG-04
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007
Date
Readings


Rio Paguate/Rio Moquino Round Four
Atmospheric Pressure
1.01
1.00
0.99
0.98
0.97
0.96
0.95
0.94
RMQ-01
RPG-02
RPG-03
RPG-04
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007
Date
Readings

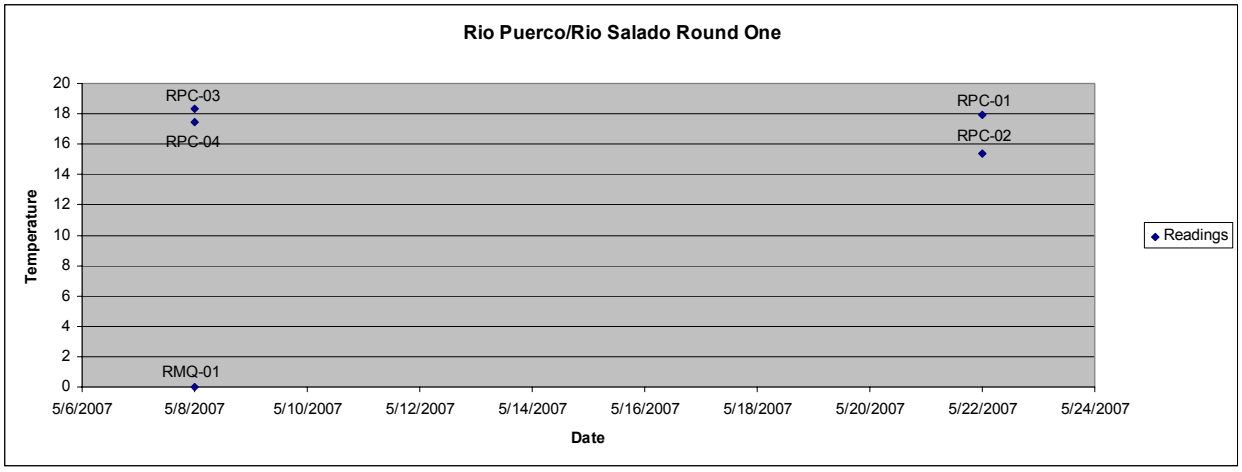

Rio Paguate/Rio Moquino Round One
Turbidity
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RMQ-01
RGP-02
RPG-03
RPG-04
4/15/2007
4/16/2007
4/16/2007
4/17/2007
4/17/2007
4/18/2007
4/18/2007
4/19/2007
4/19/2007
Date
Readings

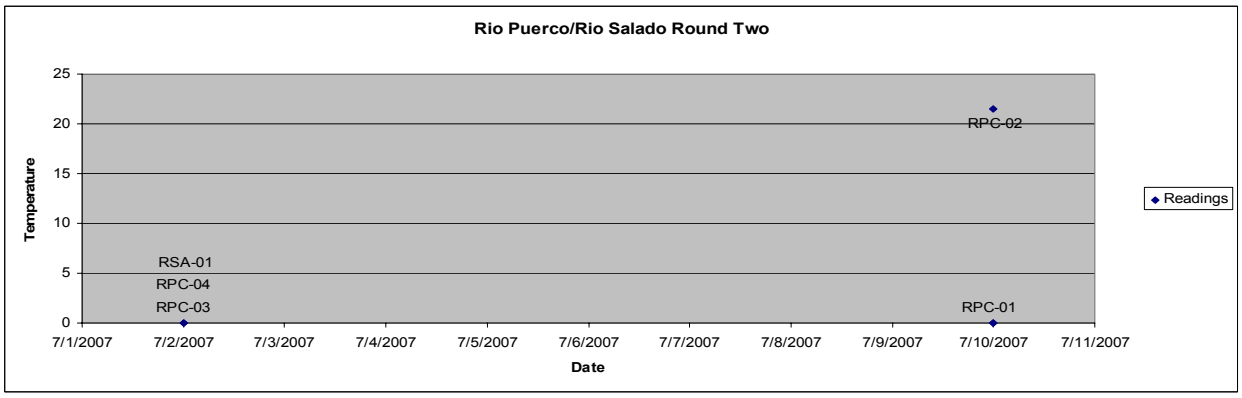

Rio Paguate/Rio Moquino Round Two
Turbidity
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
6/3/2007
6/4/2007
6/4/2007
6/5/2007
6/5/2007
6/6/2007
6/6/2007
6/7/2007
6/7/2007
Date
Readings

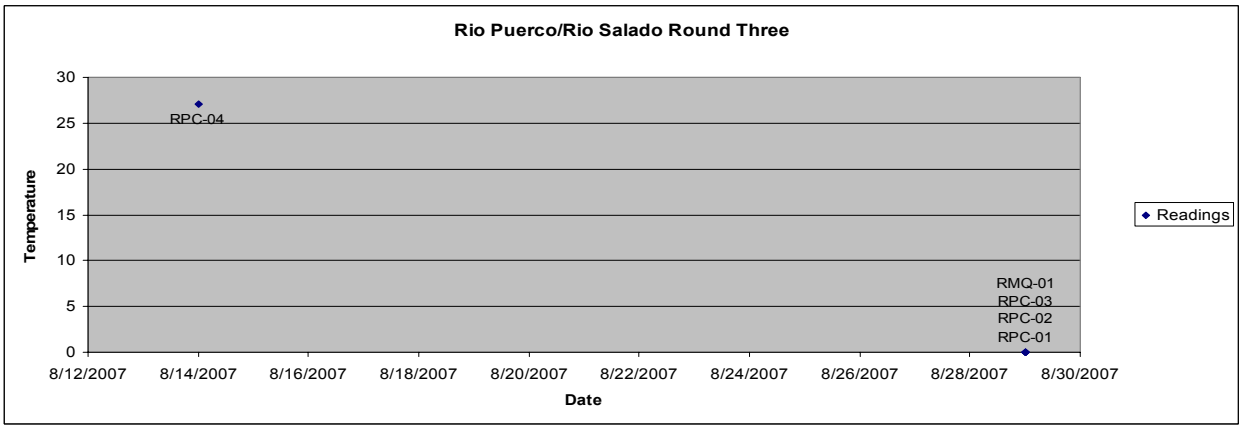

Rio Paguate/Rio Moquino Round Three
Turbidity
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
7/22/2007
7/23/2007
7/23/2007
7/24/2007
7/24/2007
7/25/2007
7/25/2007
7/26/2007
7/26/2007
Date
Readings

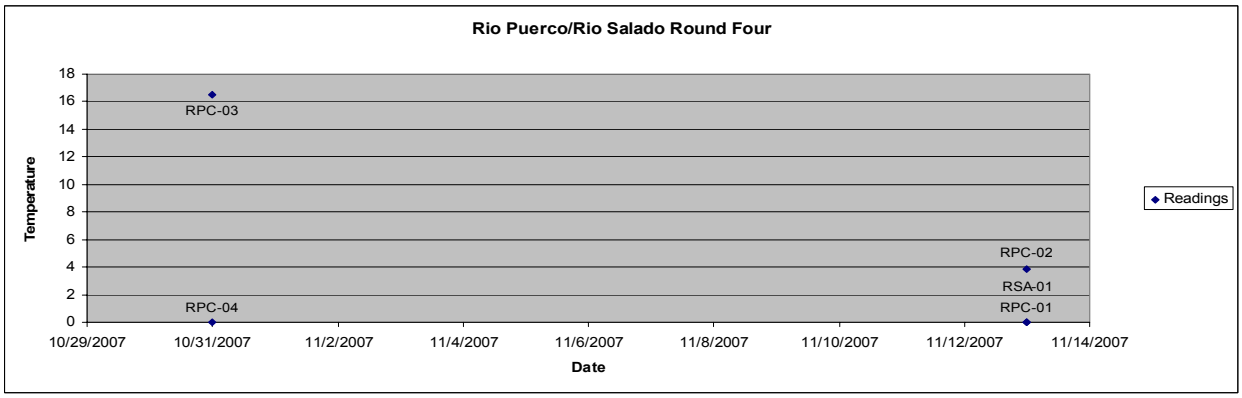

Rio Paguate/Rio Moquino Round Four
Turbidity
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
RMQ-01
RPG-02
RPG-03
RPG-04
10/14/2007
10/15/2007
10/16/2007
10/17/2007
10/18/2007
10/19/2007
10/20/2007
10/21/2007
10/22/2007
10/23/2007
Date
Readings

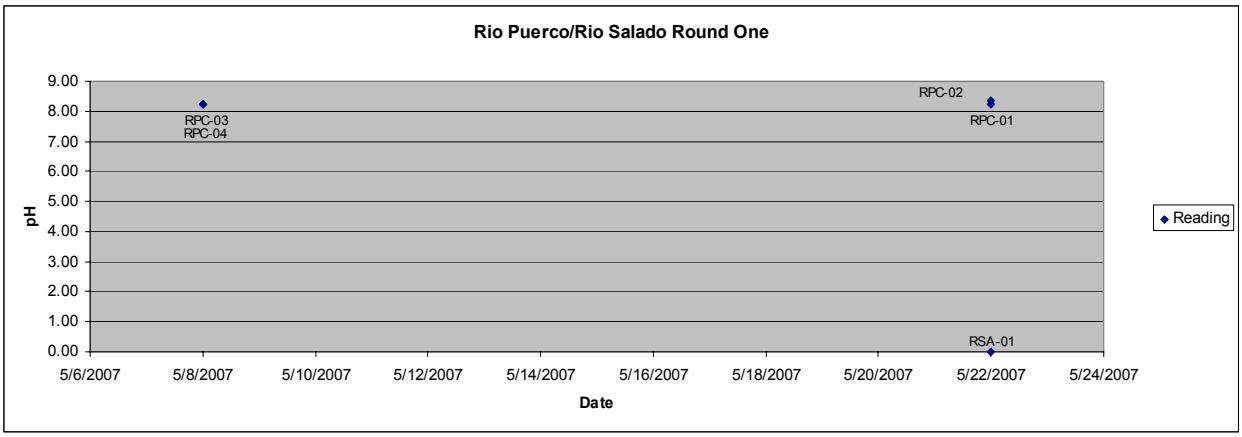
Rio Puerco/Rio Salado

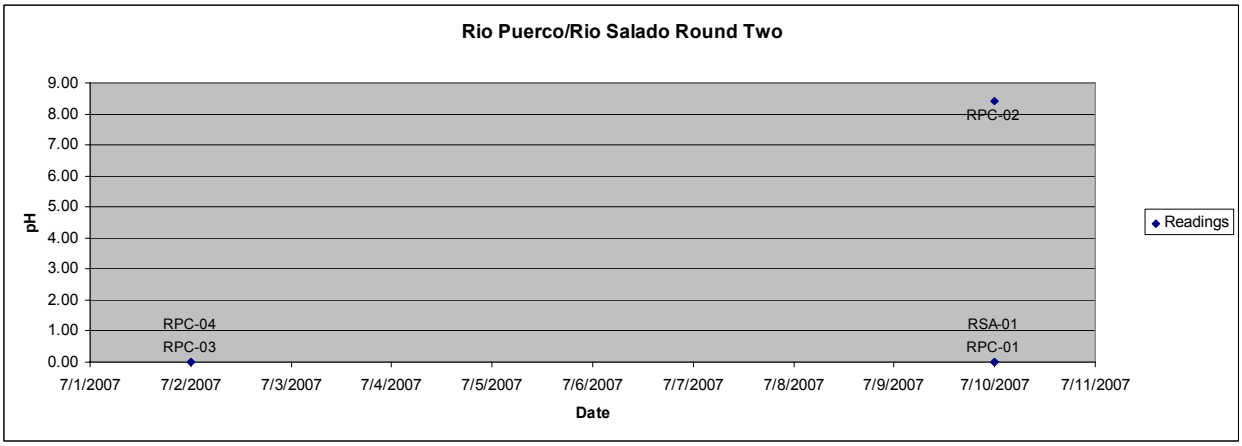


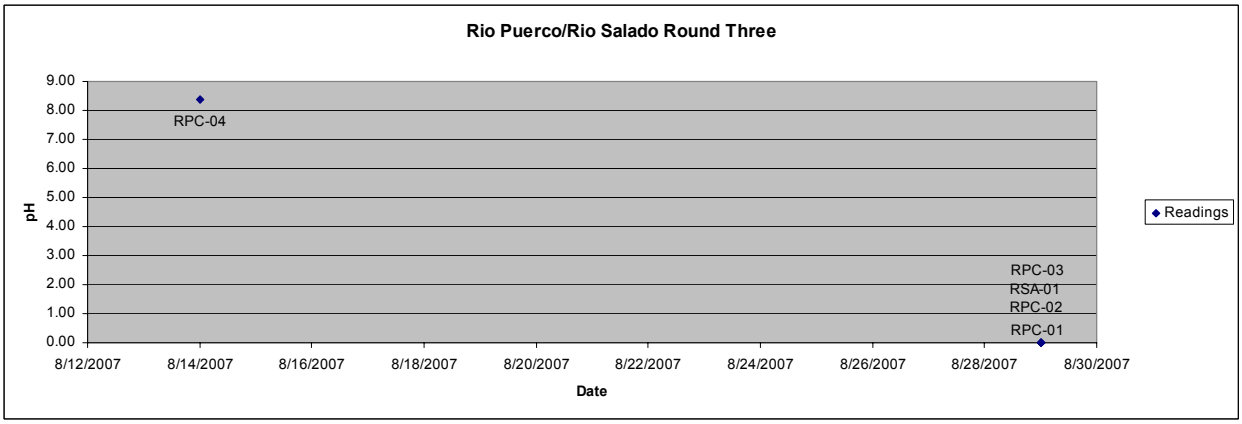


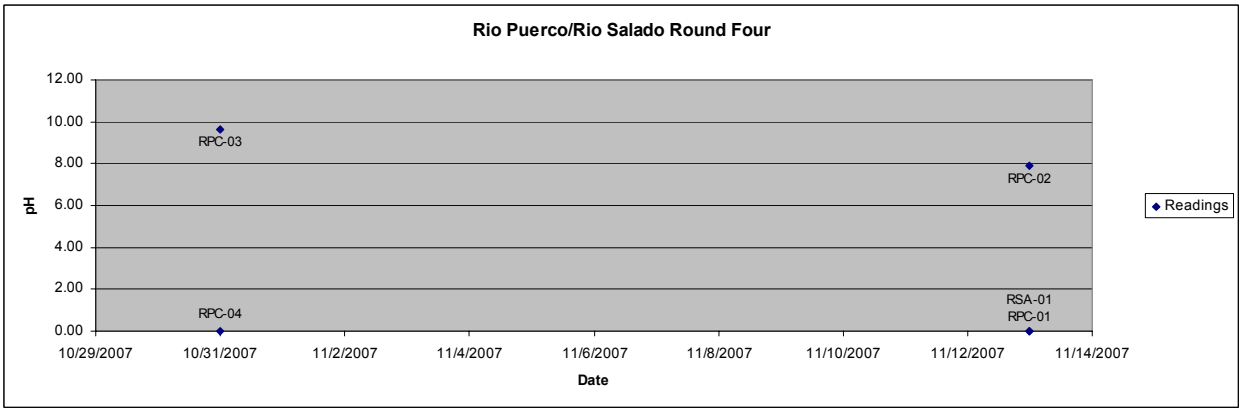


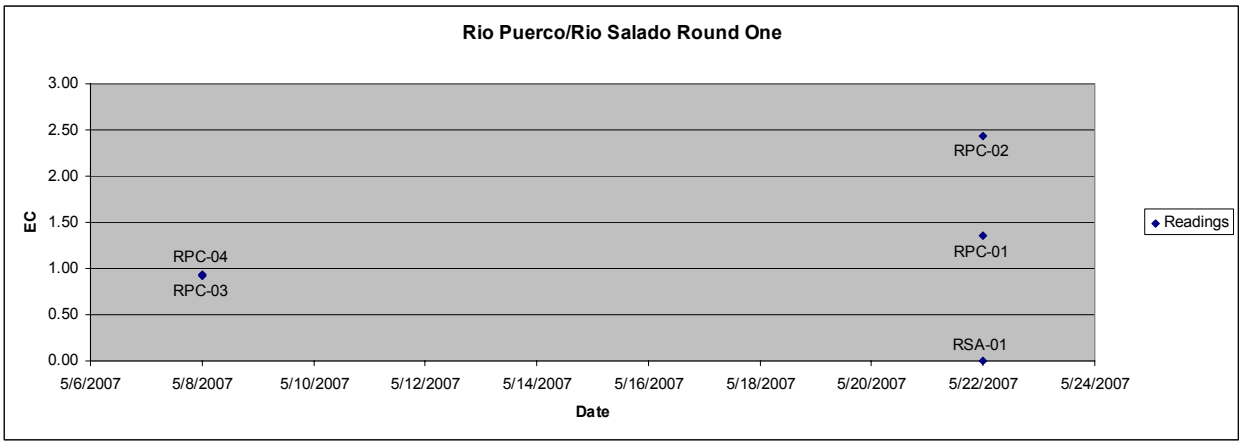


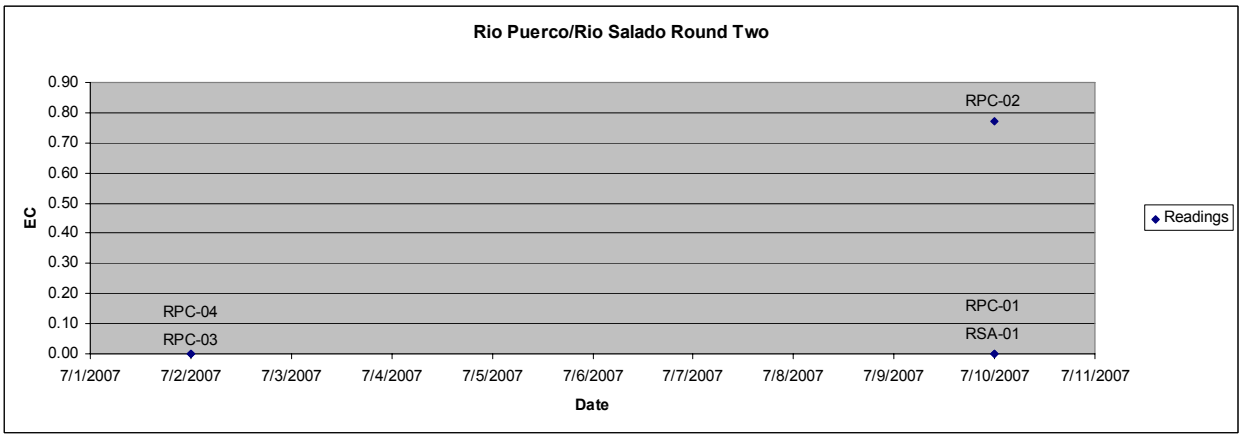

Rio Puerco/Rio Salado Round One
pH
Date
Reading
RPC-03
RPC-04
RPC-02
RPC-01
RSA-01

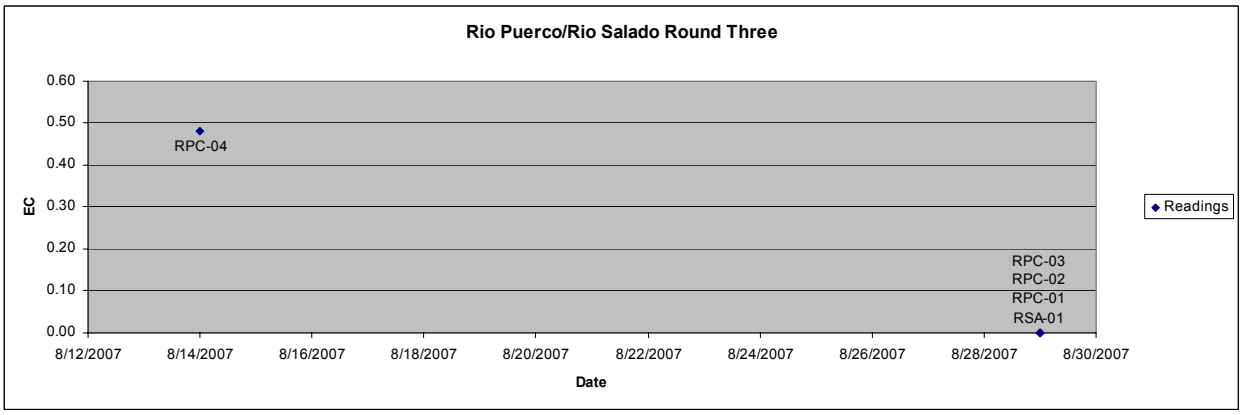

Rio Puerco/Rio Salado Round Two
pH
Date
Readings
RPC-02
RPC-04
RPC-03
RSA-01
RPC-01

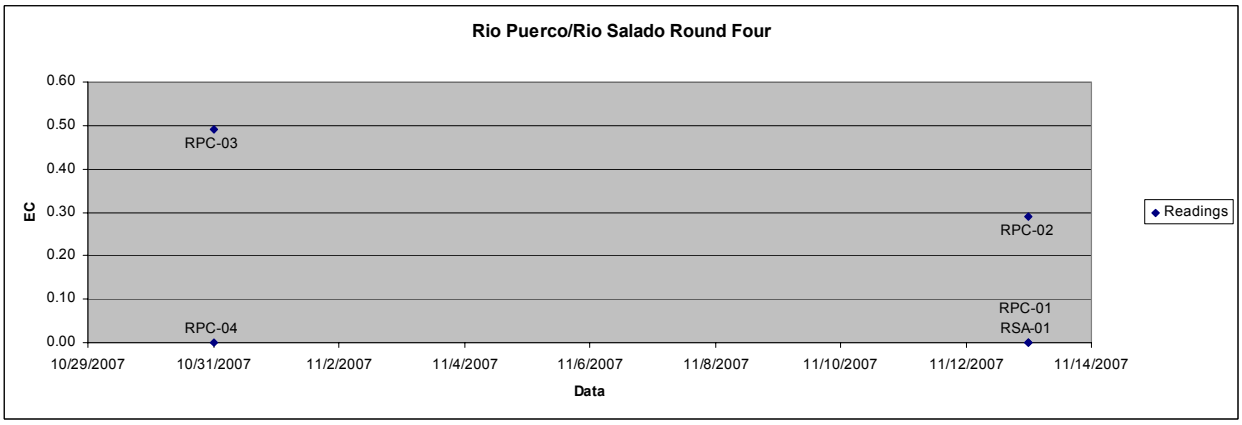

Rio Puerco/Rio Salado Round Three
pH
Date
Readings
RPC-04
RPC-03
RSA-01
RPC-02
RPC-01

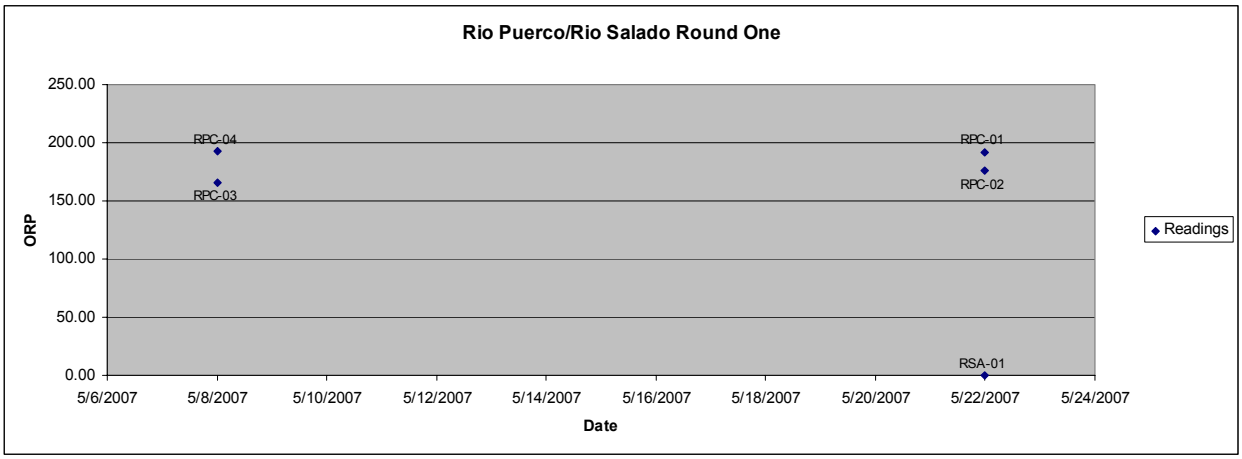

Rio Puerco/Rio Salado Round Four
pH
Date
Readings
RPC-03
RPC-02
RPC-04
RSA-01
RPC-01

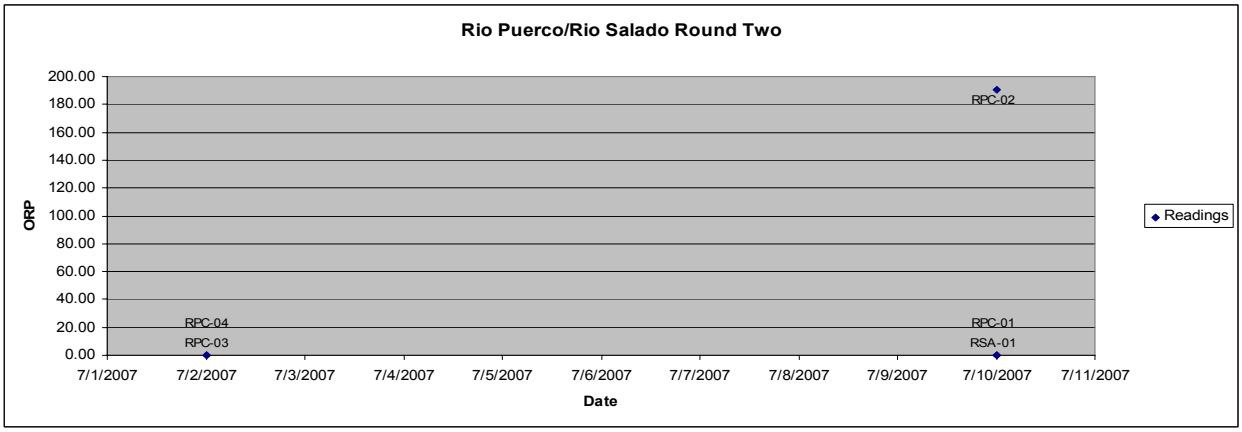

Rio Puerco/Rio Salado Round One
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EC
RPC-02
RPC-01
RPC-04
RPC-03
RSA-01
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
5/24/2007
Date
Readings

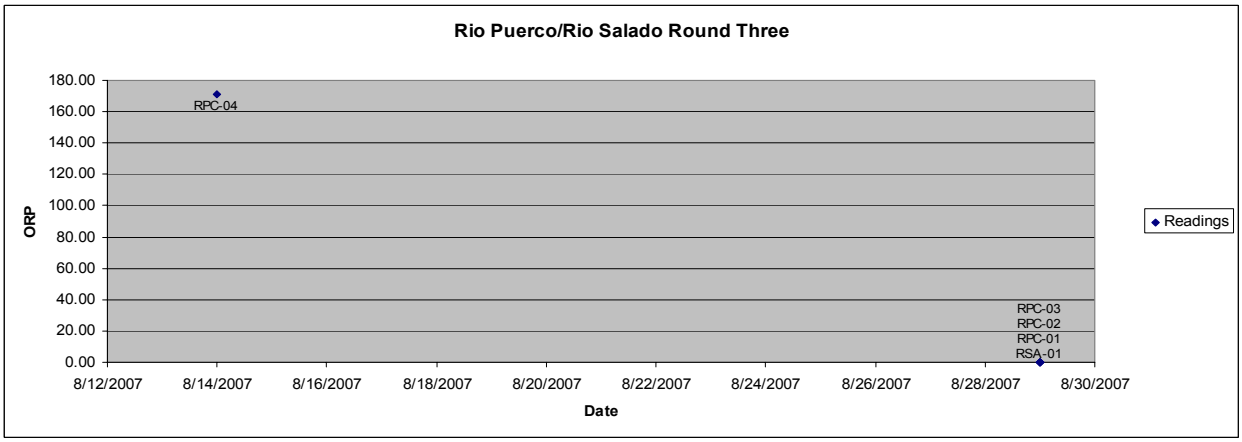

Rio Puerco/Rio Salado Round Two
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
EC
RPC-02
RPC-04
RPC-01
RPC-03
RSA-01
7/1/2007
7/2/2007
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
7/11/2007
Date
Readings

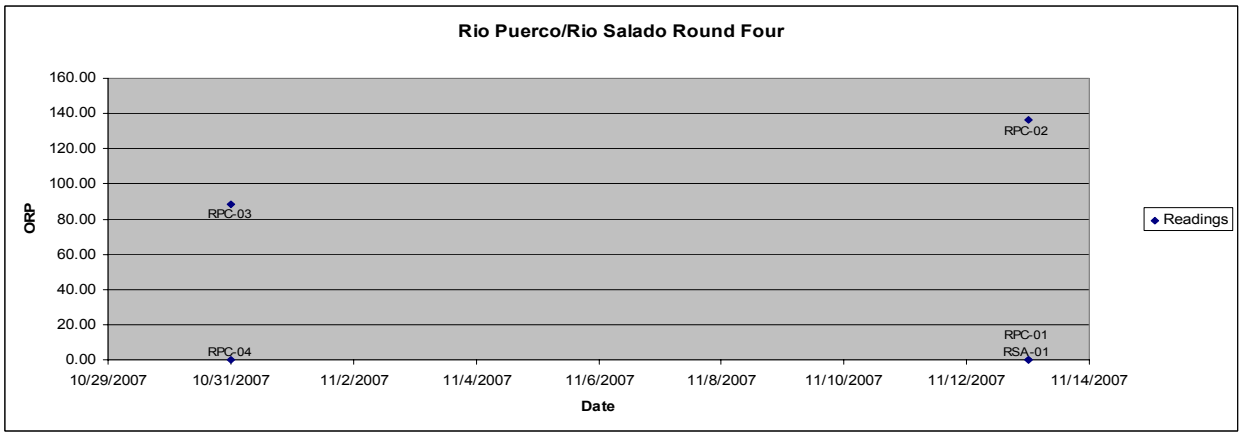

Rio Puerco/Rio Salado Round Three
0.60
0.50
0.40
0.30
0.20
0.10
0.00
EC
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
8/12/2007
8/14/2007
8/16/2007
8/18/2007
8/20/2007
8/22/2007
8/24/2007
8/26/2007
8/28/2007
8/30/2007
Date
Readings

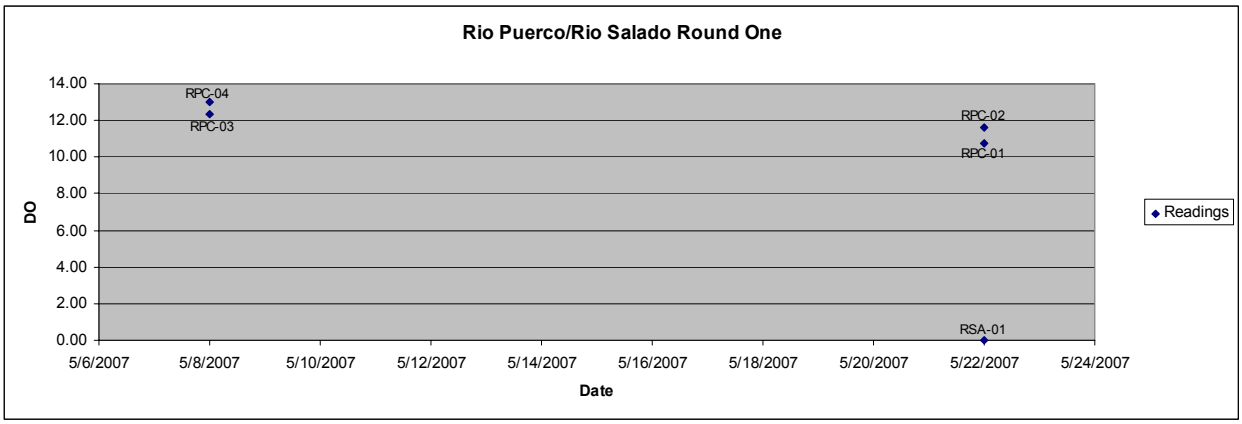

Rio Puerco/Rio Salado Round Four
0.60
0.50
0.40
0.30
0.20
0.10
0.00
EC
RPC-03
RPC-02
RPC-01
RSA-01
RPC-04
10/29/2007
10/31/2007
11/2/2007
11/4/2007
11/6/2007
11/8/2007
11/10/2007
11/12/2007
11/14/2007
Data
Readings

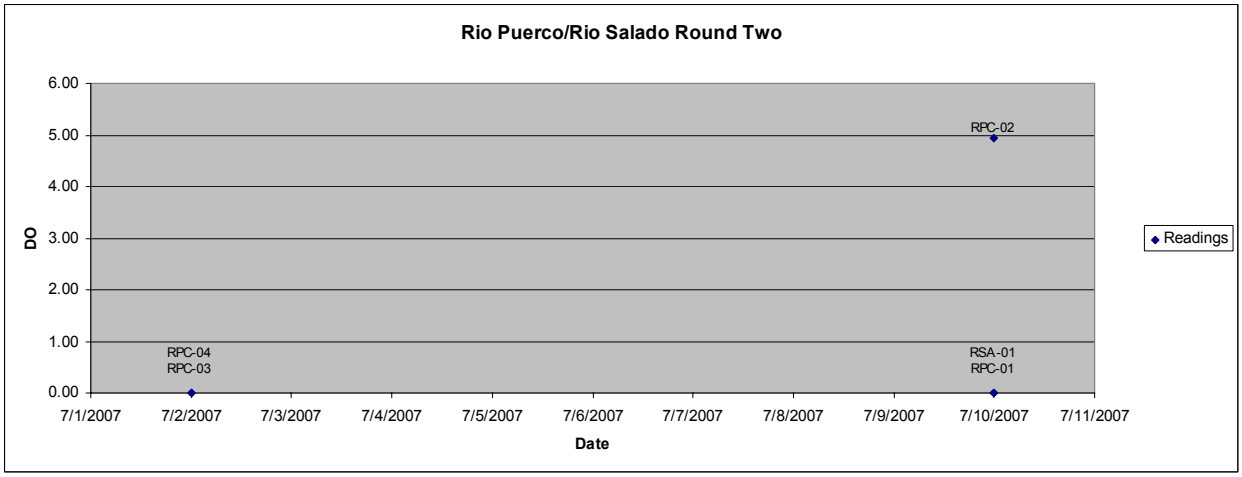

Rio Puerco/Rio Salado Round One
ORP
Date
Readings
RPC-04
RPC-03
RPC-01
RPC-02
RSA-01

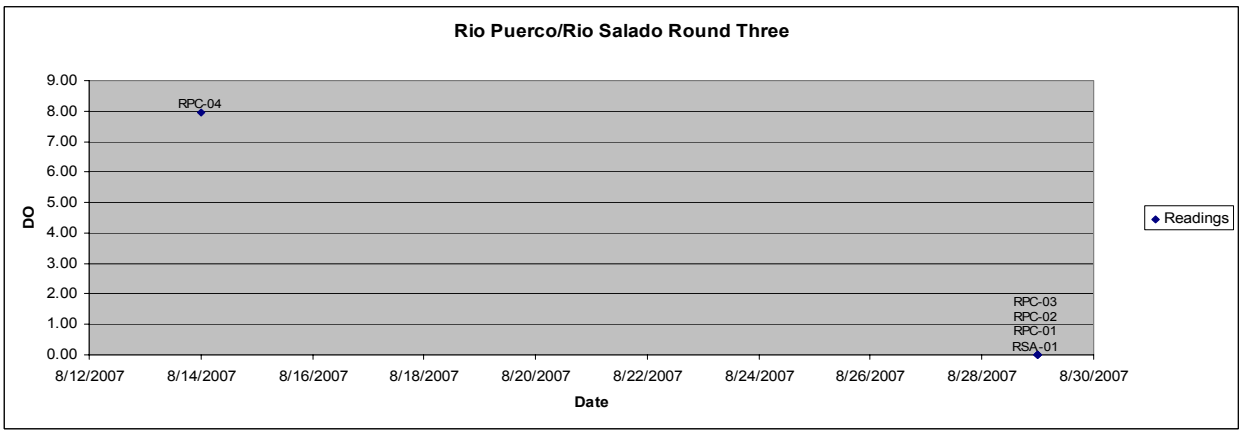

Rio Puerco/Rio Salado Round Two
ORP
Date
Readings
RPC-02
RPC-04
RPC-03
RPC-01
RSA-01

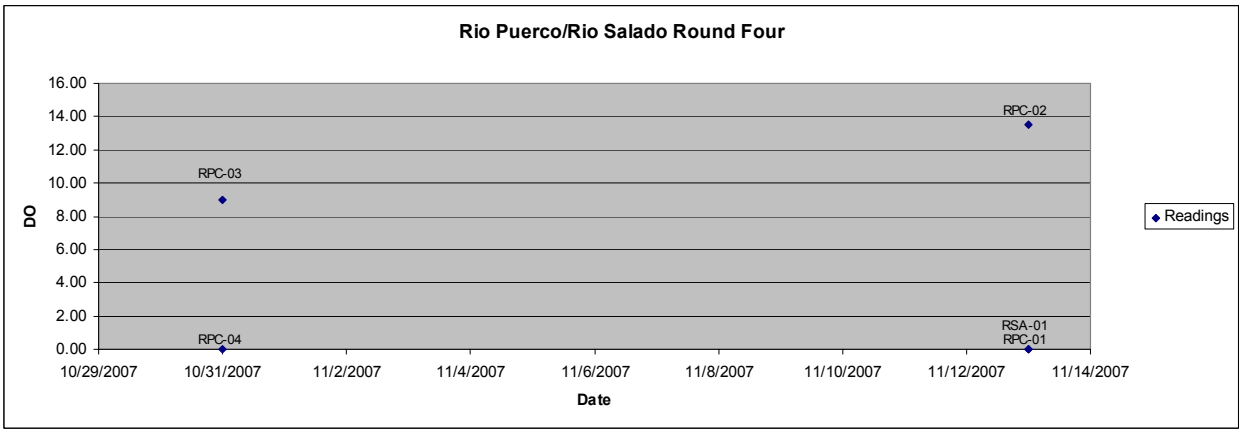

Rio Puerco/Rio Salado Round Three
ORP
Date
Readings
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01

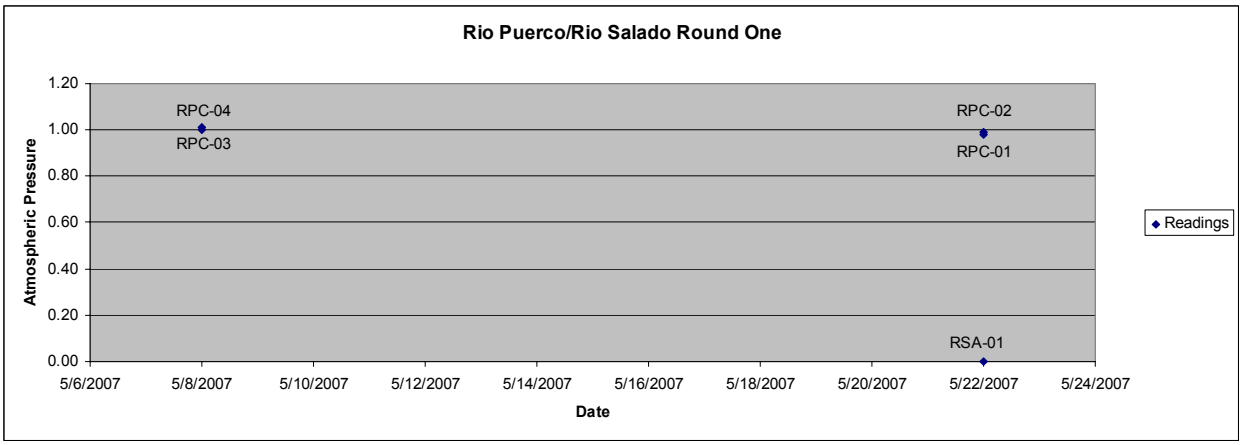

Rio Puerco/Rio Salado Round Four
ORP
Date
Readings
RPC-02
RPC-03
RPC-01
RSA-01
RPC-04

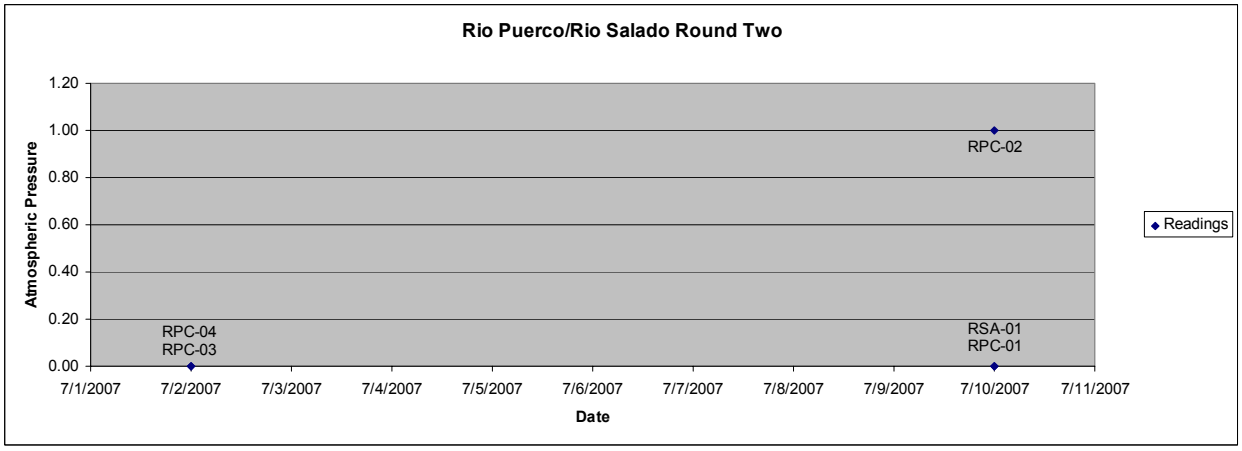

Rio Puerco/Rio Salado Round One
DO
Date
Readings
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
5/24/2007

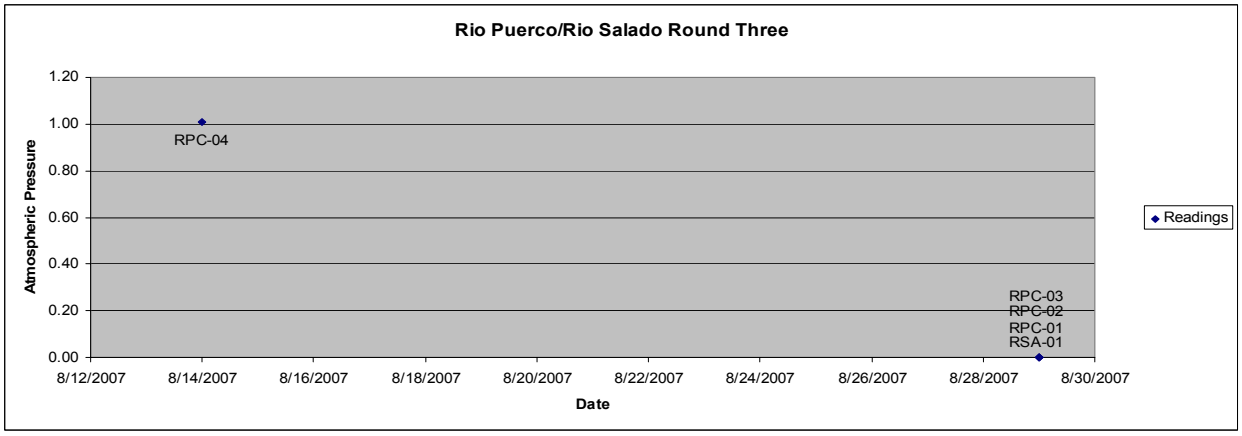

Rio Puerco/Rio Salado Round Two
DO
Date
Readings
RPC-02
RPC-04
RPC-03
RSA-01
RPC-01
6.00
5.00
4.00
3.00
2.00
1.00
0.00
7/1/2007
7/2/2007
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
7/11/2007

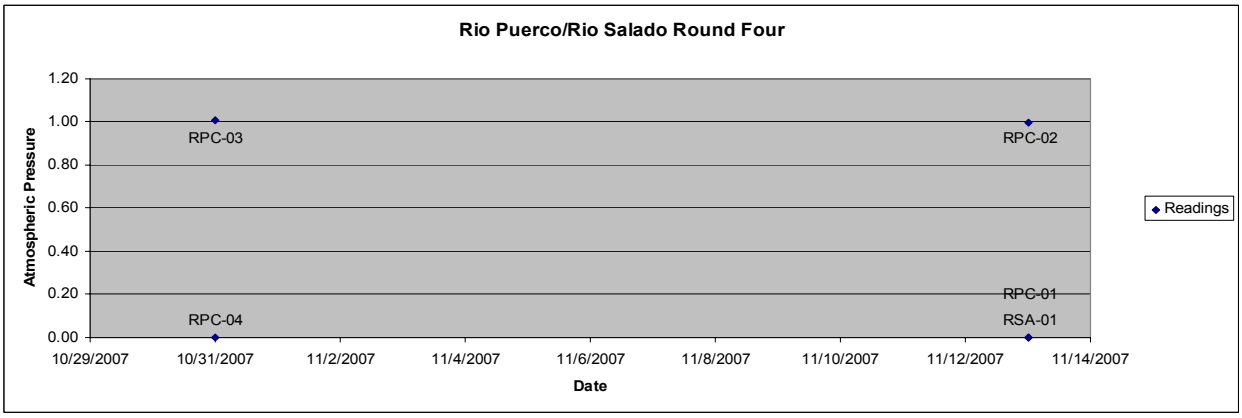

Rio Puerco/Rio Salado Round Three
DO
Date
Readings
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
8/12/2007
8/14/2007
8/16/2007
8/18/2007
8/20/2007
8/22/2007
8/24/2007
8/26/2007
8/28/2007
8/30/2007

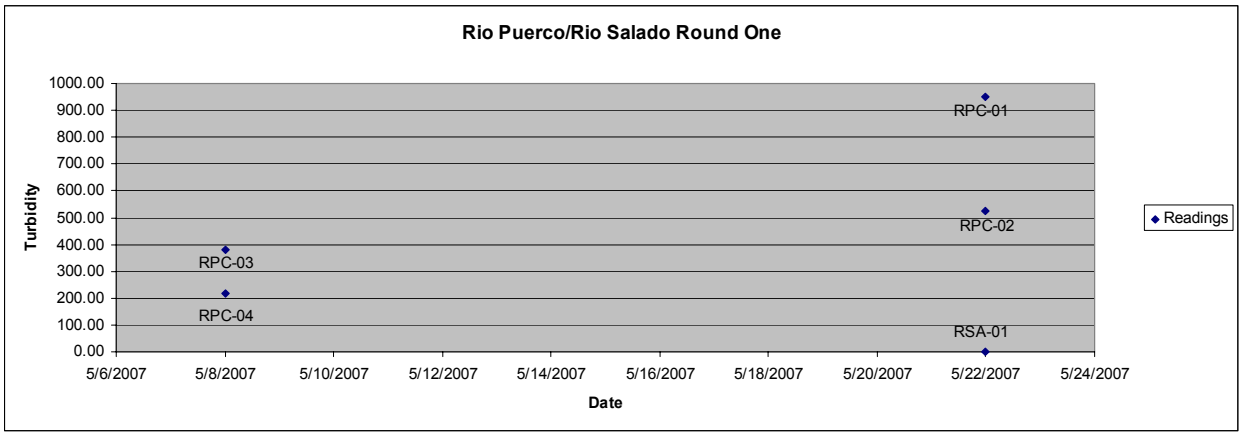

Rio Puerco/Rio Salado Round Four
DO
Date
Readings
RPC-02
RPC-03
RPC-04
RSA-01
RPC-01
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
10/29/2007
10/31/2007
11/2/2007
11/4/2007
11/6/2007
11/8/2007
11/10/2007
11/12/2007
11/14/2007

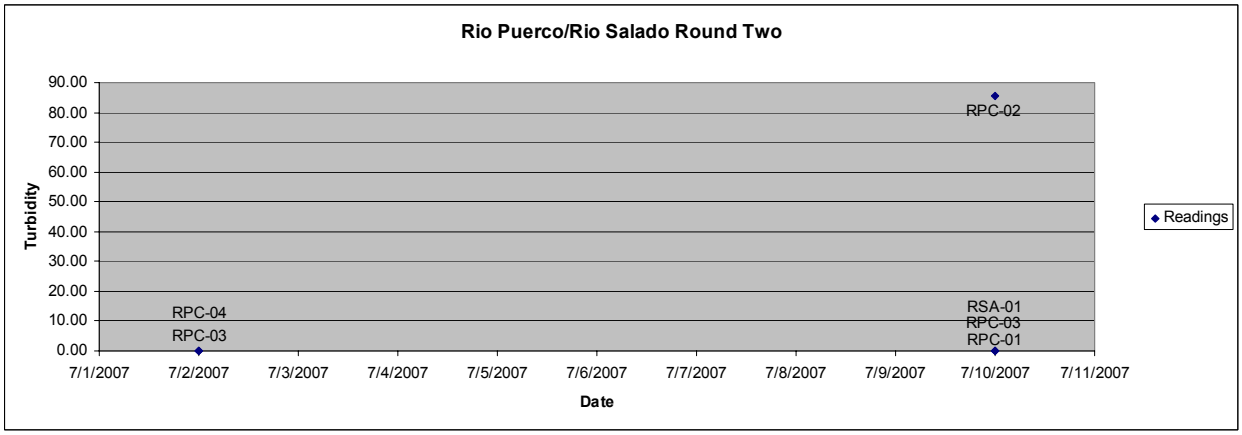

Rio Puerco/Rio Salado Round One
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
5/24/2007
Date
Readings

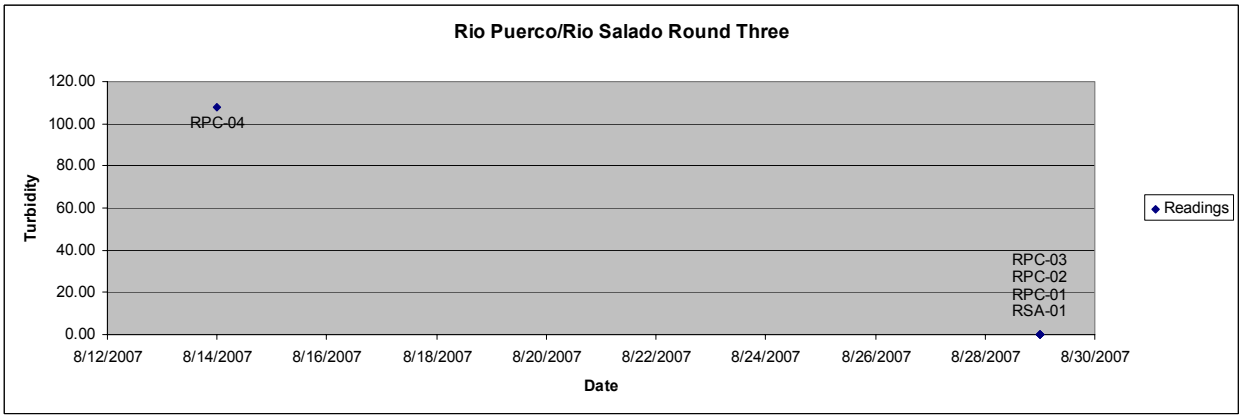

Rio Puerco/Rio Salado Round Two
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-02
RPC-04
RPC-03
RSA-01
RPC-01
7/1/2007
7/2/2007
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
7/11/2007
Date
Readings

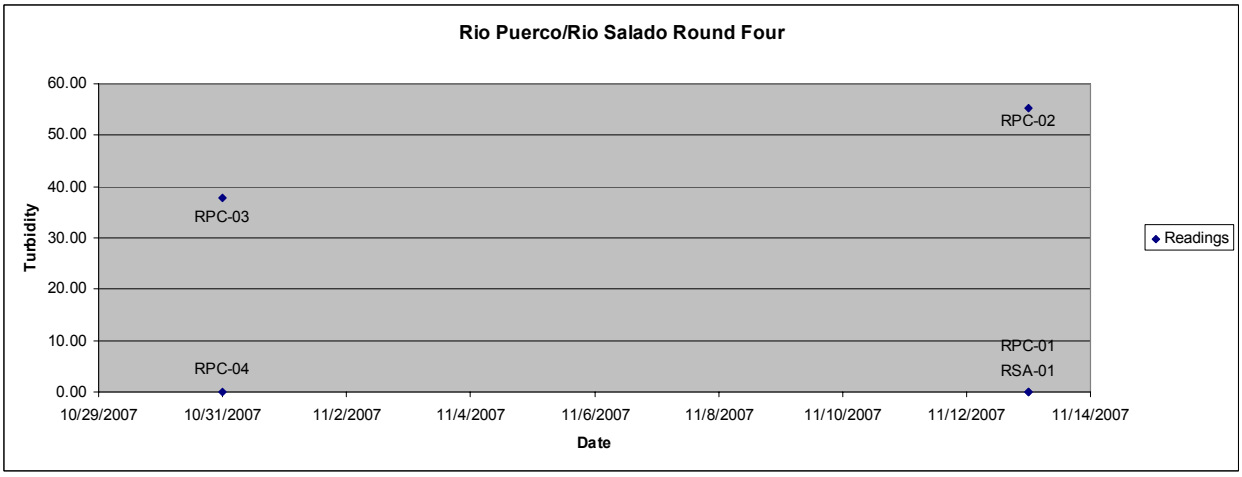

Rio Puerco/Rio Salado Round Three
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
8/12/2007
8/14/2007
8/16/2007
8/18/2007
8/20/2007
8/22/2007
8/24/2007
8/26/2007
8/28/2007
8/30/2007
Date
Readings


Rio Puerco/Rio Salado Round Four
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RPC-03
RPC-02
RPC-01
RPC-04
RSA-01
10/29/2007
10/31/2007
11/2/2007
11/4/2007
11/6/2007
11/8/2007
11/10/2007
11/12/2007
11/14/2007
Date
Readings

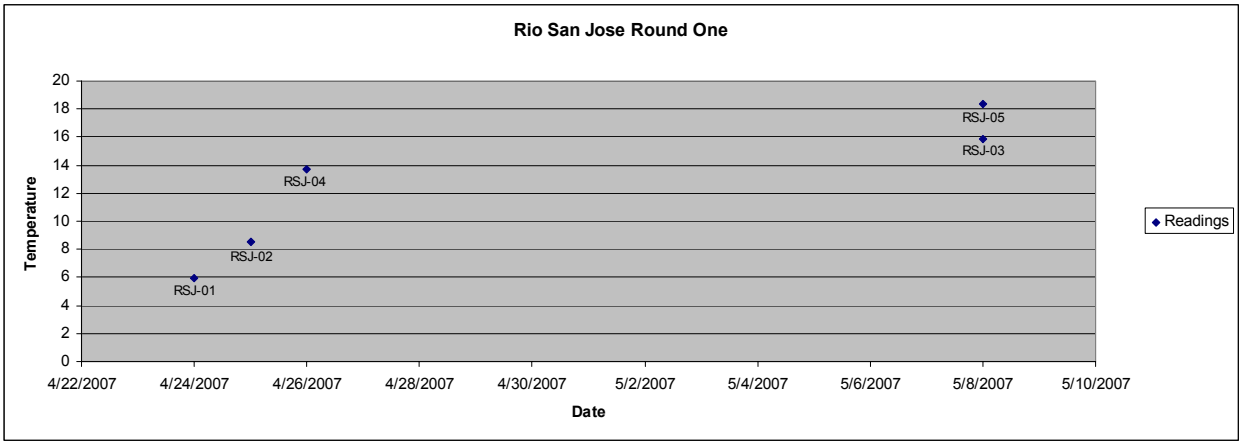

Rio Puerco/Rio Salado Round One
Turbidity
1000.00
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
5/24/2007
Date
RPC-01
RPC-02
RPC-03
RPC-04
RSA-01
Readings

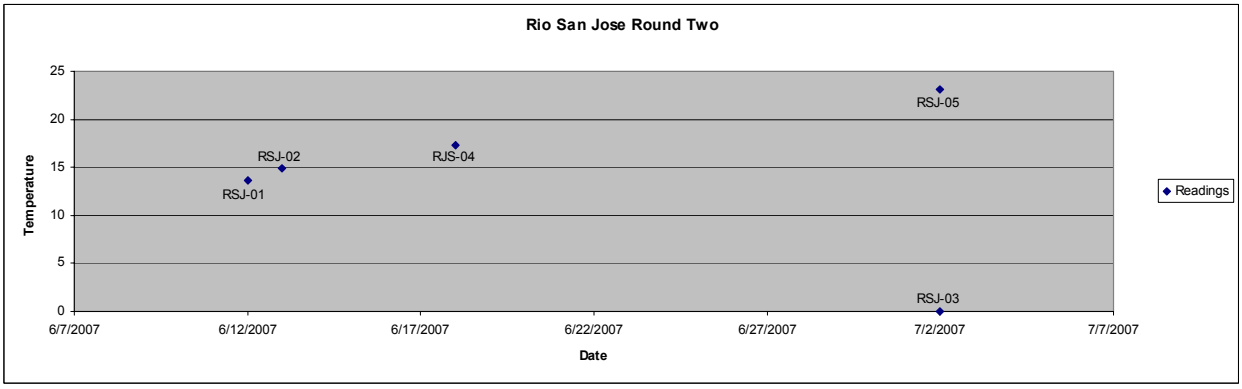

Rio Puerco/Rio Salado Round Two
Turbidity
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
7/1/2007
7/2/2007
7/3/2007
7/4/2007
7/5/2007
7/6/2007
7/7/2007
7/8/2007
7/9/2007
7/10/2007
7/11/2007
Date
RPC-02
RPC-04
RPC-03
RSA-01
RPC-03
RPC-01
Readings

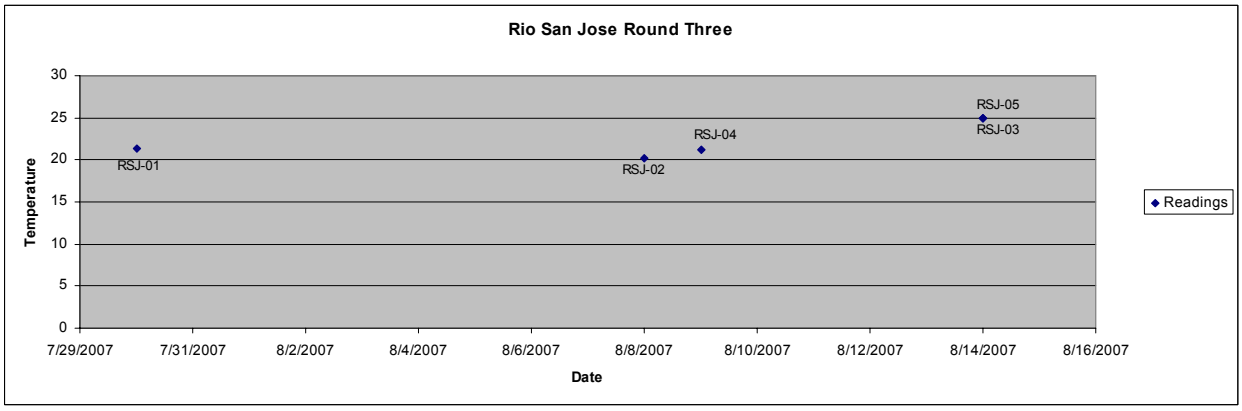

Rio Puerco/Rio Salado Round Three
Turbidity
120.00
100.00
80.00
60.00
40.00
20.00
0.00
8/12/2007
8/14/2007
8/16/2007
8/18/2007
8/20/2007
8/22/2007
8/24/2007
8/26/2007
8/28/2007
8/30/2007
Date
RPC-04
RPC-03
RPC-02
RPC-01
RSA-01
Readings

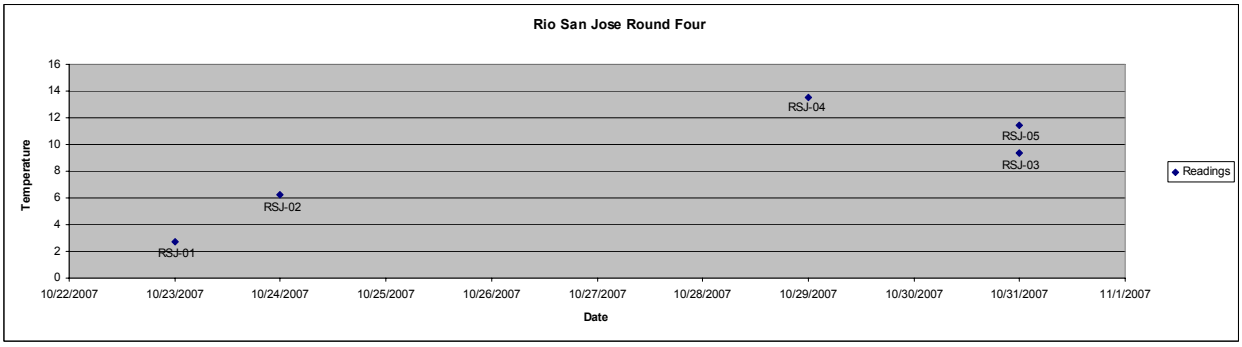

Rio Puerco/Rio Salado Round Four
Turbidity
60.00
50.00
40.00
30.00
20.00
10.00
0.00
10/29/2007
10/31/2007
11/2/2007
11/4/2007
11/6/2007
11/8/2007
11/10/2007
11/12/2007
11/14/2007
Date
RPC-02
RPC-03
RPC-01
RSA-01
RPC-04
Readings

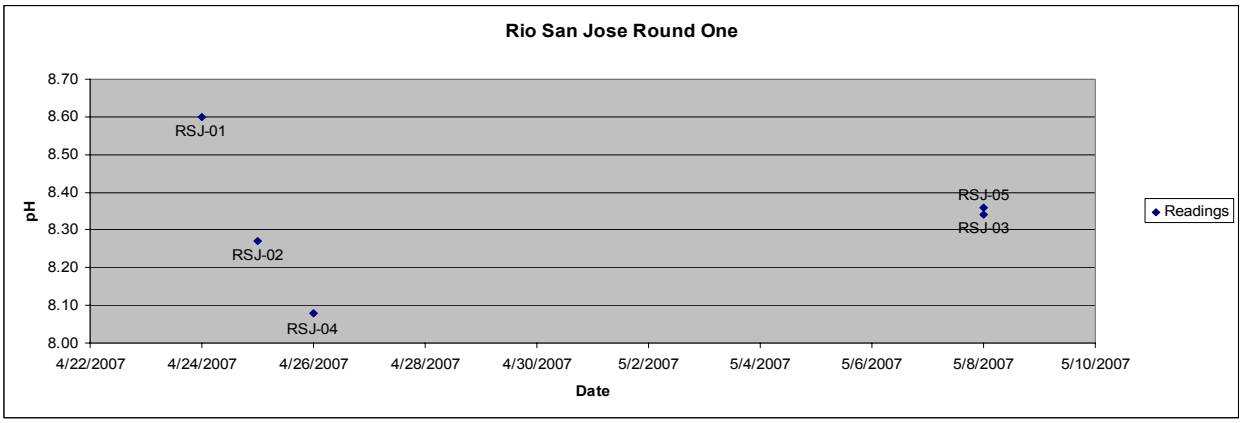
Rio San Jose

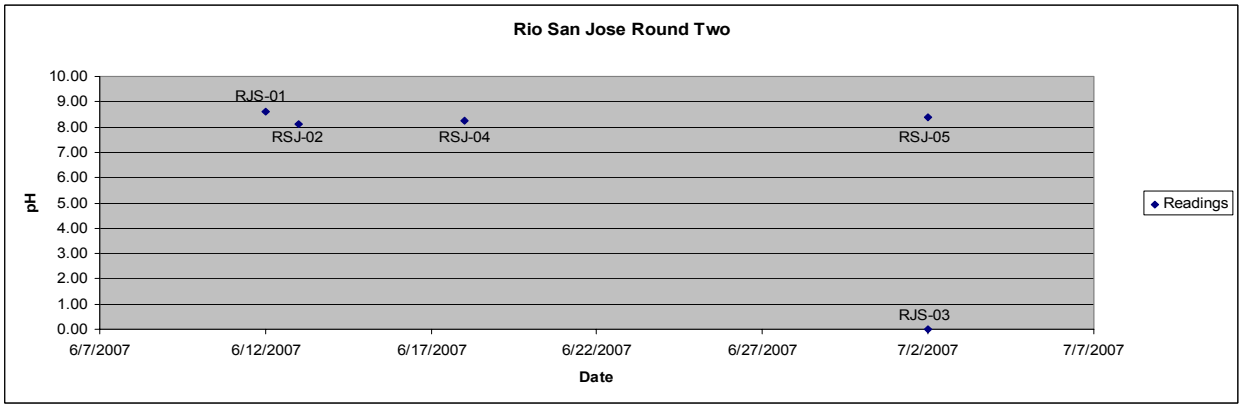

Rio San Jose Round One
Temperature
Date
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
Readings

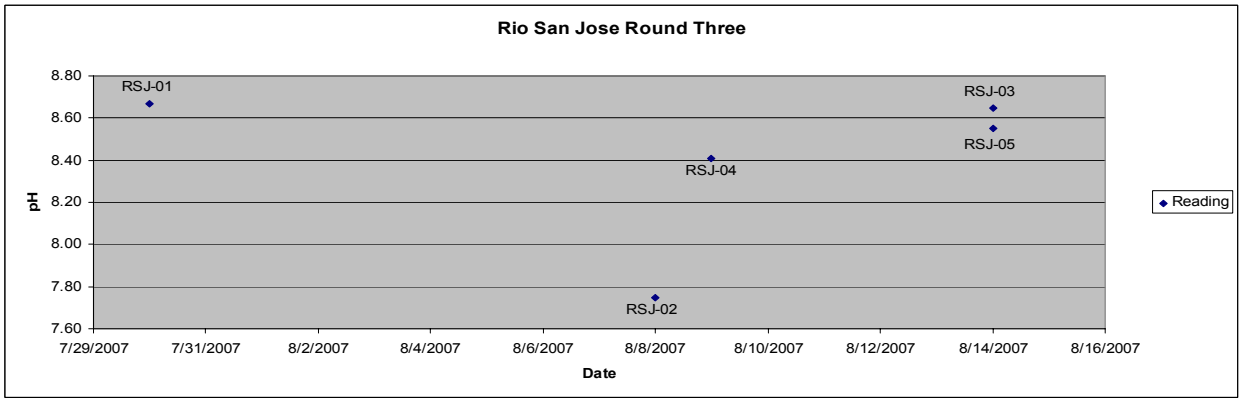

Rio San Jose Round Two
Temperature
Date
RSJ-01
RSJ-02
RJS-04
RSJ-05
RSJ-03
Readings

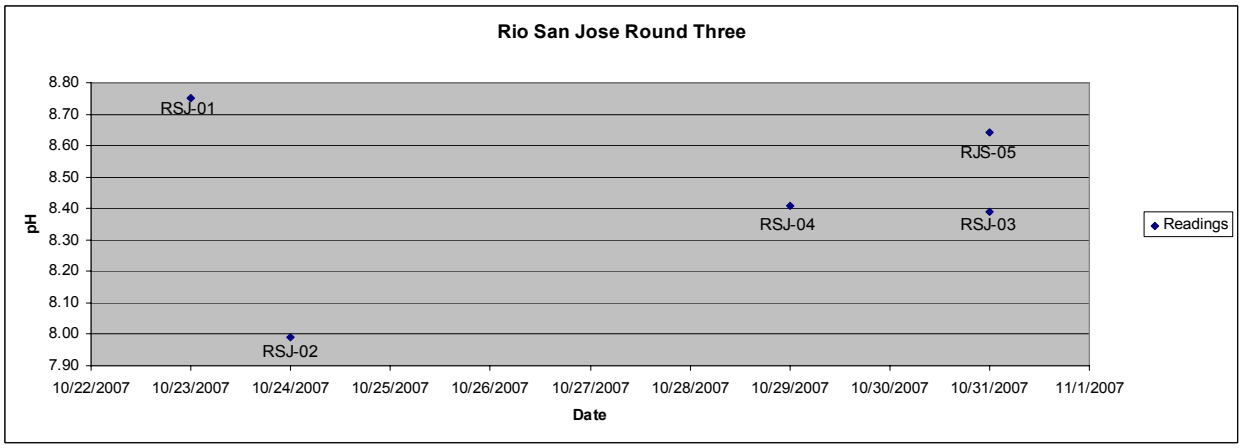

Rio San Jose Round Three
Temperature
Date
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
Readings

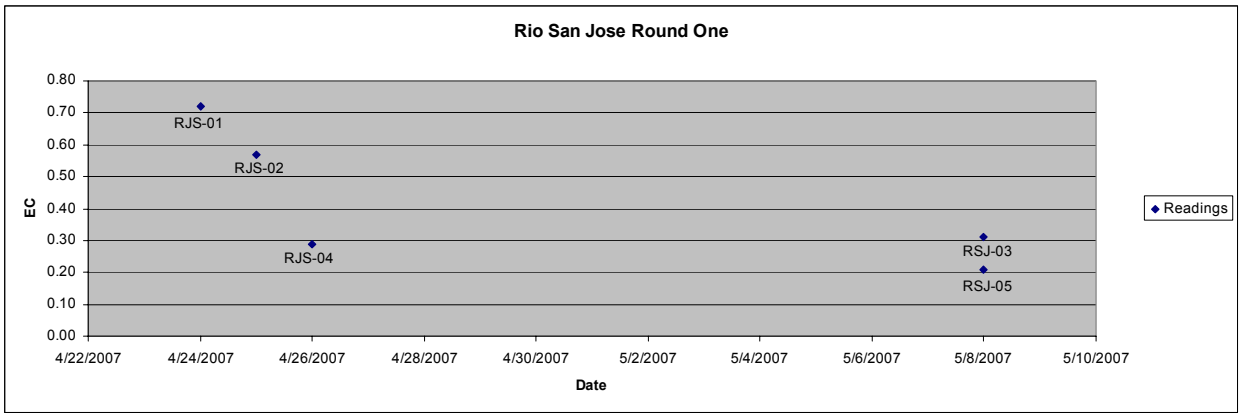

Rio San Jose Round Four
Temperature
Date
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
Readings

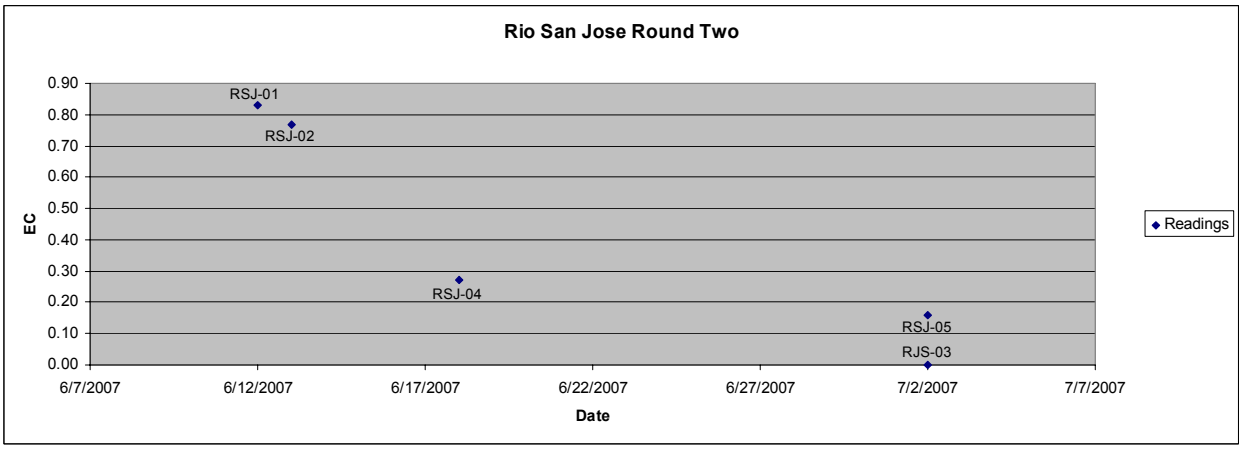

Rio San Jose Round One
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
pH
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007
Date
Readings

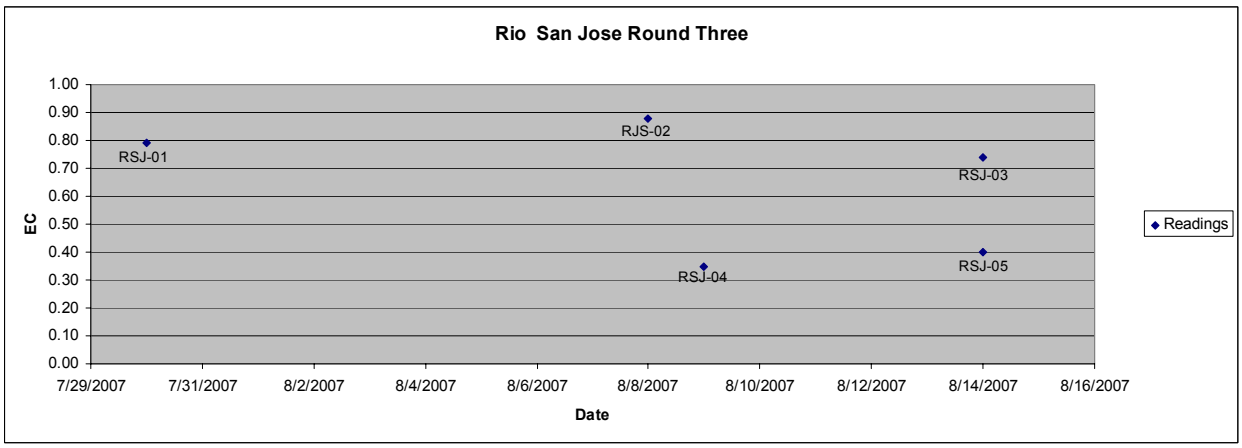

Rio San Jose Round Two
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
RJS-01
RSJ-02
RSJ-04
RSJ-05
RJS-03
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007
Date
Readings

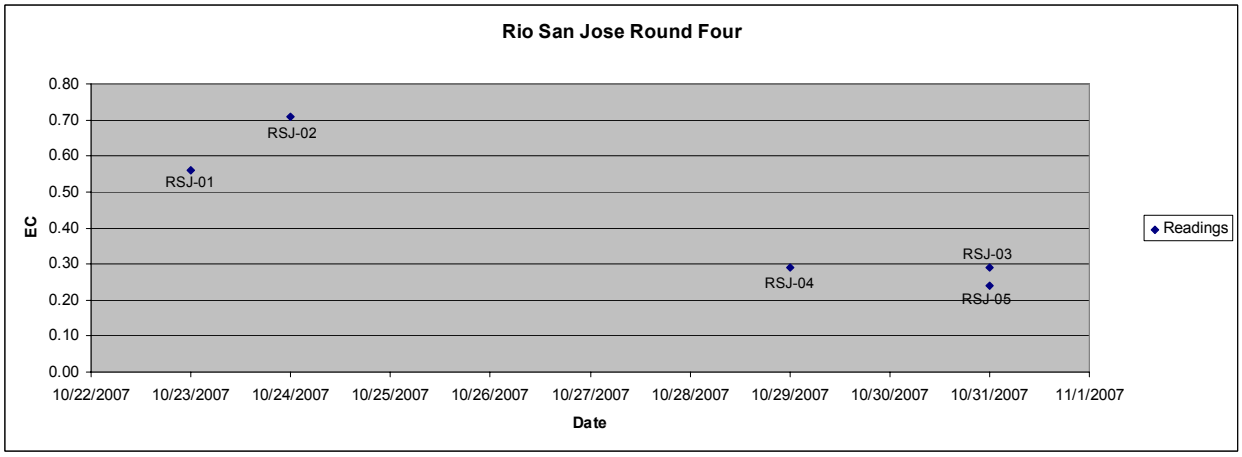

Rio San Jose Round Three
8.80
8.60
8.40
8.20
8.00
7.80
7.60
pH
RSJ-01
RSJ-03
RSJ-05
RSJ-04
RSJ-02
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007
Date
Reading

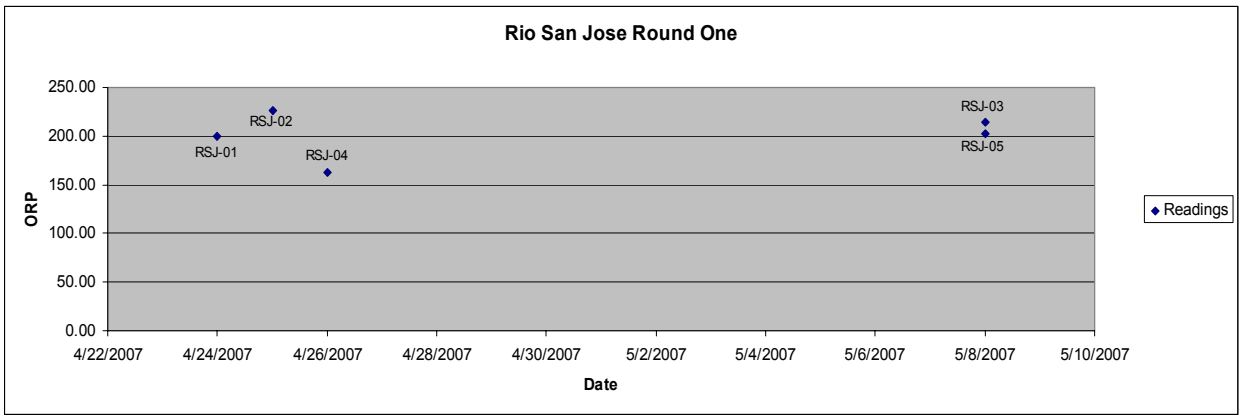

Rio San Jose Round Three
8.80
8.70
8.60
8.50
8.40
8.30
8.20
8.10
8.00
7.90
pH
RSJ-01
RJS-05
RSJ-04
RSJ-03
RSJ-02
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
Readings

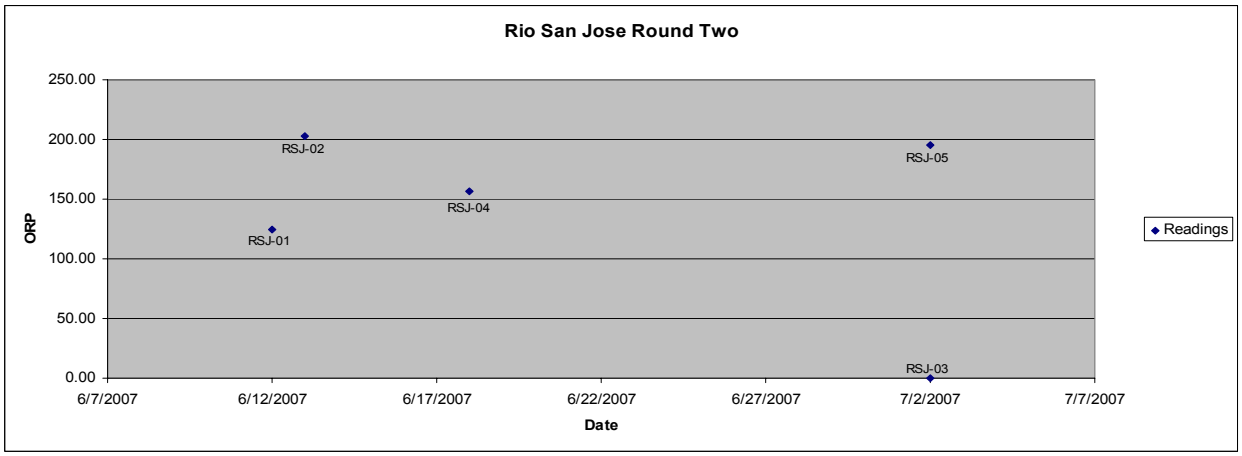

Rio San Jose Round One
EC
Date
Readings
RJS-01
RJS-02
RJS-04
RSJ-03
RSJ-05
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007

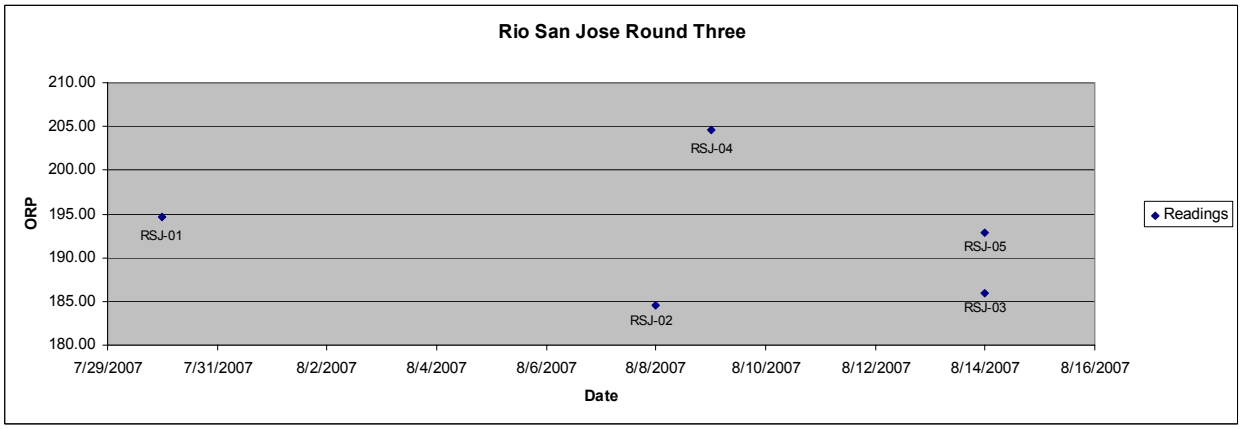

Rio San Jose Round Two
EC
Date
Readings
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RJS-03
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007

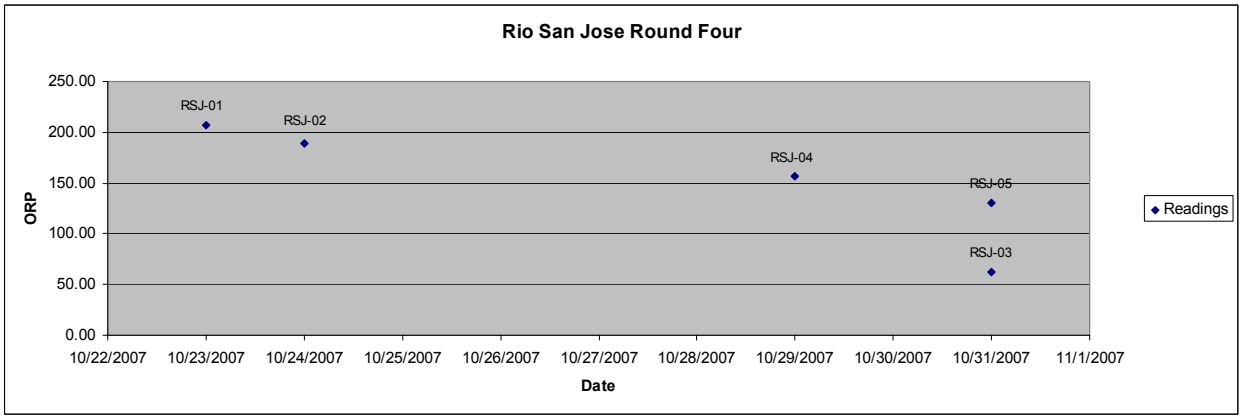

Rio San Jose Round Three
EC
Date
Readings
RSJ-01
RJS-02
RSJ-04
RSJ-03
RSJ-05
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007

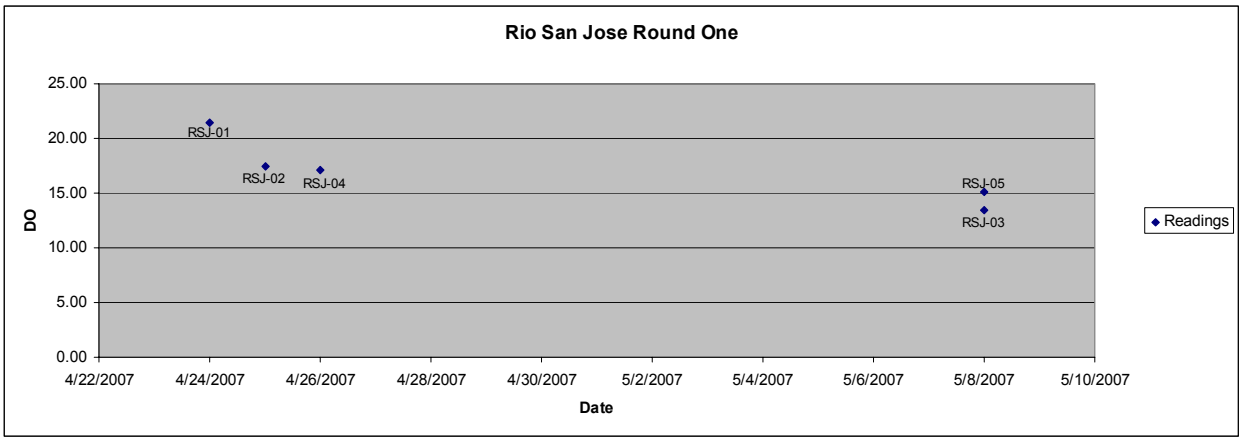

Rio San Jose Round Four
EC
Date
Readings
RSJ-02
RSJ-01
RSJ-04
RSJ-03
RSJ-05
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007

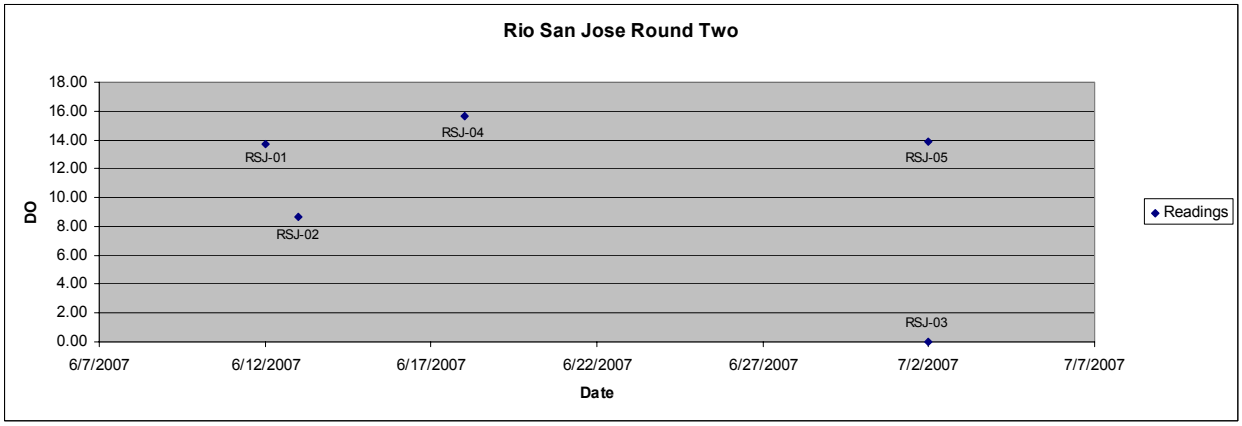

Rio San Jose Round One
ORP
250.00
200.00
150.00
100.00
50.00
0.00
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007
Date
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
Readings

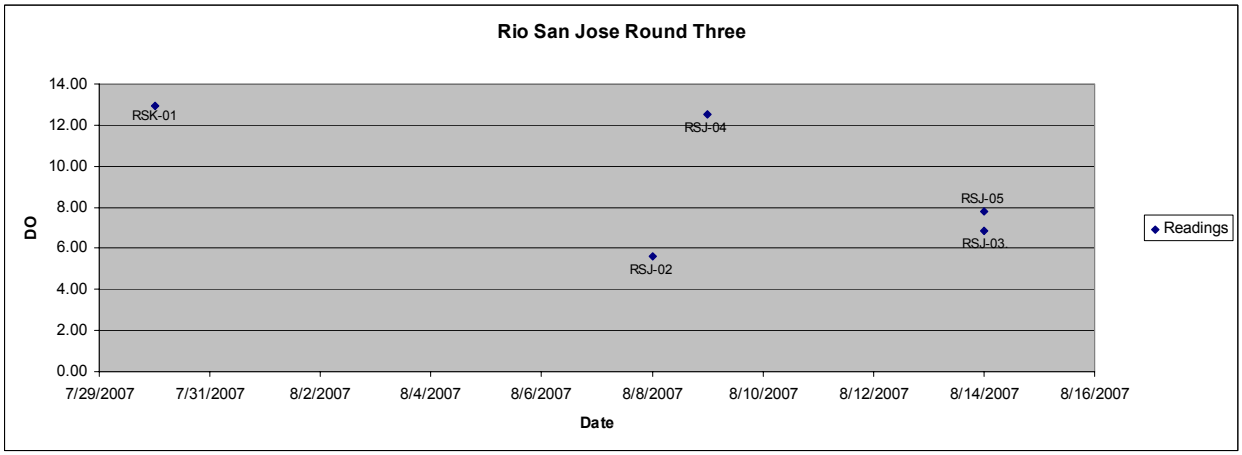

Rio San Jose Round Two
ORP
250.00
200.00
150.00
100.00
50.00
0.00
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007
Date
RSJ-02
RSJ-05
RSJ-04
RSJ-01
RSJ-03
Readings

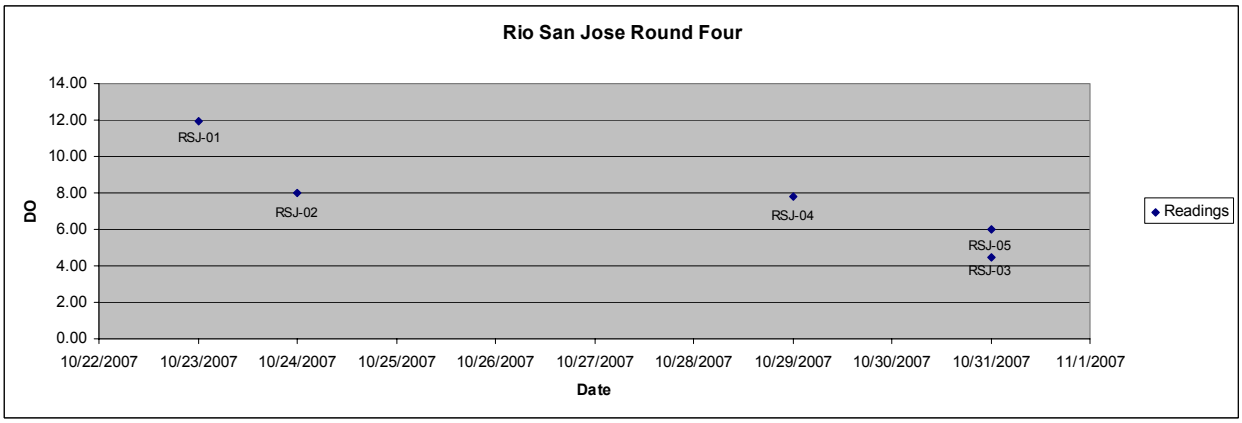

Rio San Jose Round Three
ORP
210.00
205.00
200.00
195.00
190.00
185.00
180.00
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007
Date
RSJ-04
RSJ-01
RSJ-05
RSJ-03
RSJ-02
Readings

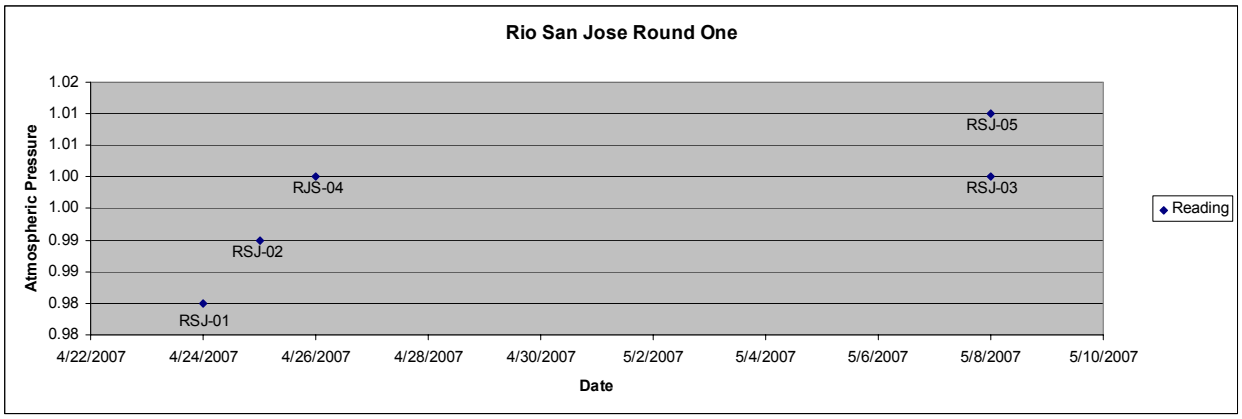

Rio San Jose Round Four
ORP
250.00
200.00
150.00
100.00
50.00
0.00
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
Readings

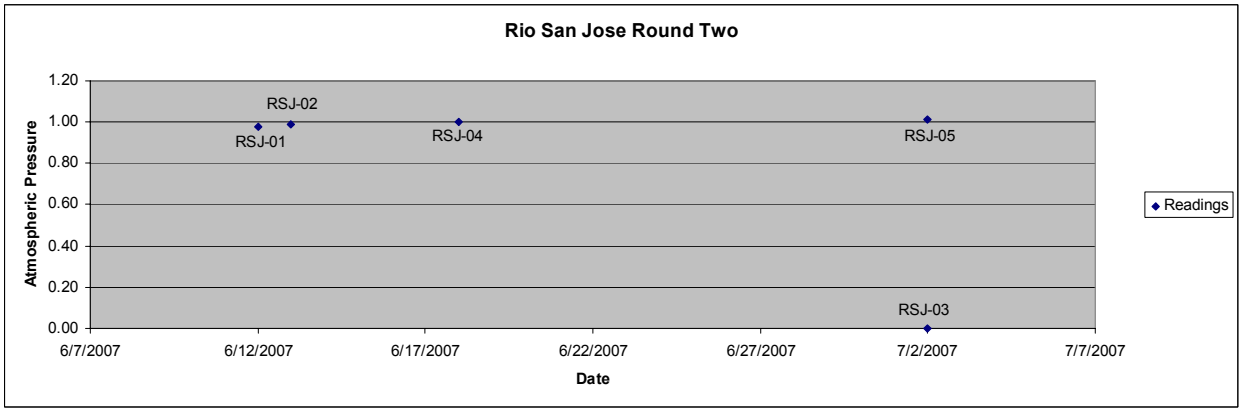

Rio San Jose Round One
25.00
20.00
15.00
10.00
5.00
0.00
DO
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007
Date
Readings

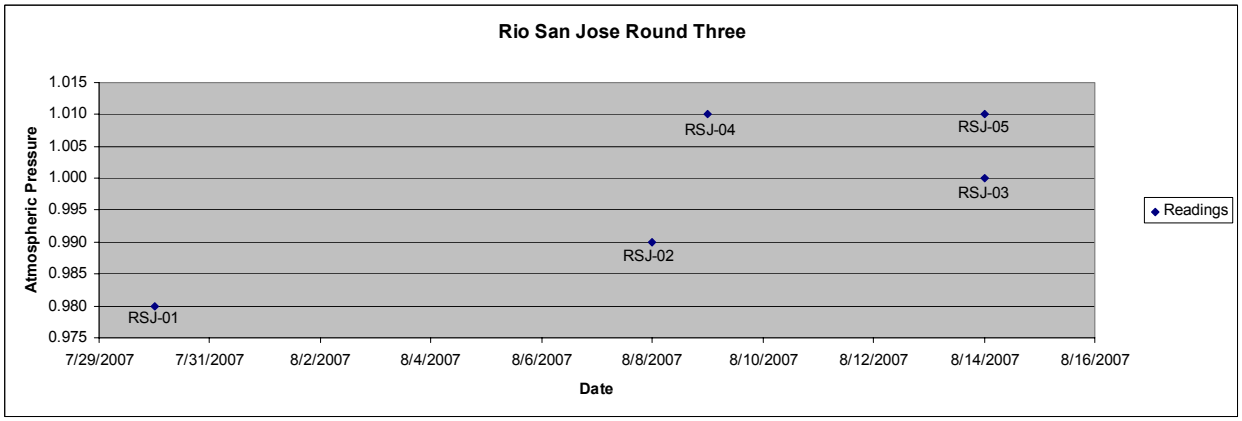

Rio San Jose Round Two
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DO
RSJ-04
RSJ-01
RSJ-05
RSJ-02
RSJ-03
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007
Date
Readings

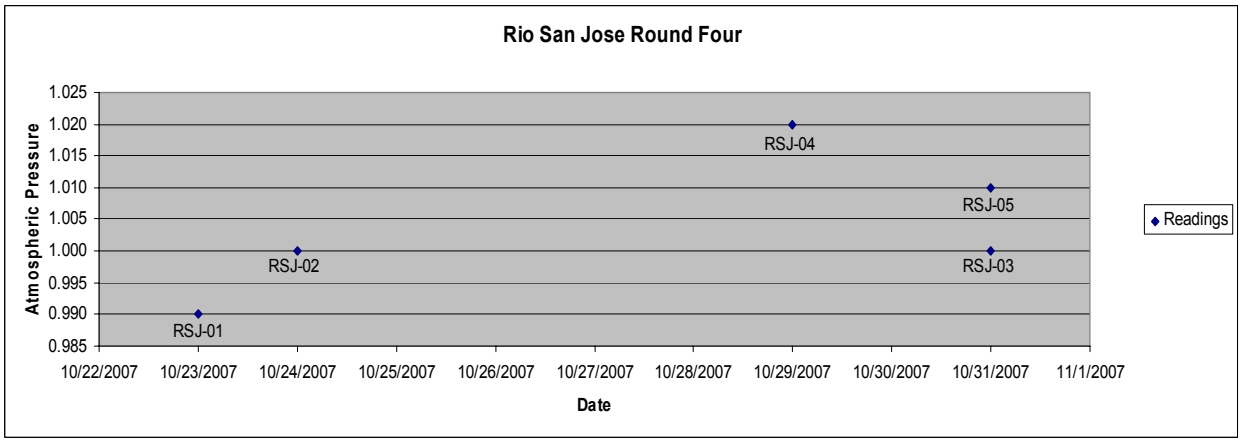

Rio San Jose Round Three
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DO
RSK-01
RSJ-04
RSJ-05
RSJ-03
RSJ-02
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007
Date
Readings

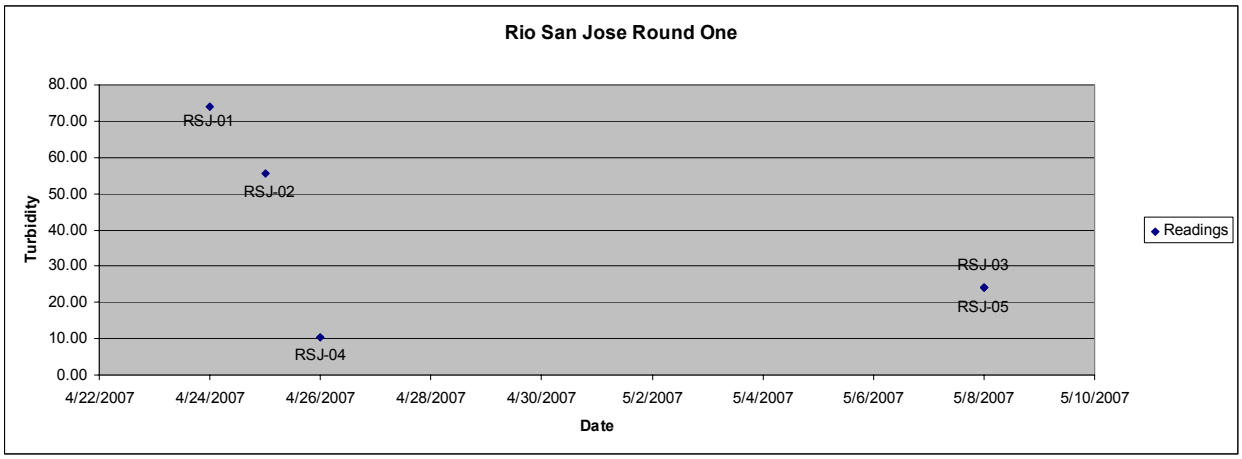

Rio San Jose Round Four
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DO
RSJ-01
RSJ-02
RSJ-04
RSJ-05
RSJ-03
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
Readings

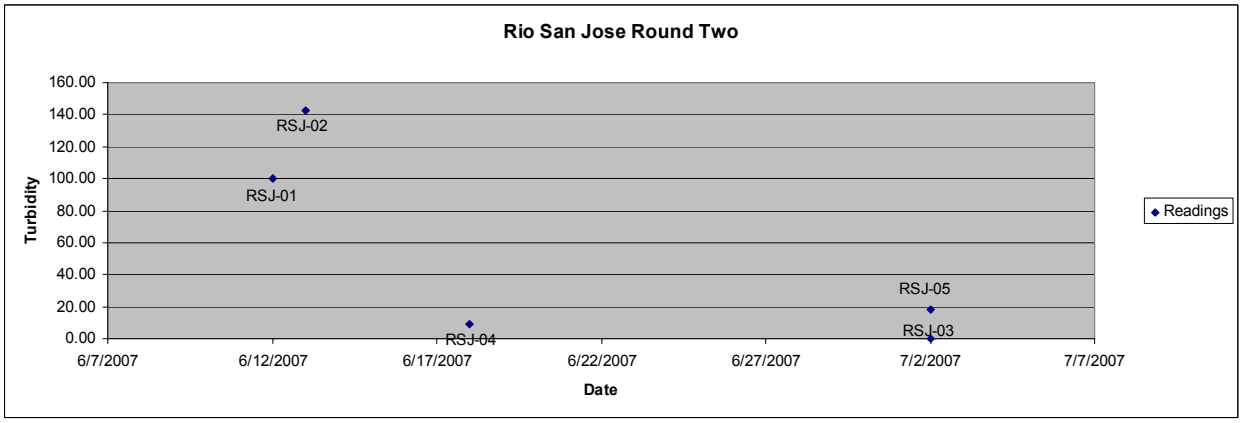

Rio San Jose Round One
Atmospheric Pressure
1.02
1.01
1.01
1.00
1.00
0.99
0.99
0.98
0.98
RSJ-05
RJS-04
RSJ-03
RSJ-02
RSJ-01
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007
Date
Reading

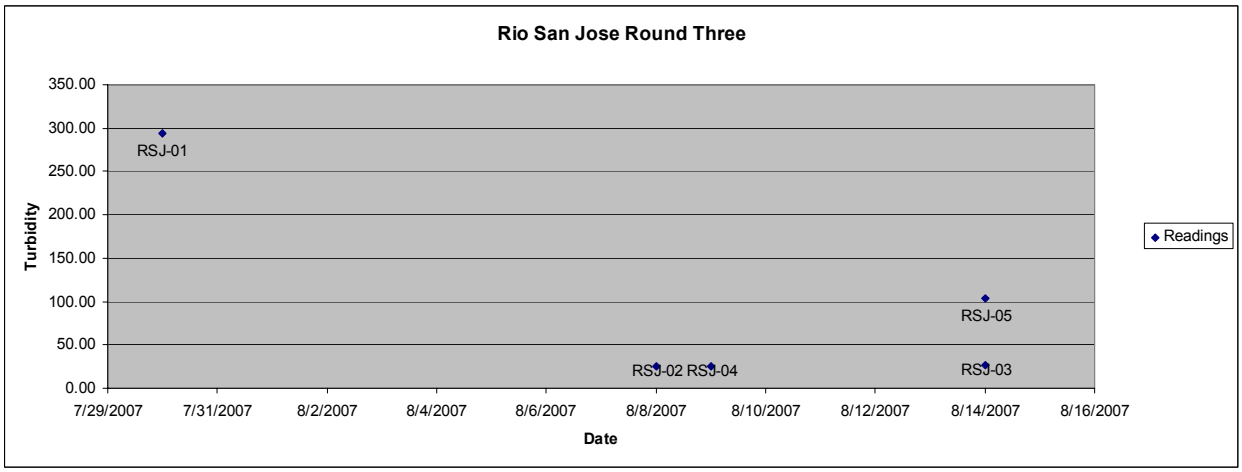

Rio San Jose Round Two
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
RSJ-02
RSJ-01
RSJ-04
RSJ-05
RSJ-03
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007
Date
Readings

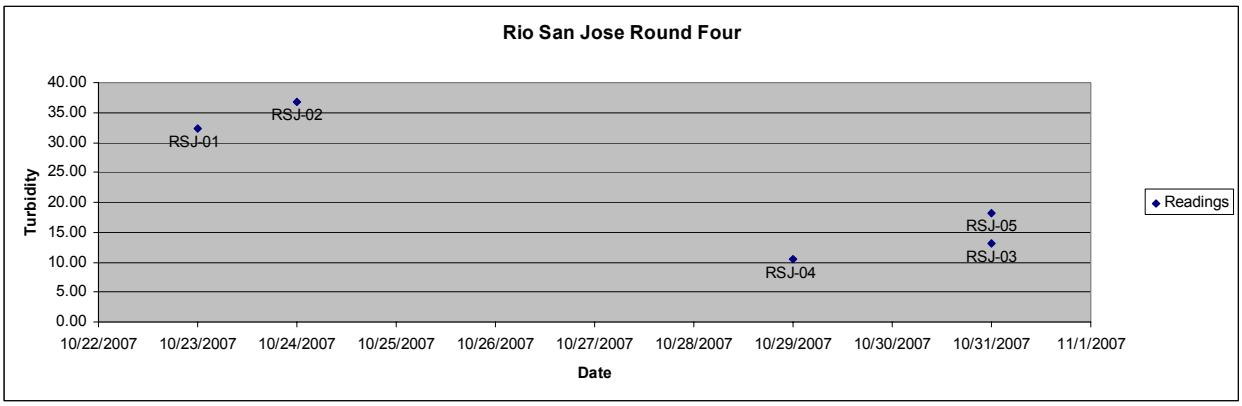

Rio San Jose Round Three
Atmospheric Pressure
1.015
1.010
1.005
1.000
0.995
0.990
0.985
0.980
0.975
RSJ-04
RSJ-05
RSJ-03
RSJ-02
RSJ-01
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007
Date
Readings


Rio San Jose Round Four
Atmospheric Pressure
1.025
1.020
1.015
1.010
1.005
1.000
0.995
0.990
0.985
RSJ-04
RSJ-05
RSJ-02
RSJ-03
RSJ-01
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
Readings

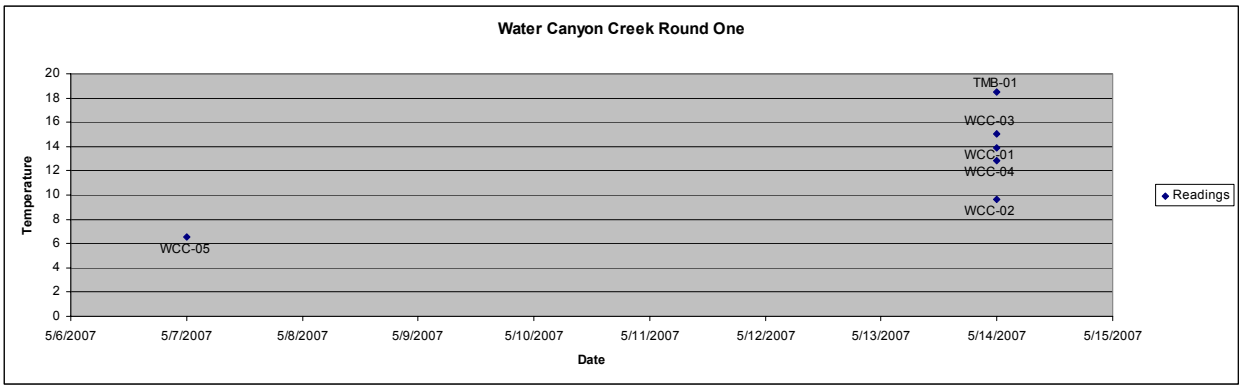

Rio San Jose Round One
Turbidity
Date
Readings
RSJ-01
RSJ-02
RSJ-04
RSJ-03
RSJ-05
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
4/22/2007
4/24/2007
4/26/2007
4/28/2007
4/30/2007
5/2/2007
5/4/2007
5/6/2007
5/8/2007
5/10/2007

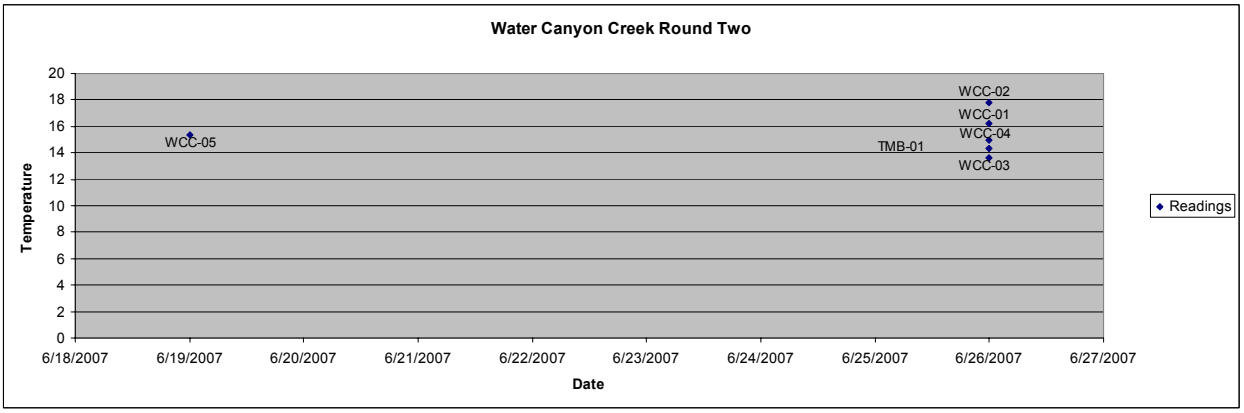

Rio San Jose Round Two
Turbidity
Date
Readings
RSJ-02
RSJ-01
RSJ-04
RSJ-05
RSJ-03
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
6/7/2007
6/12/2007
6/17/2007
6/22/2007
6/27/2007
7/2/2007
7/7/2007

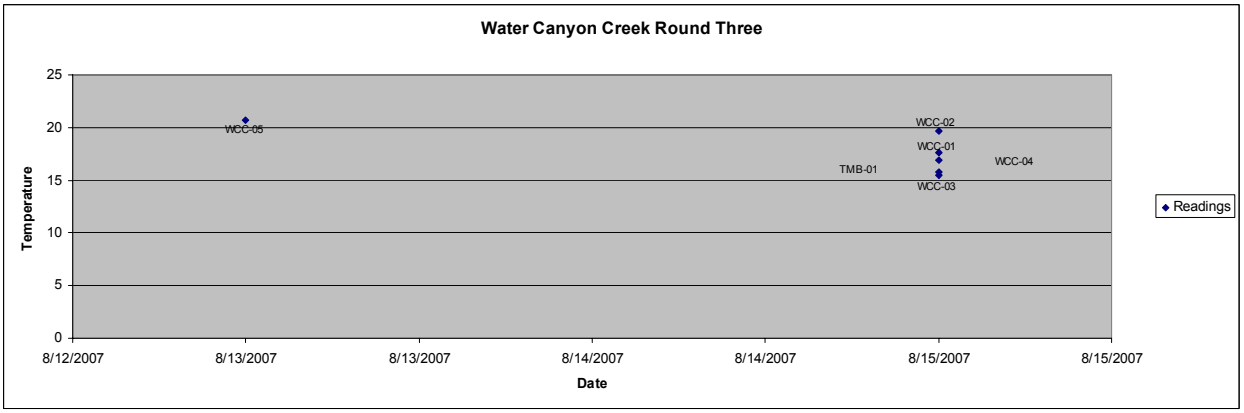

Rio San Jose Round Three
Turbidity
Date
Readings
RSJ-01
RSJ-05
RSJ-02 RSJ-04
RSJ-03
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
7/29/2007
7/31/2007
8/2/2007
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007

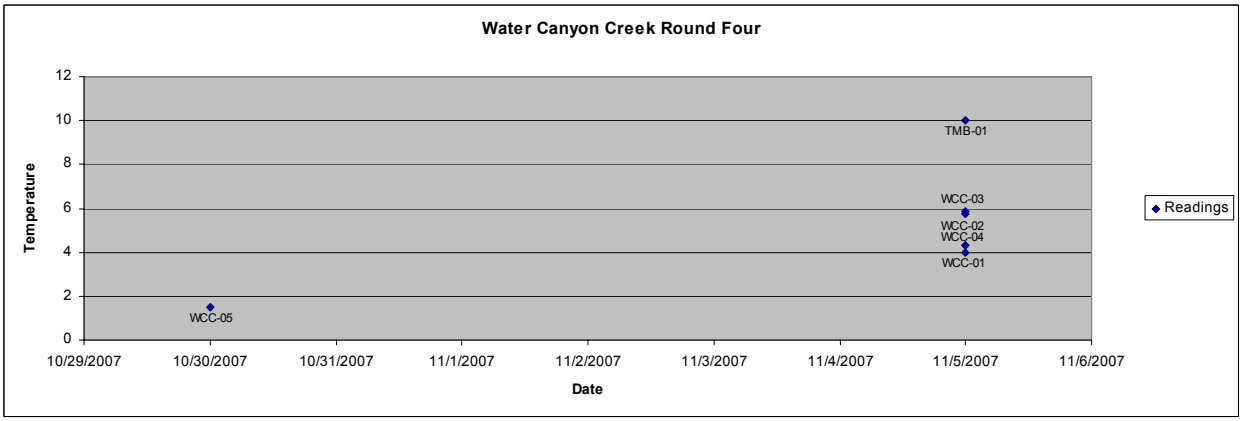

Rio San Jose Round Four
Turbidity
Date
Readings
RSJ-02
RSJ-01
RSJ-05
RSJ-03
RSJ-04
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
10/22/2007
10/23/2007
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007

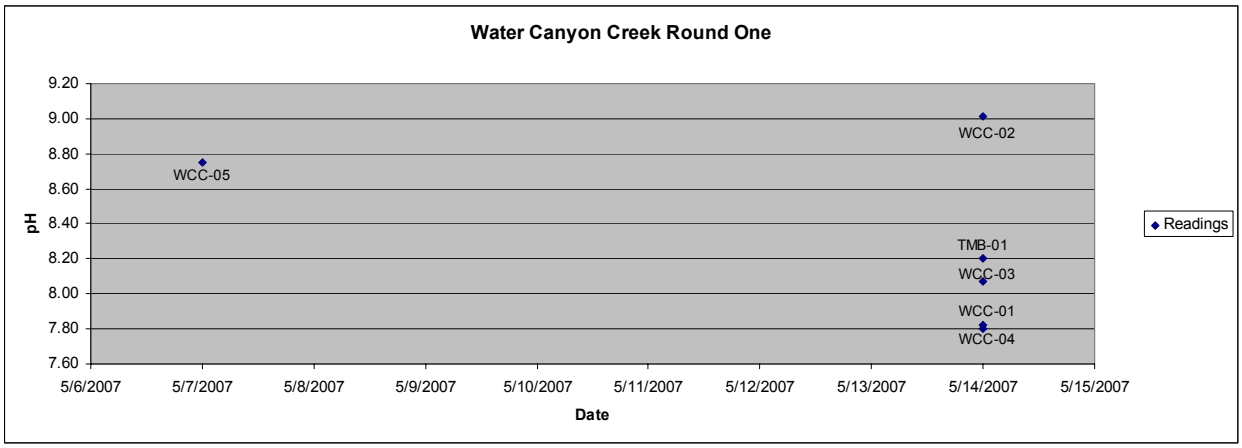
Water Canyon Creek

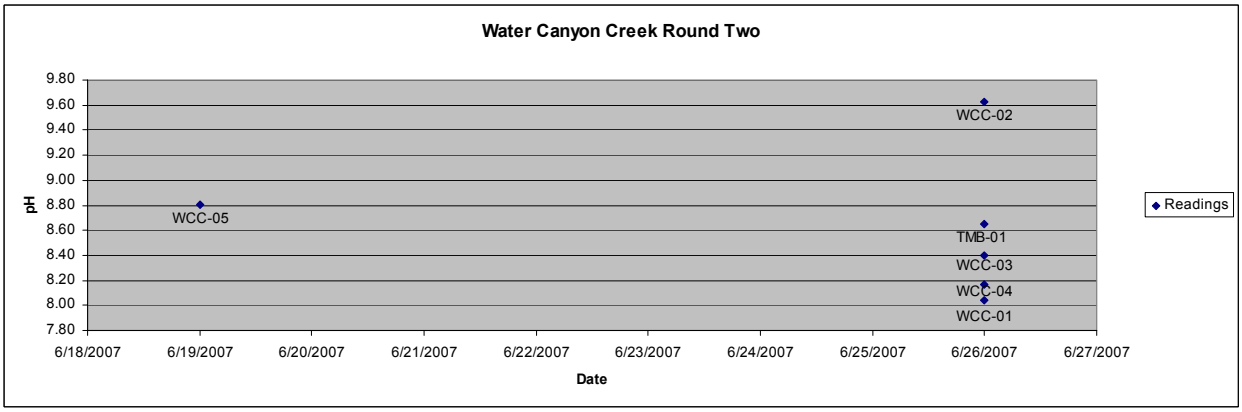


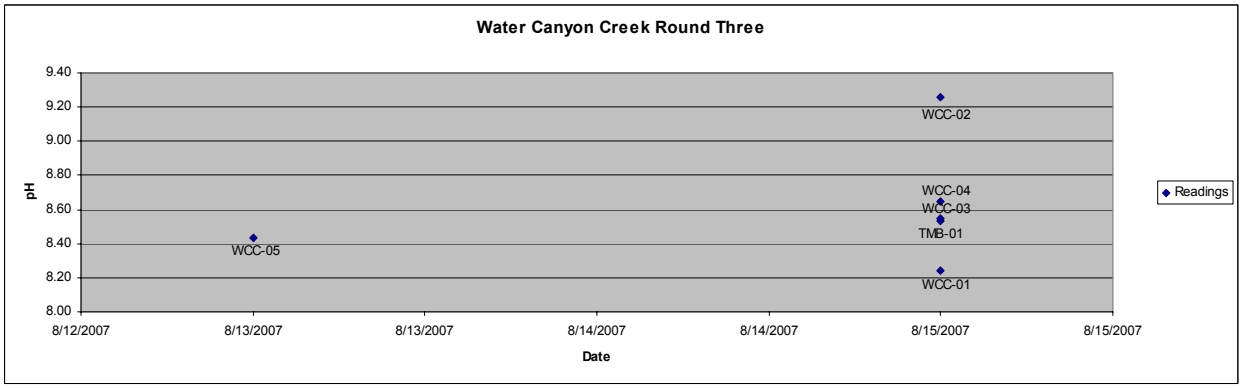


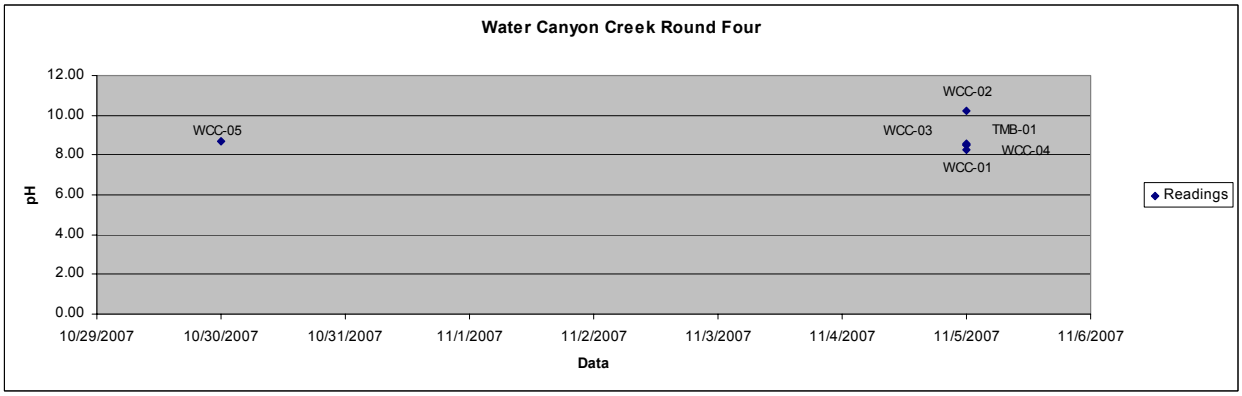


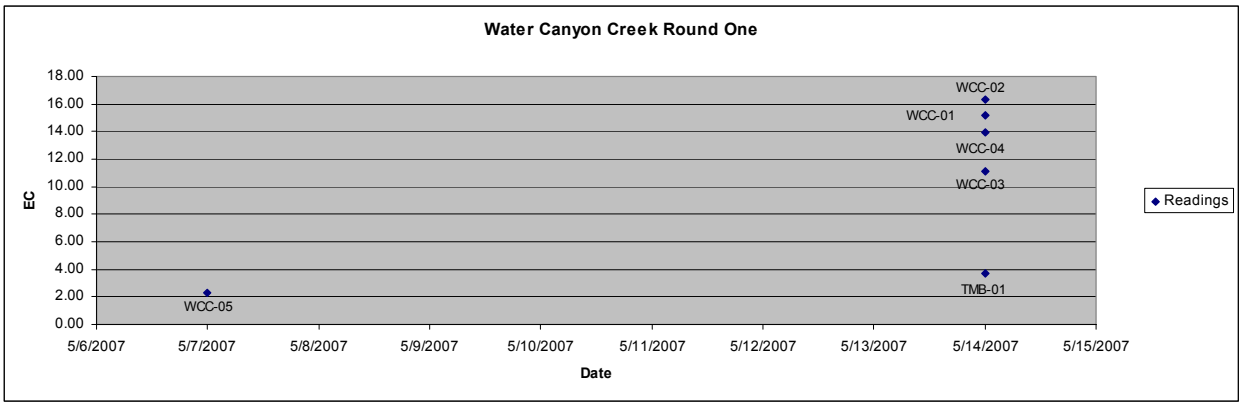


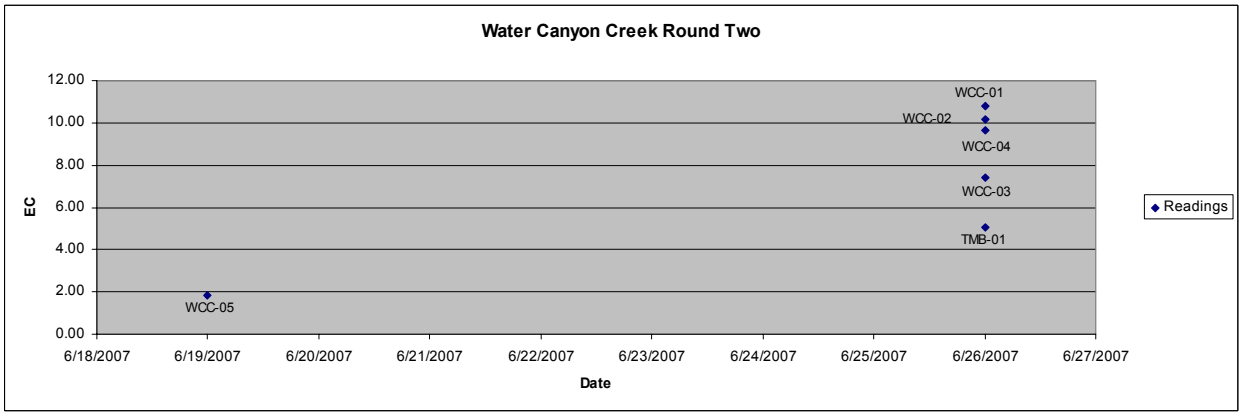

Water Canyon Creek Round One
9.20
9.00
8.80
8.60
8.40
8.20
8.00
7.80
7.60
pH
WCC-05
WCC-02
TMB-01
WCC-03
WCC-01
WCC-04
5/6/2007
5/7/2007
5/8/2007
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
Date
Readings

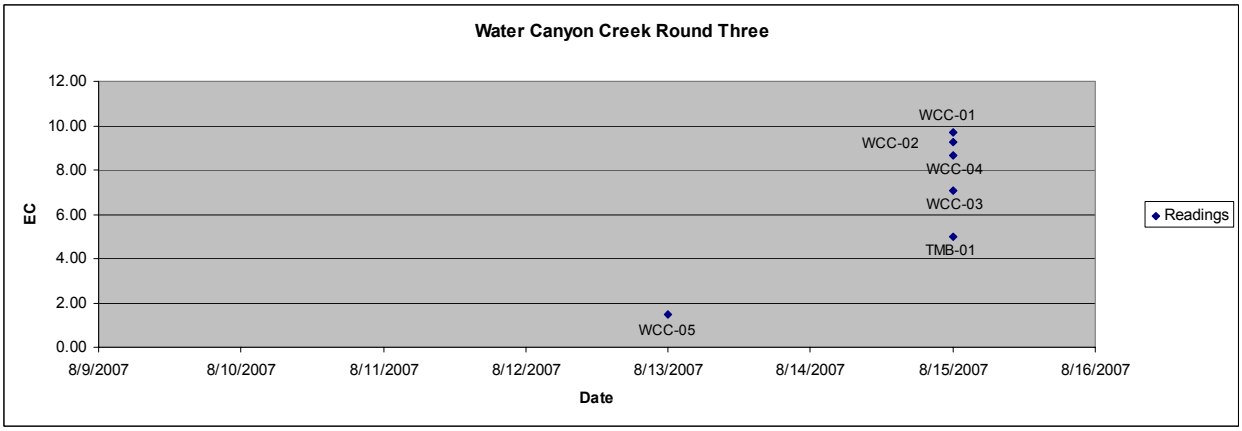

Water Canyon Creek Round Two
9.80
9.60
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
7.80
pH
WCC-05
WCC-02
TMB-01
WCC-03
WCC-04
WCC-01
6/18/2007
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

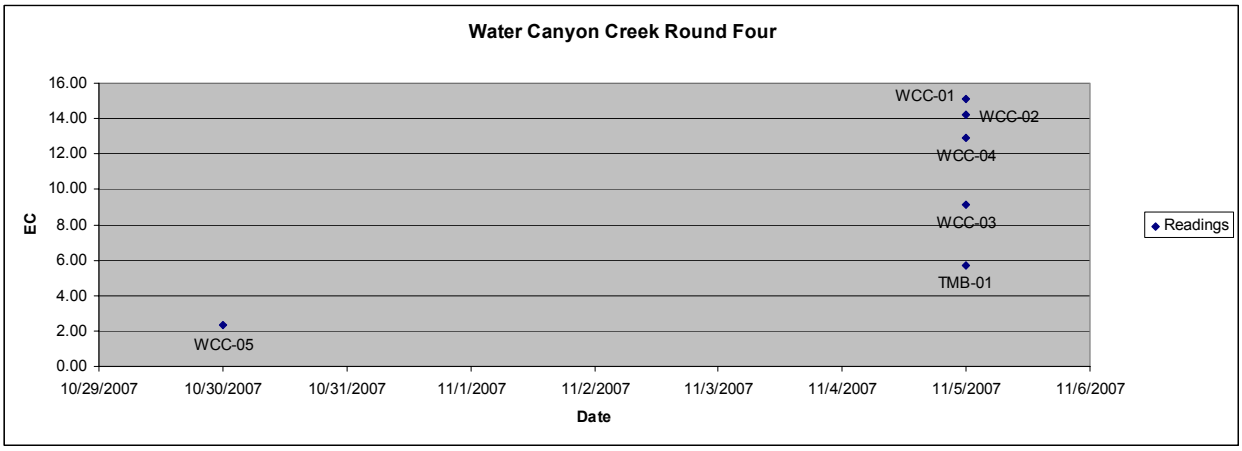

Water Canyon Creek Round Three
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
pH
WCC-02
WCC-04
WCC-03
TMB-01
WCC-05
WCC-01
8/12/2007
8/13/2007
8/13/2007
8/14/2007
8/14/2007
8/15/2007
8/15/2007
Date
Readings

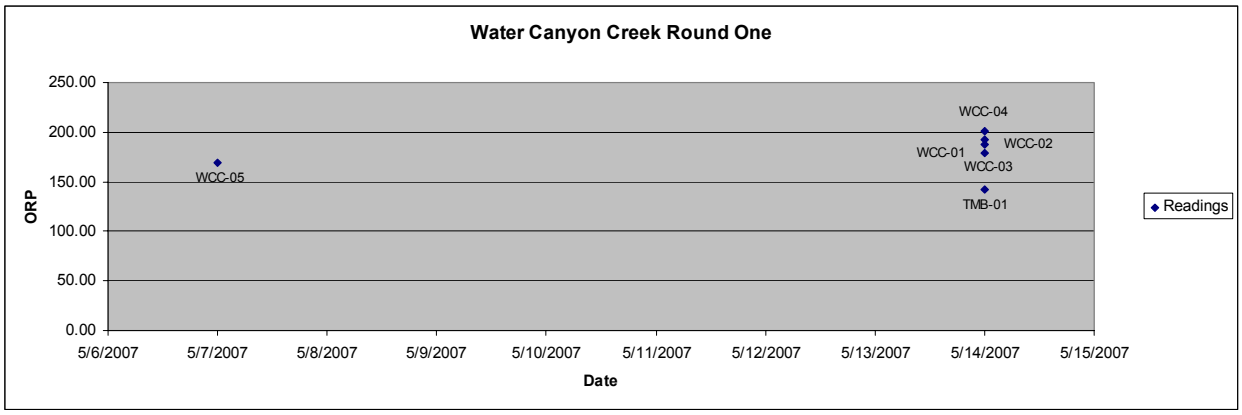

Water Canyon Creek Round Four
12.00
10.00
8.00
6.00
4.00
2.00
0.00
pH
WCC-02
WCC-05
WCC-03
TMB-01
WCC-04
WCC-01
10/29/2007
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
Data
Readings

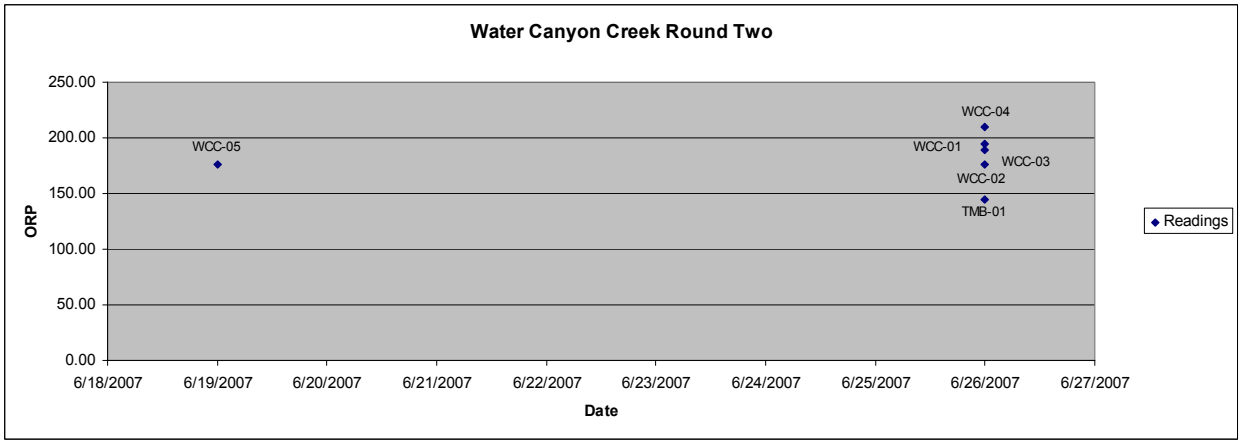

Water Canyon Creek Round One
EC
Date
Readings
WCC-02
WCC-01
WCC-04
WCC-03
TMB-01
WCC-05
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
5/6/2007
5/7/2007
5/8/2007
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007

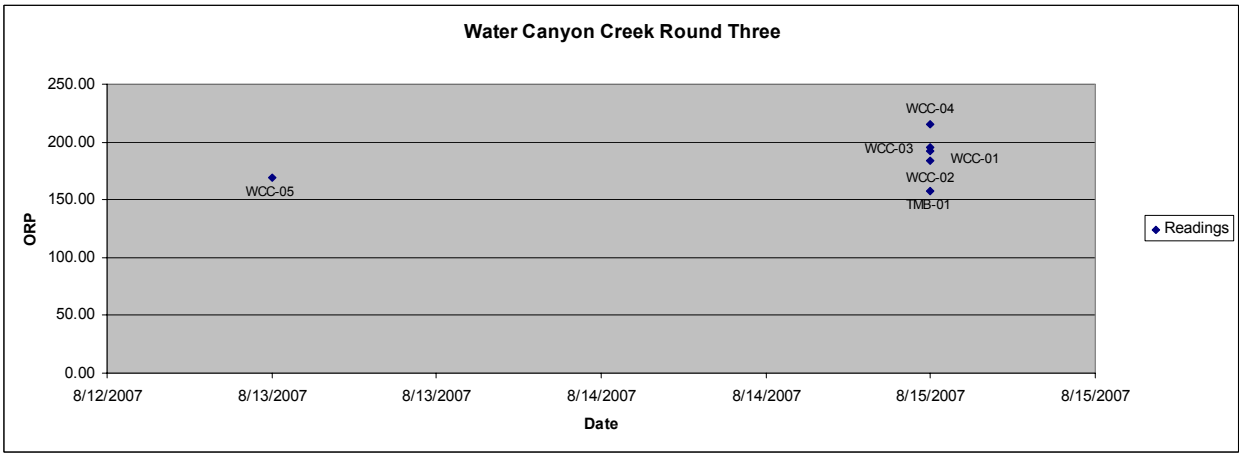

Water Canyon Creek Round Two
EC
Date
Readings
WCC-01
WCC-02
WCC-04
WCC-03
TMB-01
WCC-05
12.00
10.00
8.00
6.00
4.00
2.00
0.00
6/18/2007
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007

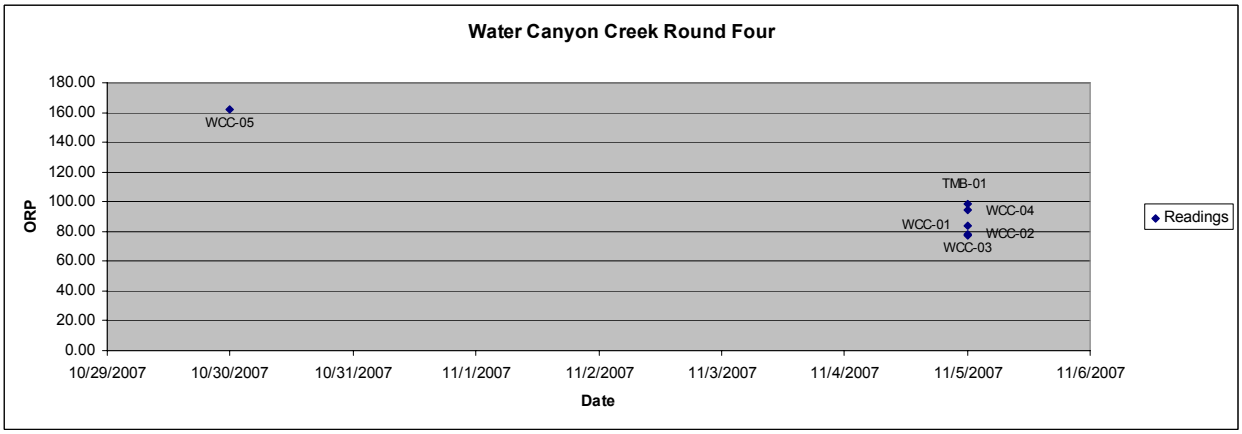

Water Canyon Creek Round Three
EC
Date
Readings
WCC-01
WCC-02
WCC-04
WCC-03
TMB-01
WCC-05
12.00
10.00
8.00
6.00
4.00
2.00
0.00
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007

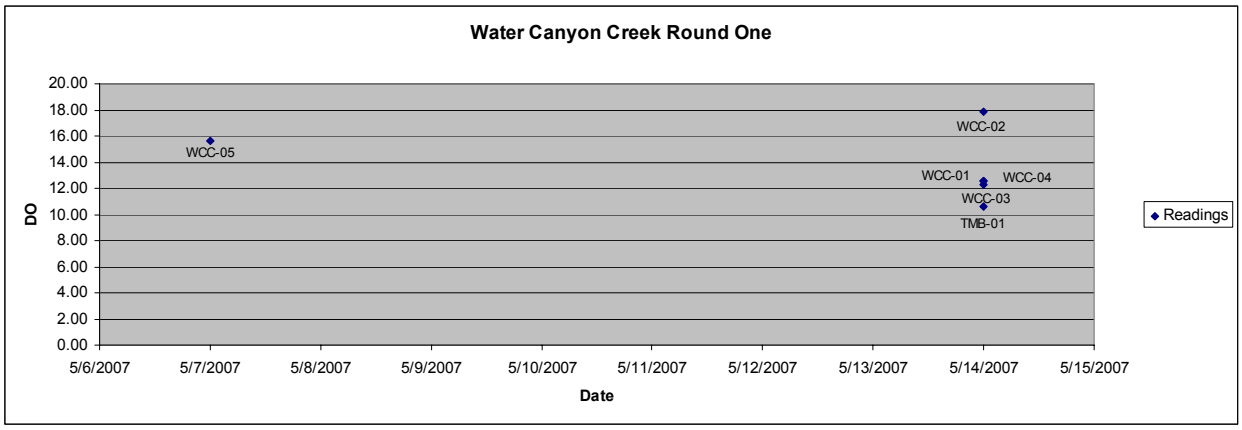

Water Canyon Creek Round Four
EC
Date
Readings
WCC-01
WCC-02
WCC-04
WCC-03
TMB-01
WCC-05
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
10/29/2007
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007

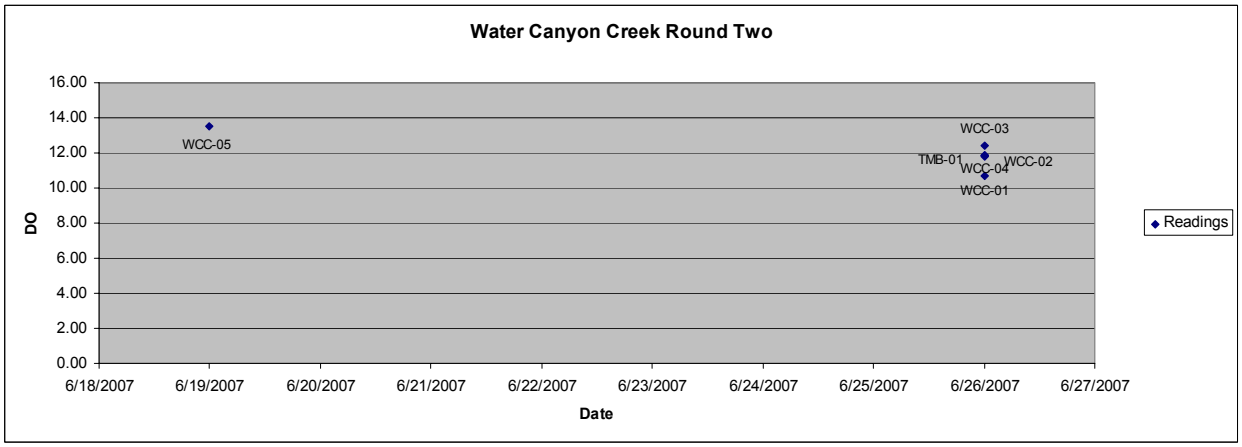

Water Canyon Creek Round One
ORP
250.00
200.00
150.00
100.00
50.00
0.00
5/6/2007
5/7/2007
5/8/2007
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
Date
WCC-05
WCC-04
WCC-01
WCC-02
WCC-03
TMB-01
Readings

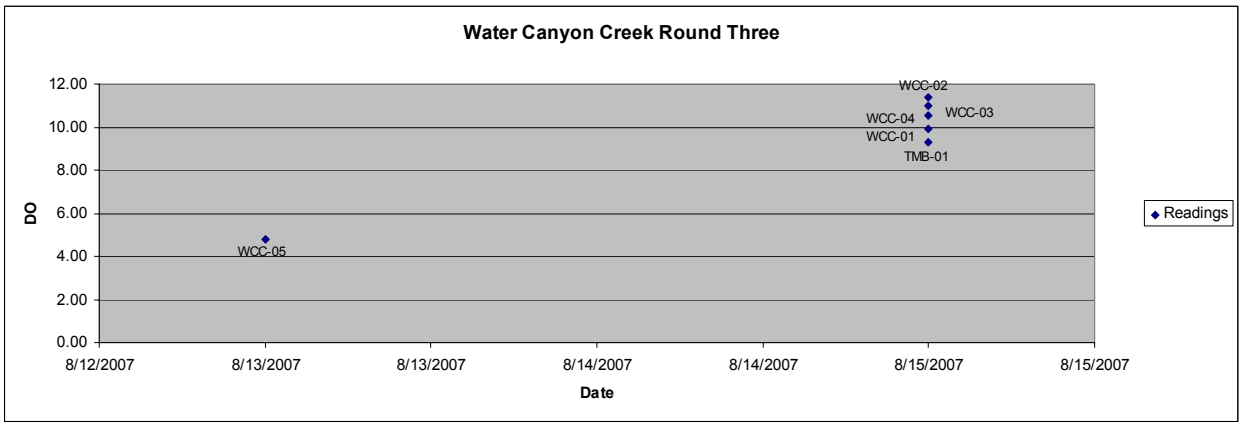

Water Canyon Creek Round Two
ORP
250.00
200.00
150.00
100.00
50.00
0.00
6/18/2007
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
WCC-05
WCC-04
WCC-01
WCC-03
WCC-02
TMB-01
Readings

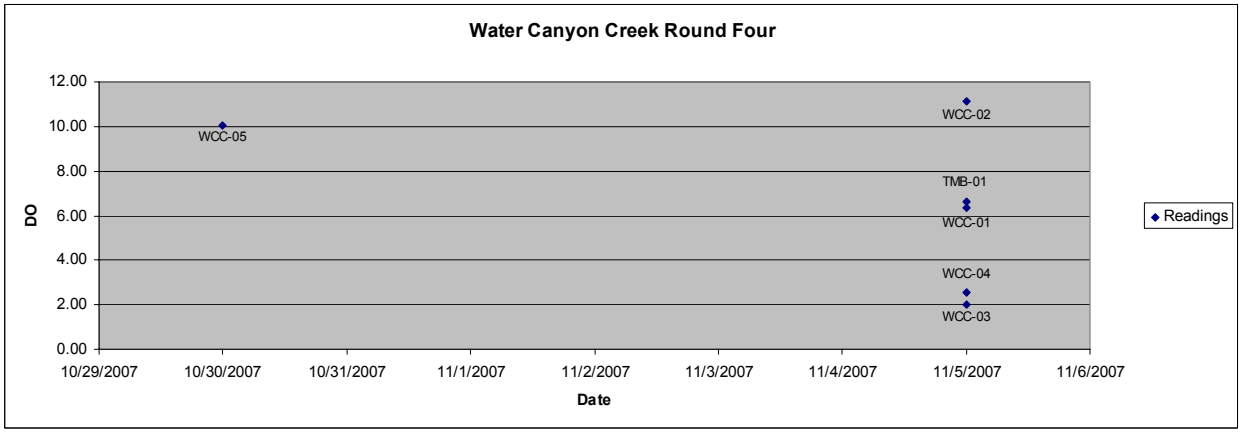

Water Canyon Creek Round Three
ORP
250.00
200.00
150.00
100.00
50.00
0.00
8/12/2007
8/13/2007
8/13/2007
8/14/2007
8/14/2007
8/15/2007
8/15/2007
Date
WCC-05
WCC-04
WCC-03
WCC-01
WCC-02
TMB-01
Readings

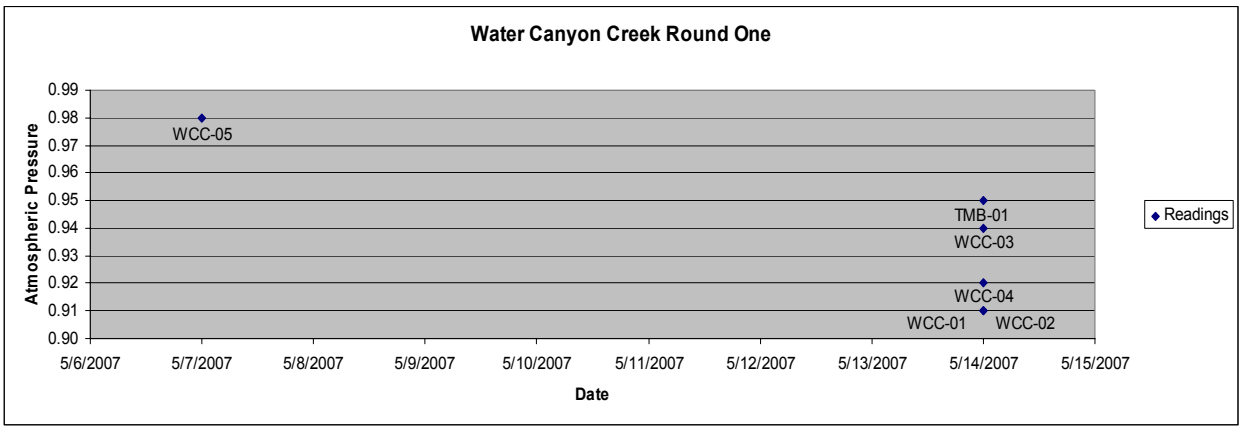

Water Canyon Creek Round Four
ORP
180.00
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
10/29/2007
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
Date
WCC-05
TMB-01
WCC-04
WCC-01
WCC-02
WCC-03
Readings

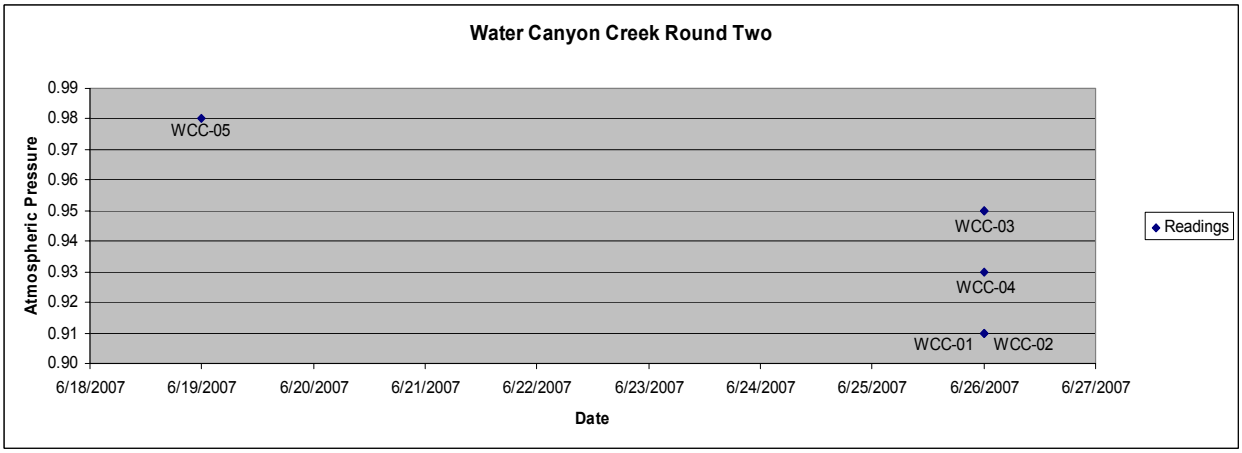

Water Canyon Creek Round One
DO
Date
Readings
WCC-05
WCC-02
WCC-01
WCC-04
WCC-03
TMB-01

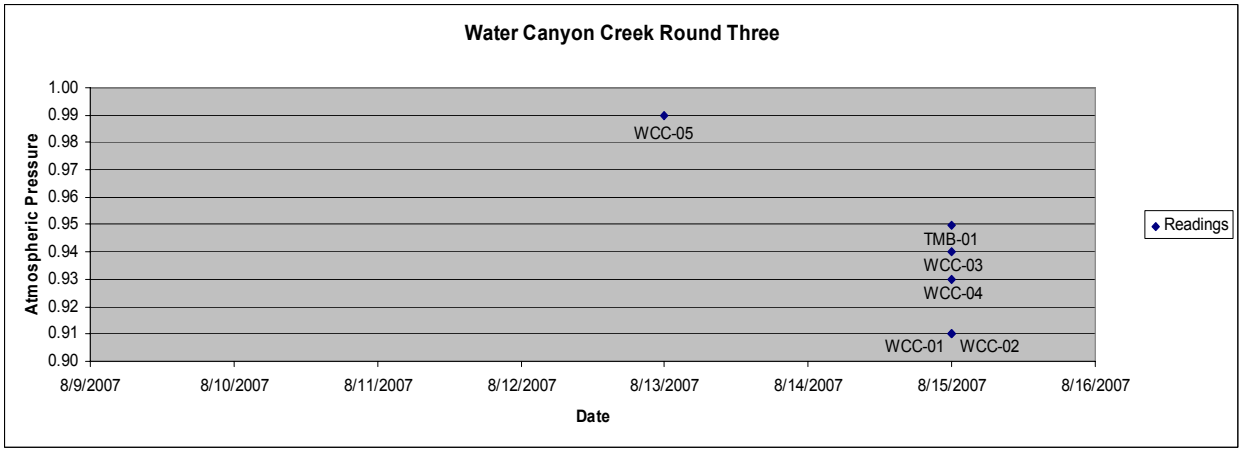

Water Canyon Creek Round Two
DO
Date
Readings
WCC-05
WCC-03
TMB-01
WCC-02
WCC-04
WCC-01

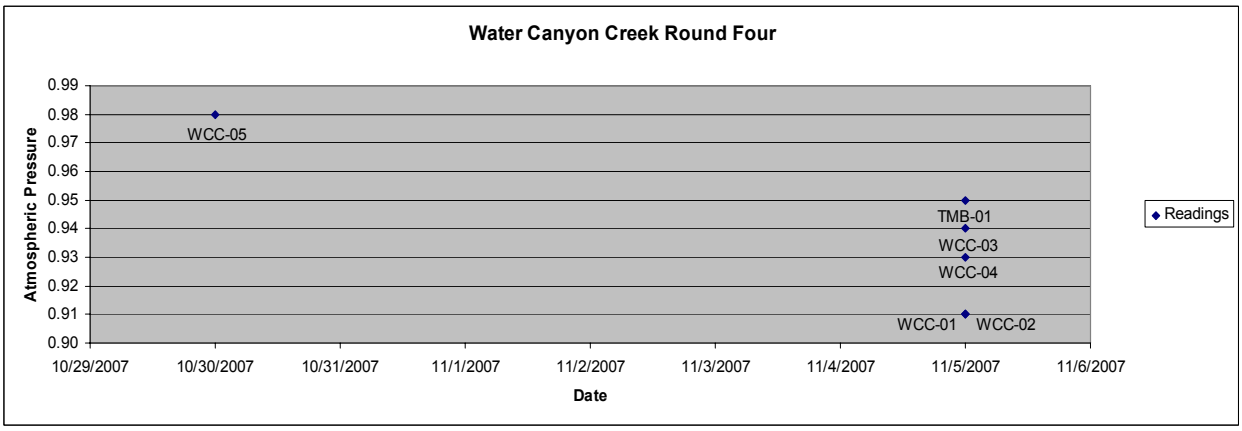

Water Canyon Creek Round Three
DO
Date
Readings
WCC-02
WCC-04
WCC-03
WCC-01
TMB-01
WCC-05

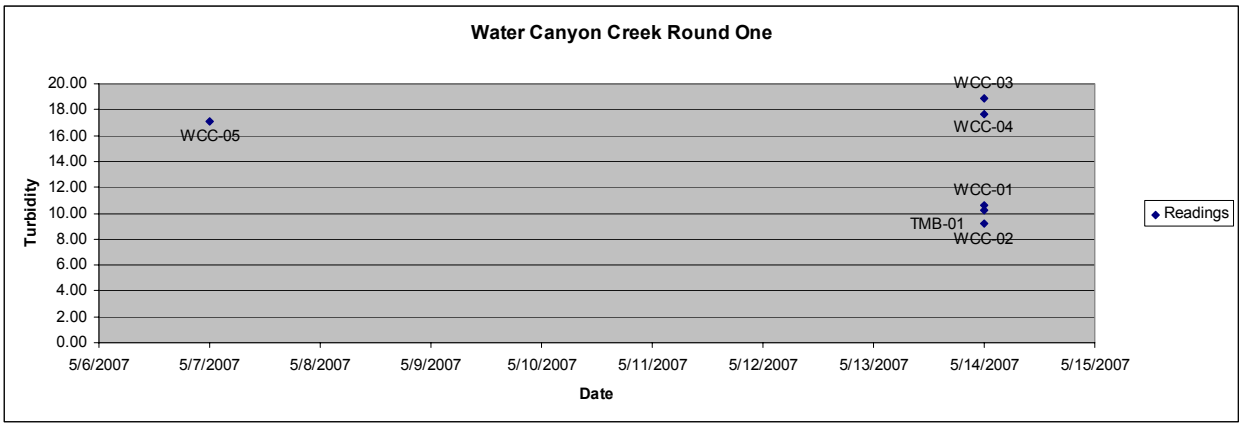

Water Canyon Creek Round Four
DO
Date
Readings
WCC-05
WCC-02
TMB-01
WCC-01
WCC-04
WCC-03

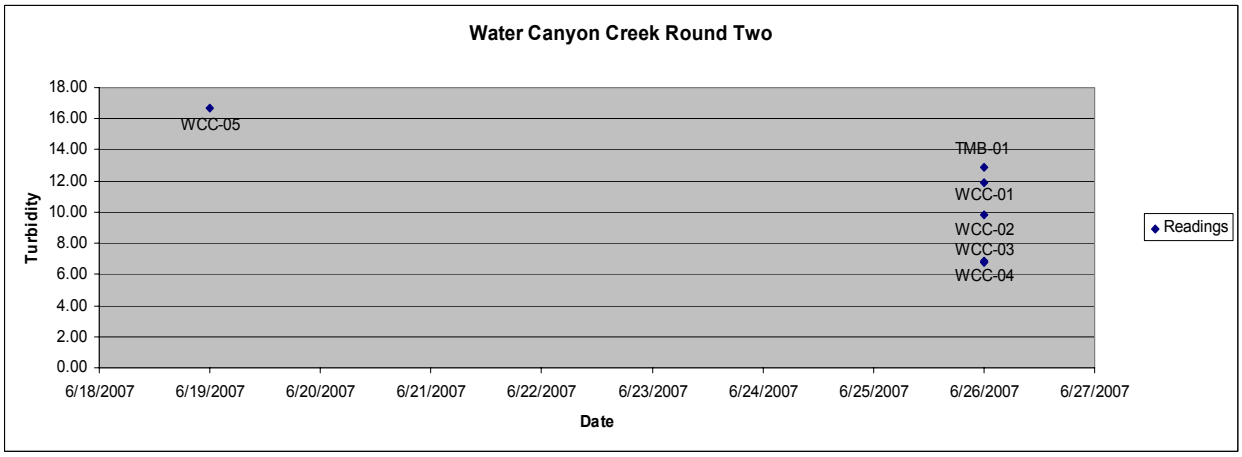

Water Canyon Creek Round One
Atmospheric Pressure
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
5/6/2007
5/7/2007
5/8/2007
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007
Date
Readings

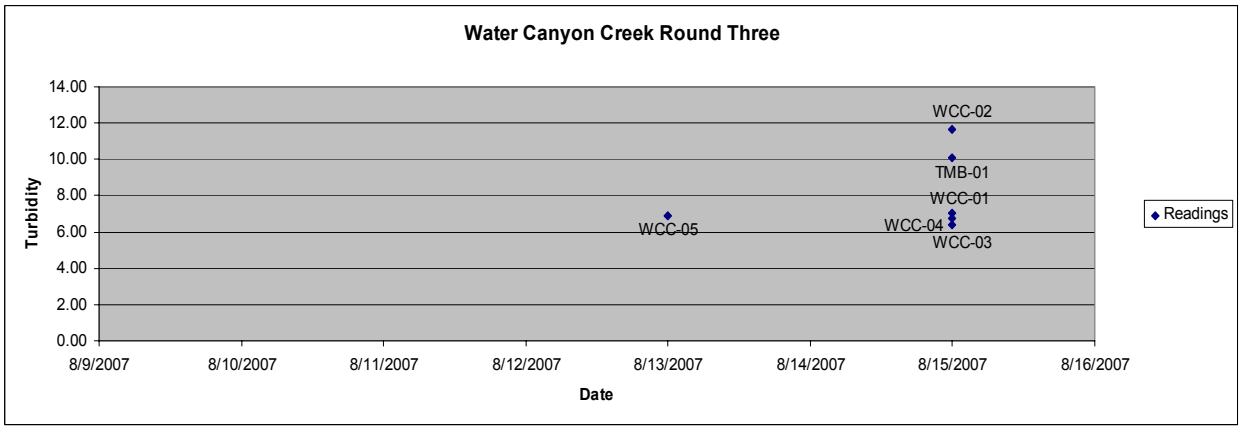

Water Canyon Creek Round Two
Atmospheric Pressure
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
WCC-05
WCC-03
WCC-04
WCC-01
WCC-02
6/18/2007
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

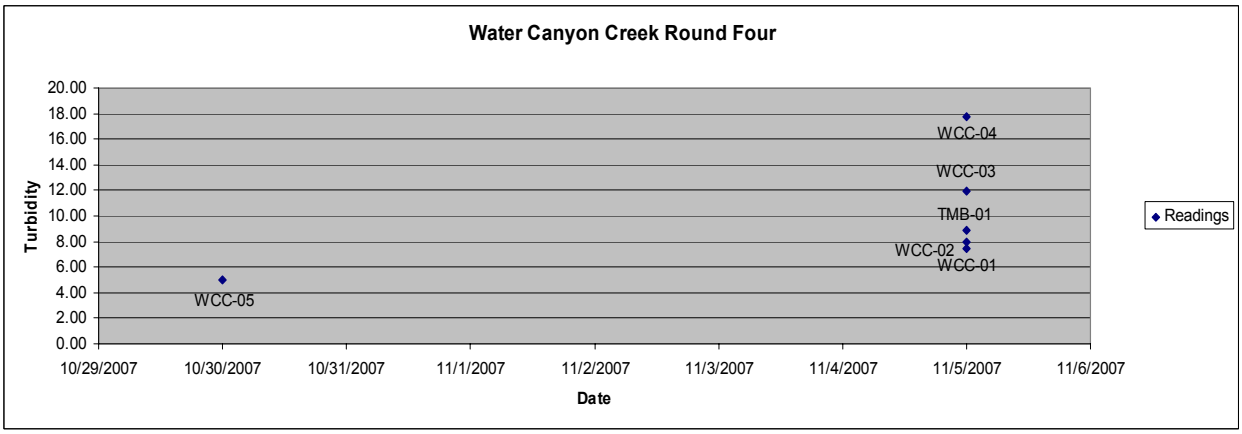

Water Canyon Creek Round Three
Atmospheric Pressure
1.00
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date
Readings


Water Canyon Creek Round Four
Atmospheric Pressure
0.99
0.98
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.90
WCC-05
TMB-01
WCC-03
WCC-04
WCC-01
WCC-02
10/29/2007
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
Date
Readings

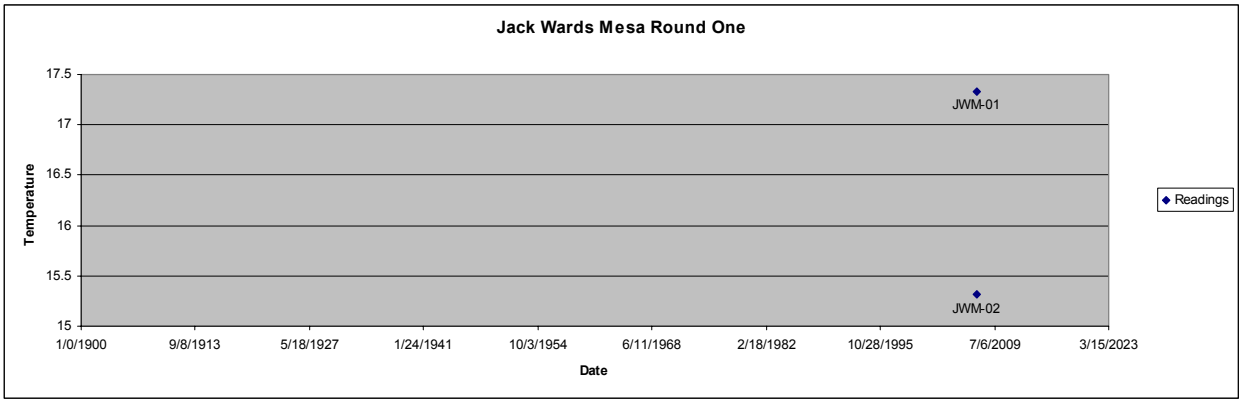

Water Canyon Creek Round One
Turbidity
Date
Readings
WCC-05
WCC-03
WCC-04
WCC-01
TMB-01
WCC-02
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
5/6/2007
5/7/2007
5/8/2007
5/9/2007
5/10/2007
5/11/2007
5/12/2007
5/13/2007
5/14/2007
5/15/2007

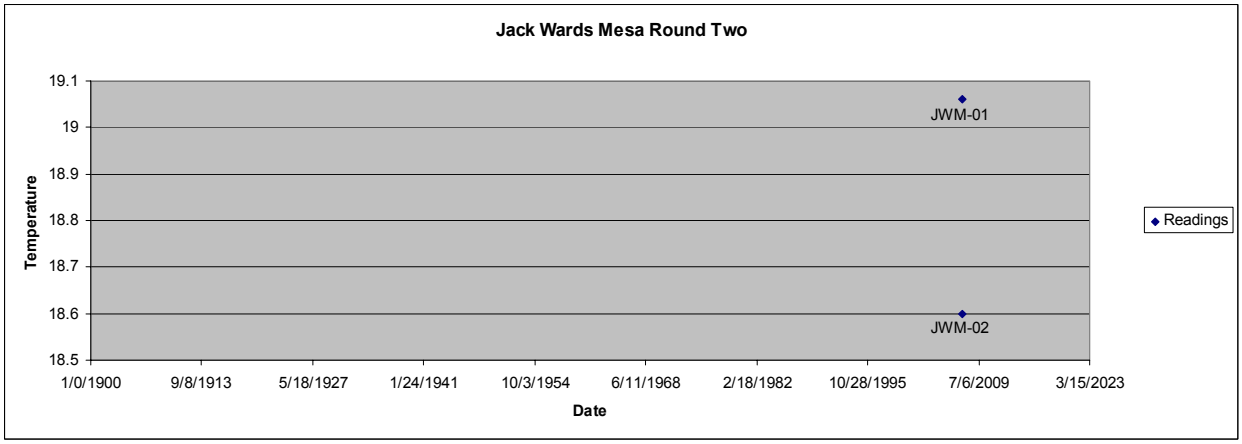

Water Canyon Creek Round Two
Turbidity
Date
Readings
WCC-05
TMB-01
WCC-01
WCC-02
WCC-03
WCC-04
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
6/18/2007
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007

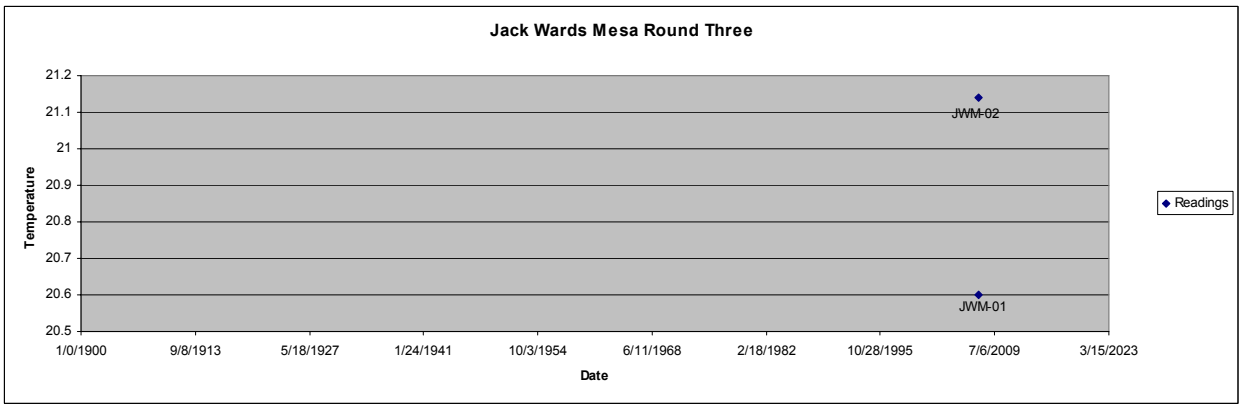

Water Canyon Creek Round Three
Turbidity
Date
Readings
WCC-02
TMB-01
WCC-01
WCC-05
WCC-04
WCC-03
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007

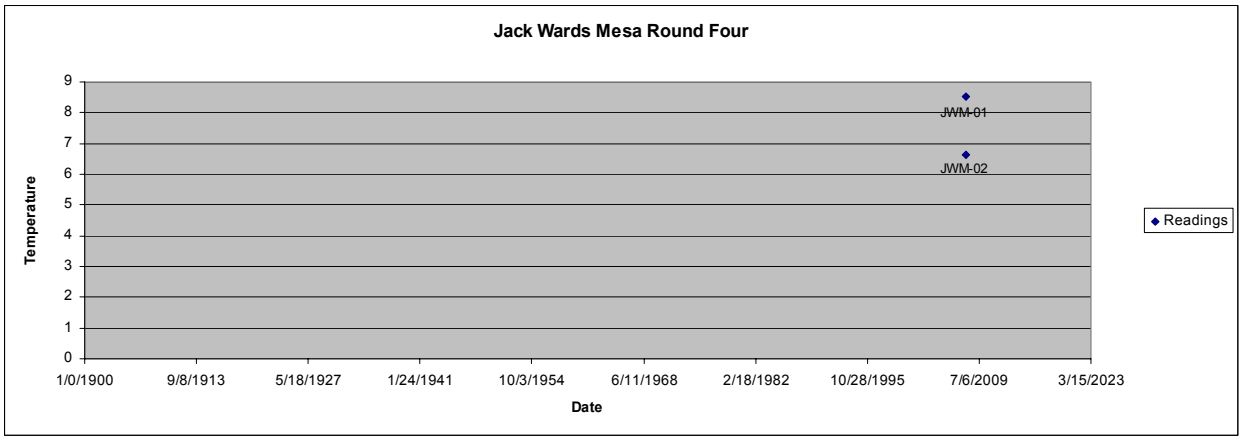

Water Canyon Creek Round Four
Turbidity
Date
Readings
WCC-04
WCC-03
TMB-01
WCC-02
WCC-01
WCC-05
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
10/29/2007
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007

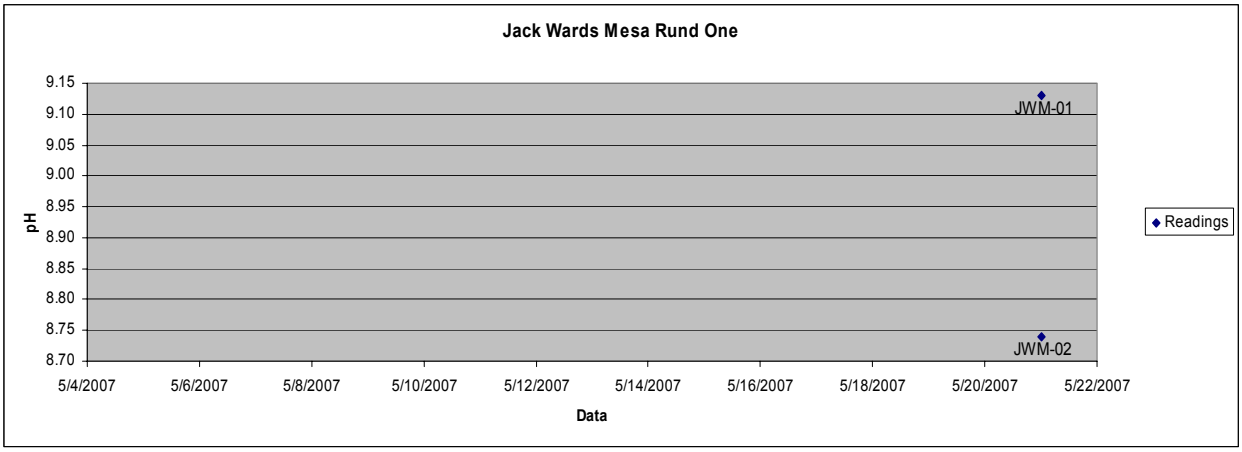
Jack Wards Mesa

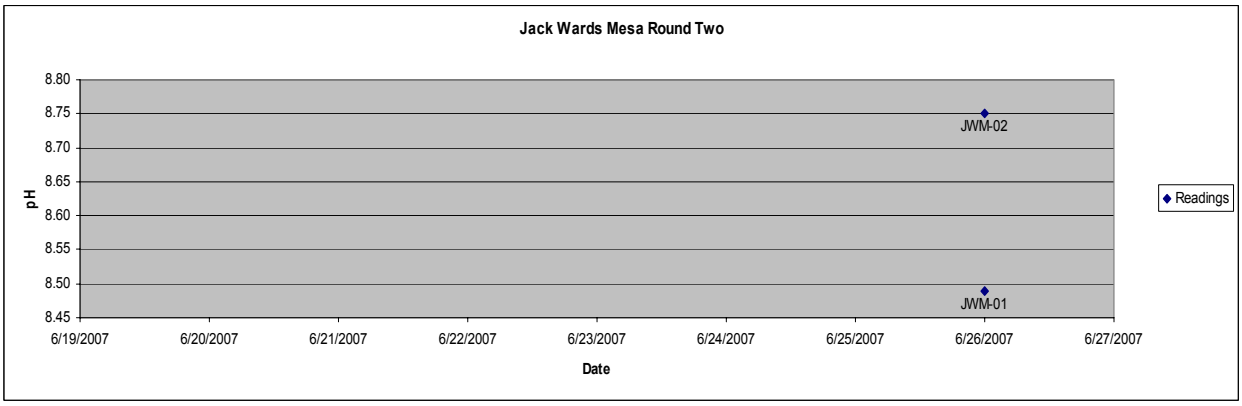


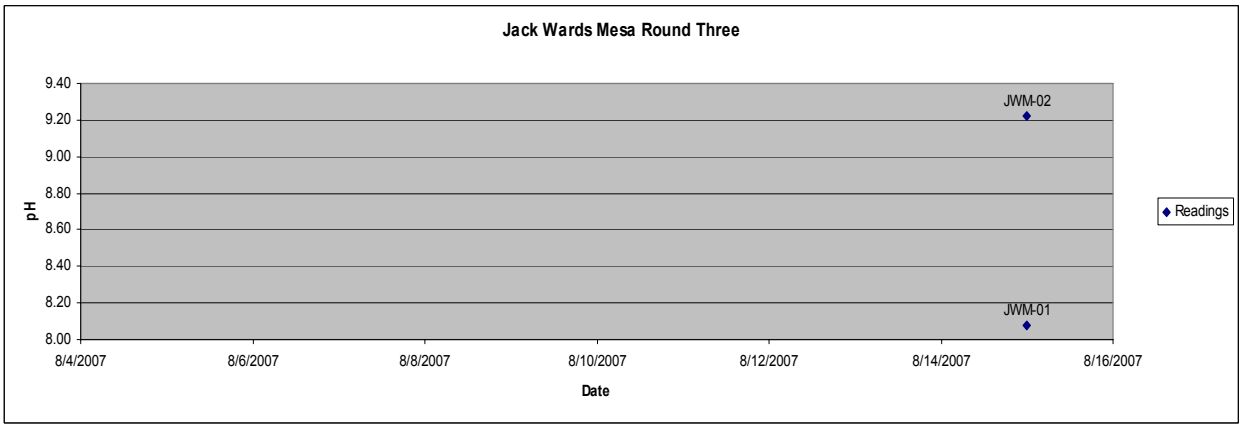


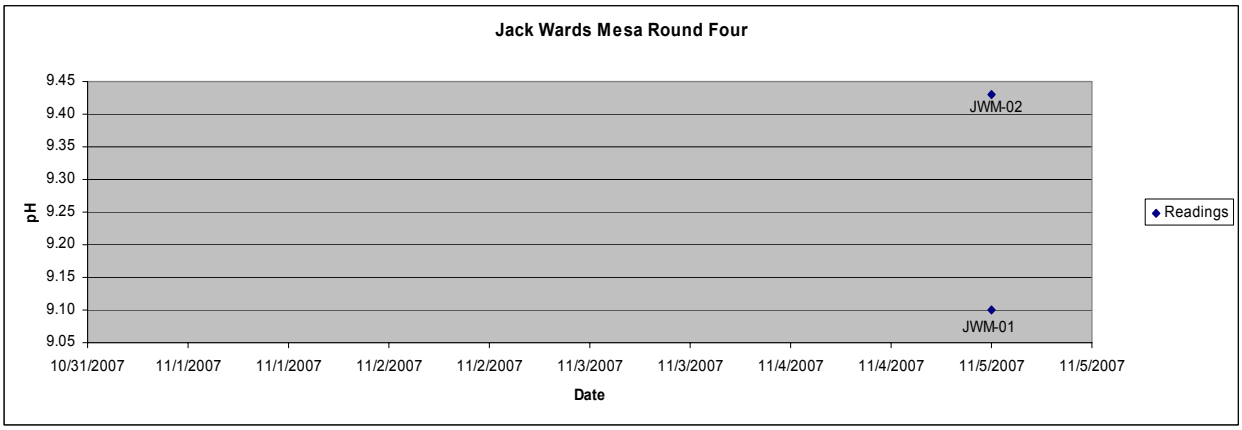


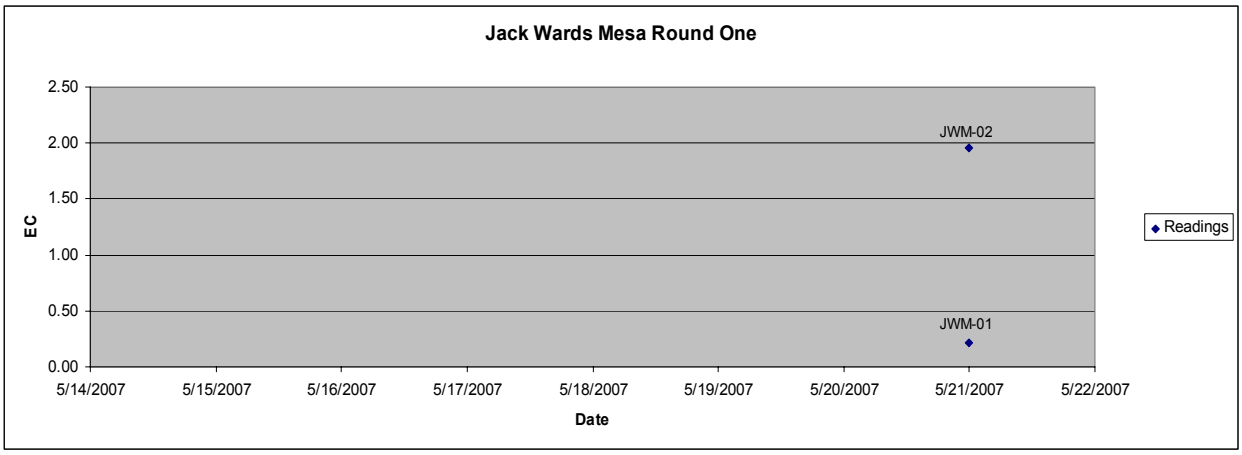


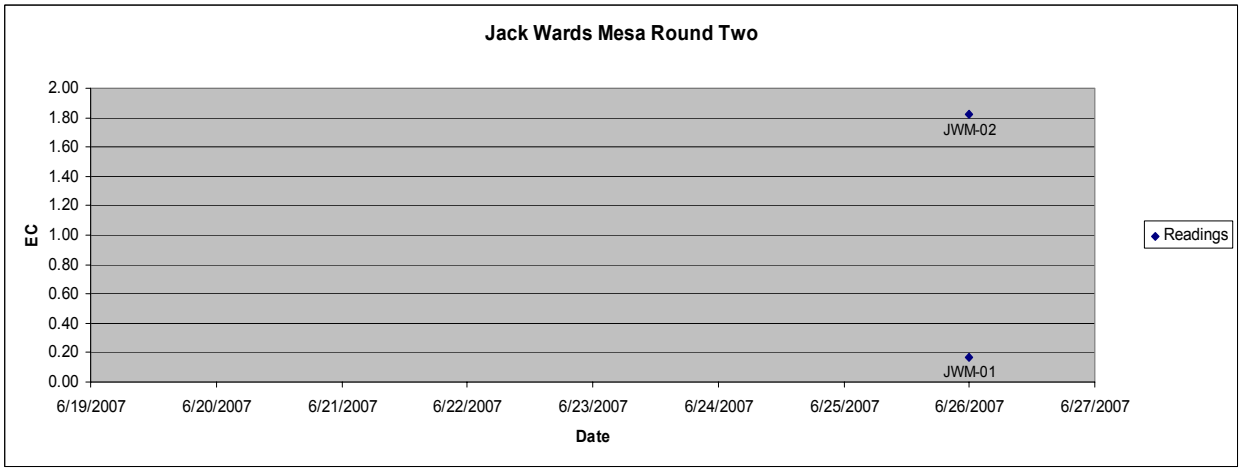

Jack Wards Mesa Rund One
9.15
9.10
9.05
9.00
8.95
8.90
8.85
8.80
8.75
8.70
pH
JWM-01
JWM-02
5/4/2007
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
Data
Readings

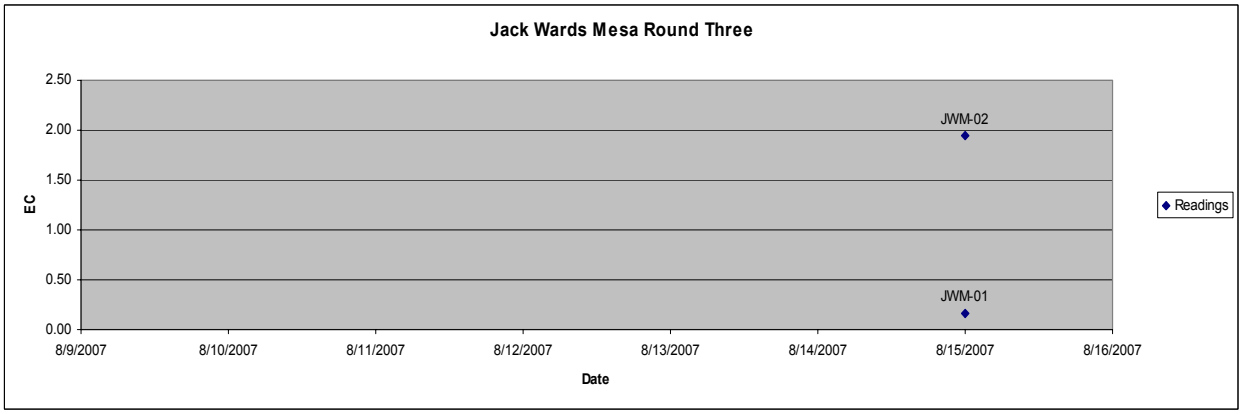

Jack Wards Mesa Round Two
8.80
8.75
8.70
8.65
8.60
8.55
8.50
8.45
pH
JWM-02
JWM-01
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

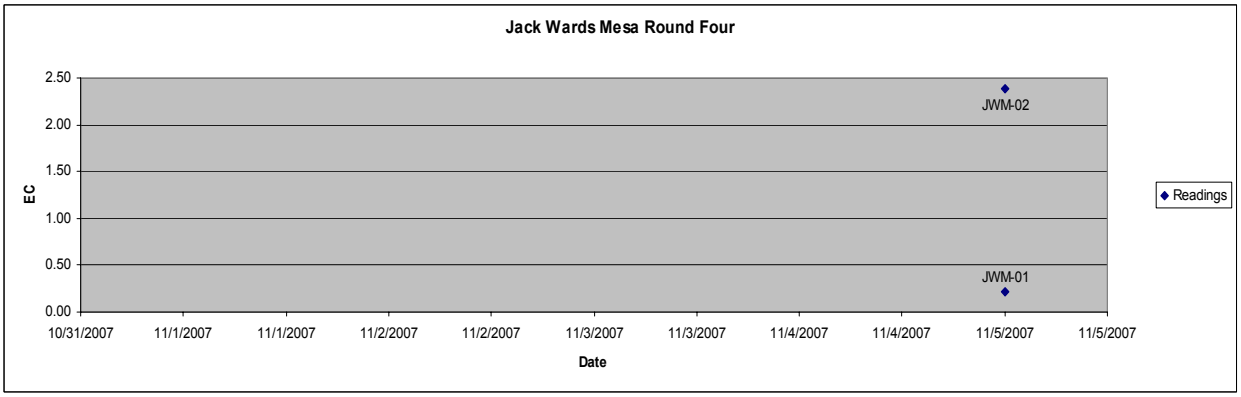

Jack Wards Mesa Round Three
9.40
9.20
9.00
8.80
8.60
8.40
8.20
8.00
pH
JWM-02
JWM-01
8/4/2007
8/6/2007
8/8/2007
8/10/2007
8/12/2007
8/14/2007
8/16/2007
Date
Readings

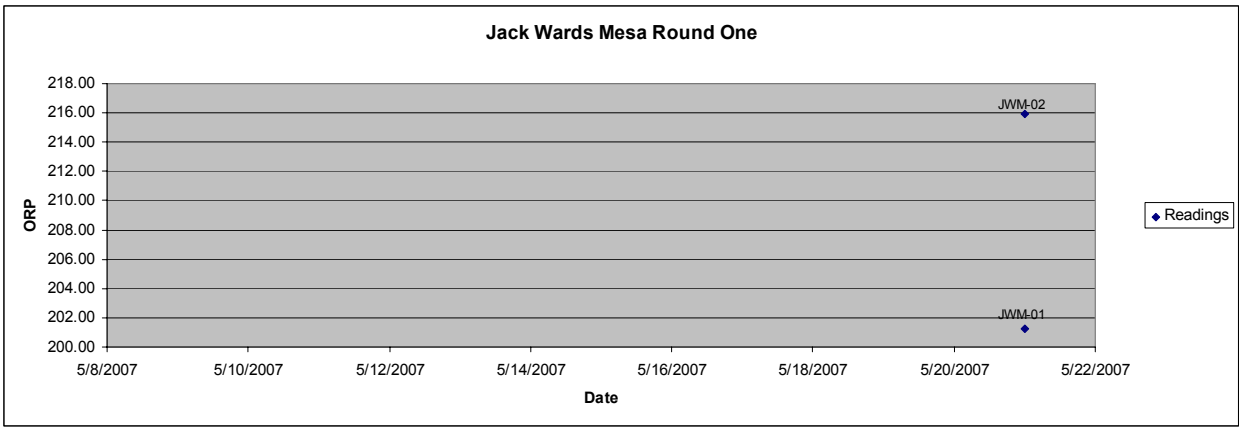

Jack Wards Mesa Round Four
9.45
9.40
9.35
9.30
9.25
9.20
9.15
9.10
9.05
pH
JWM-02
JWM-01
10/31/2007
11/1/2007
11/1/2007
11/2/2007
11/2/2007
11/3/2007
11/3/2007
11/4/2007
11/4/2007
11/5/2007
11/5/2007
Date
Readings

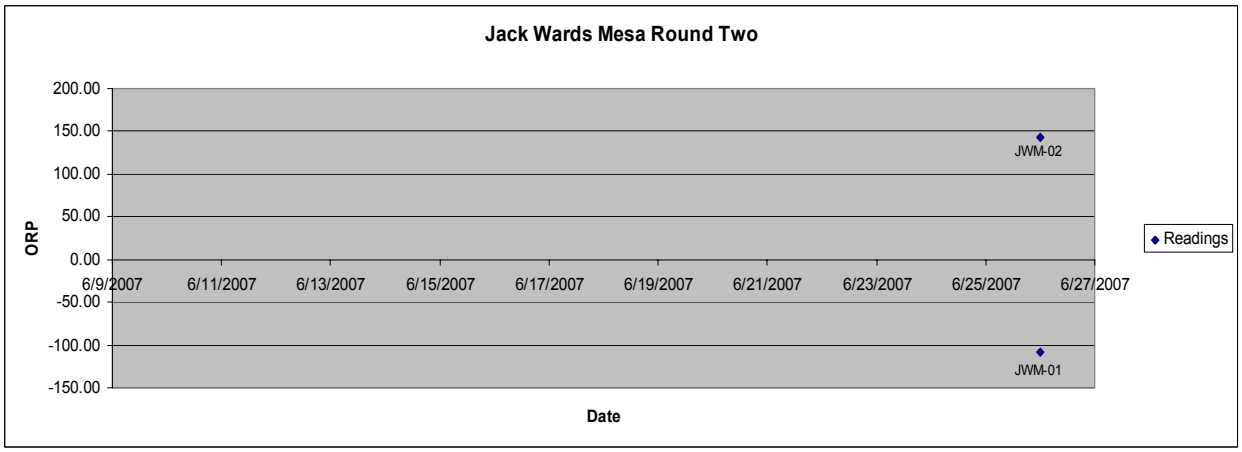

Jack Wards Mesa Round One
2.50
2.00
1.50
1.00
0.50
0.00
EC
JWM-02
JWM-01
Readings
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date

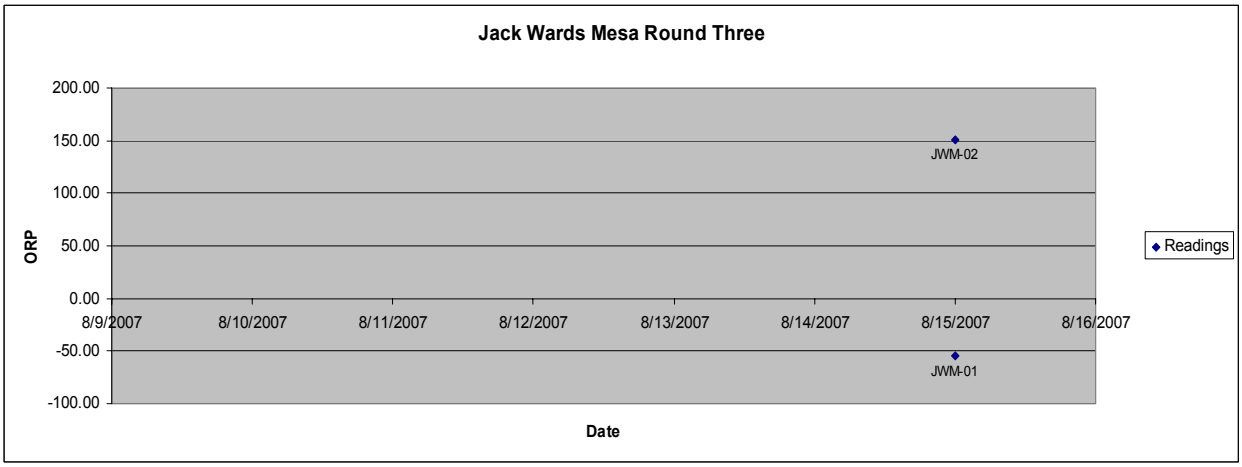

Jack Wards Mesa Round Two
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
EC
JWM-02
JWM-01
Readings
6/19/2007
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date

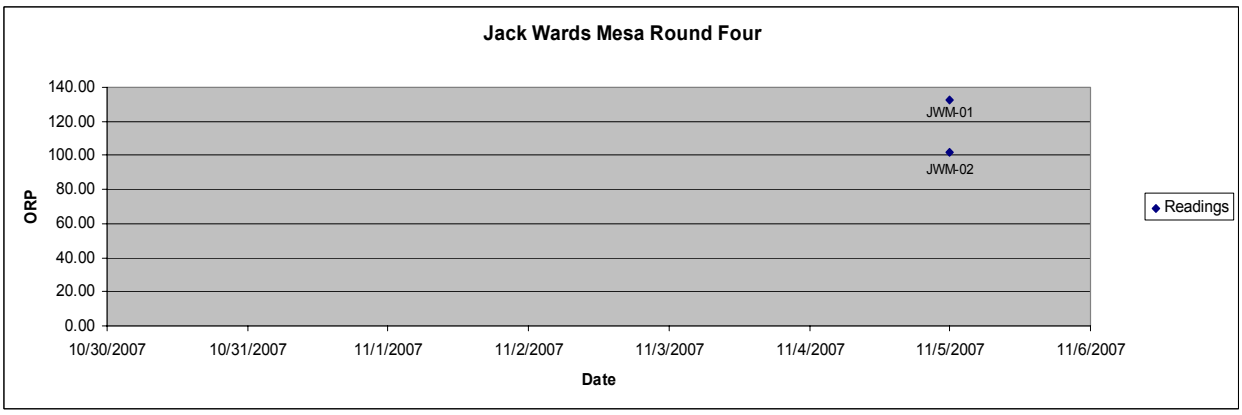

Jack Wards Mesa Round Three
2.50
2.00
1.50
1.00
0.50
0.00
EC
JWM-02
JWM-01
Readings
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date

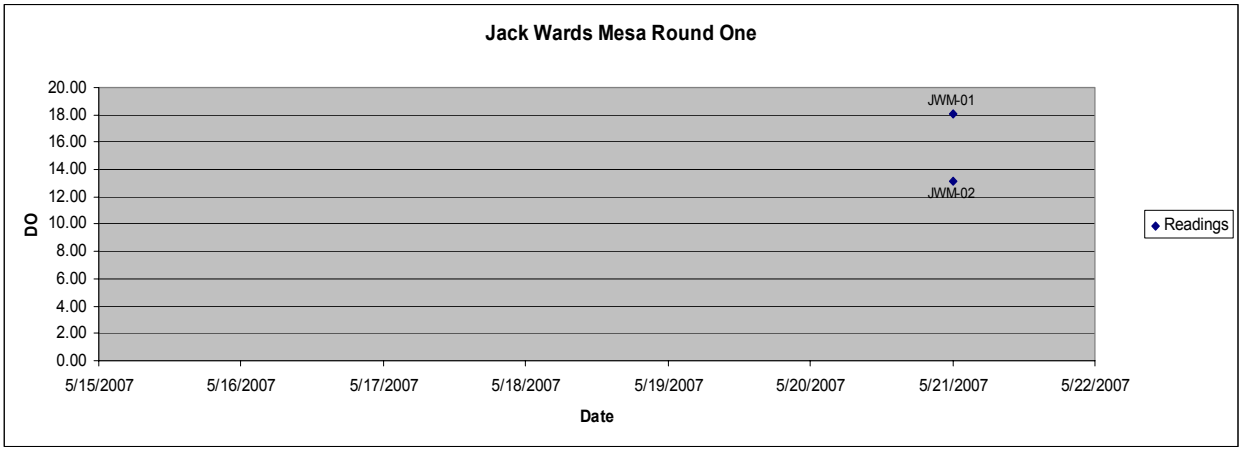

Jack Wards Mesa Round Four
2.50
2.00
1.50
1.00
0.50
0.00
EC
JWM-02
JWM-01
Readings
10/31/2007
11/1/2007
11/1/2007
11/2/2007
11/2/2007
11/3/2007
11/3/2007
11/4/2007
11/4/2007
11/5/2007
11/5/2007
Date

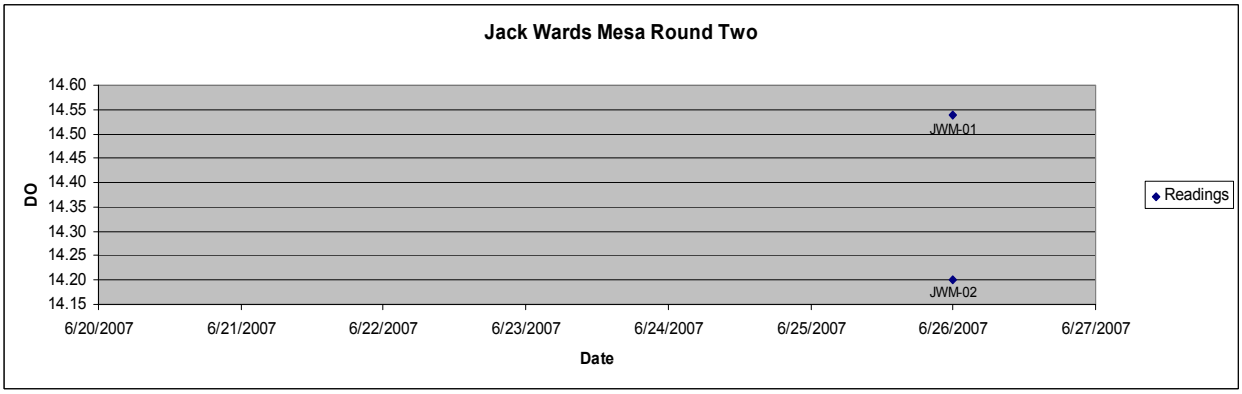

Jack Wards Mesa Round One
ORP
218.00
216.00
214.00
212.00
210.00
208.00
206.00
204.00
202.00
200.00
JWM-02
JWM-01
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
Date
Readings

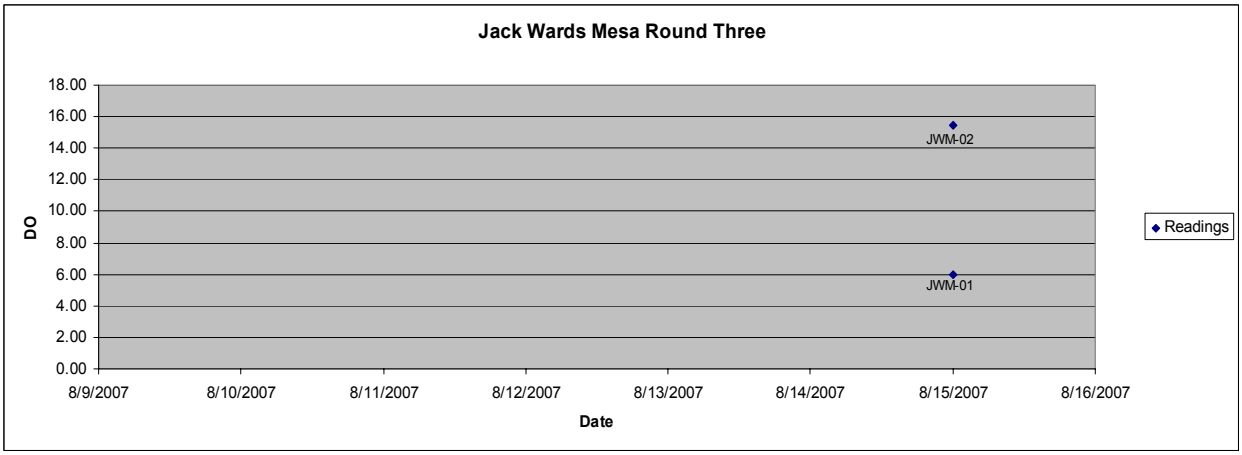

Jack Wards Mesa Round Two
ORP
200.00
150.00
100.00
50.00
0.00
-50.00
-100.00
-150.00
JWM-02
JWM-01
6/9/2007
6/11/2007
6/13/2007
6/15/2007
6/17/2007
6/19/2007
6/21/2007
6/23/2007
6/25/2007
6/27/2007
Date
Readings

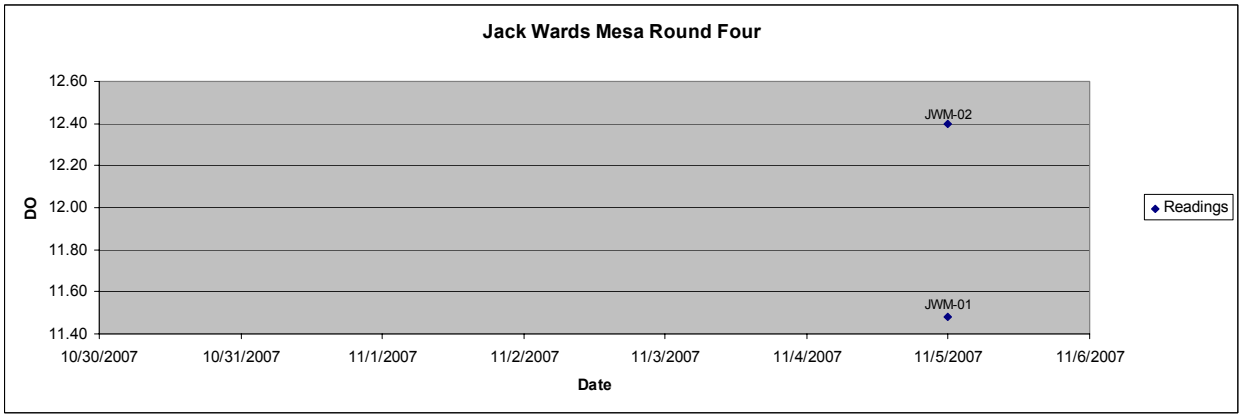

Jack Wards Mesa Round Three
ORP
200.00
150.00
100.00
50.00
0.00
-50.00
-100.00
JWM-02
JWM-01
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date
Readings

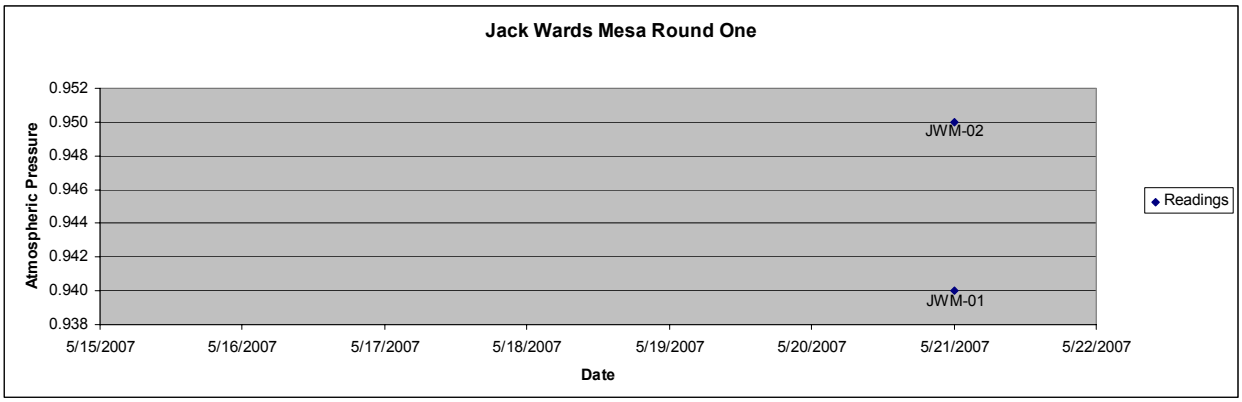

Jack Wards Mesa Round Four
ORP
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
JWM-01
JWM-02
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
Date
Readings

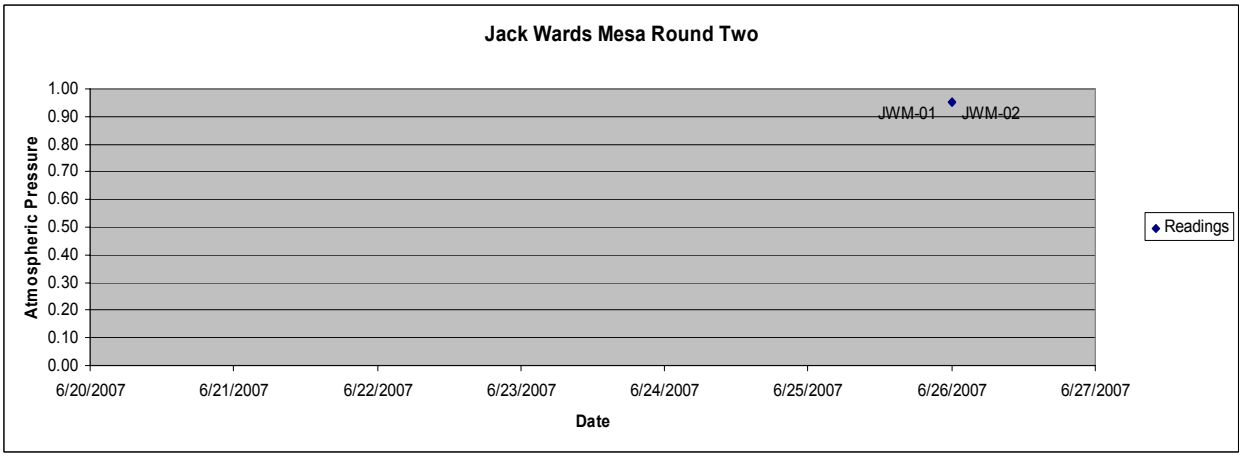

Jack Wards Mesa Round One
DO
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-01
JWM-02
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date
Readings

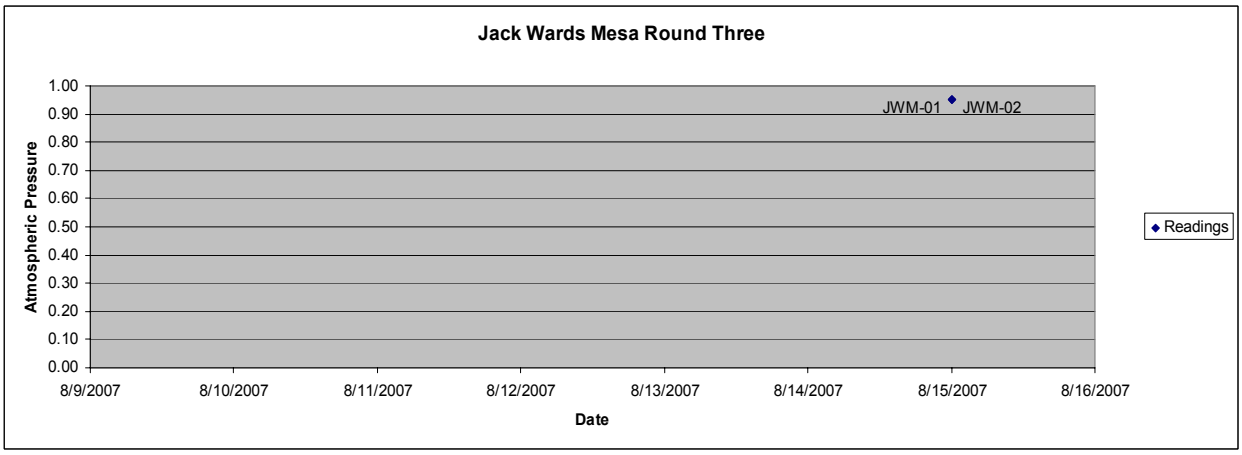

Jack Wards Mesa Round Two
DO
14.60
14.55
14.50
14.45
14.40
14.35
14.30
14.25
14.20
14.15
JWM-01
JWM-02
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

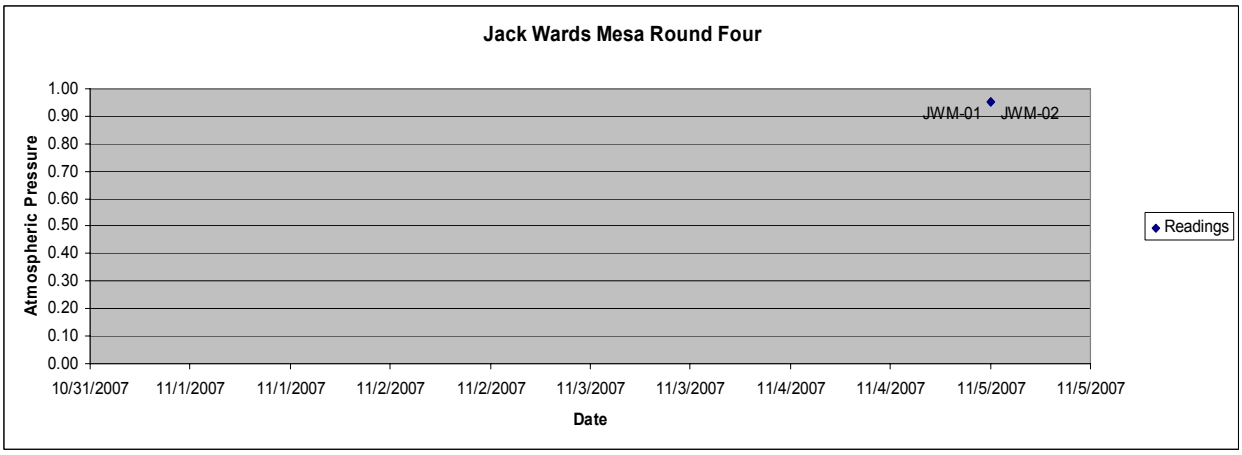

Jack Wards Mesa Round Three
DO
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-02
JWM-01
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date
Readings

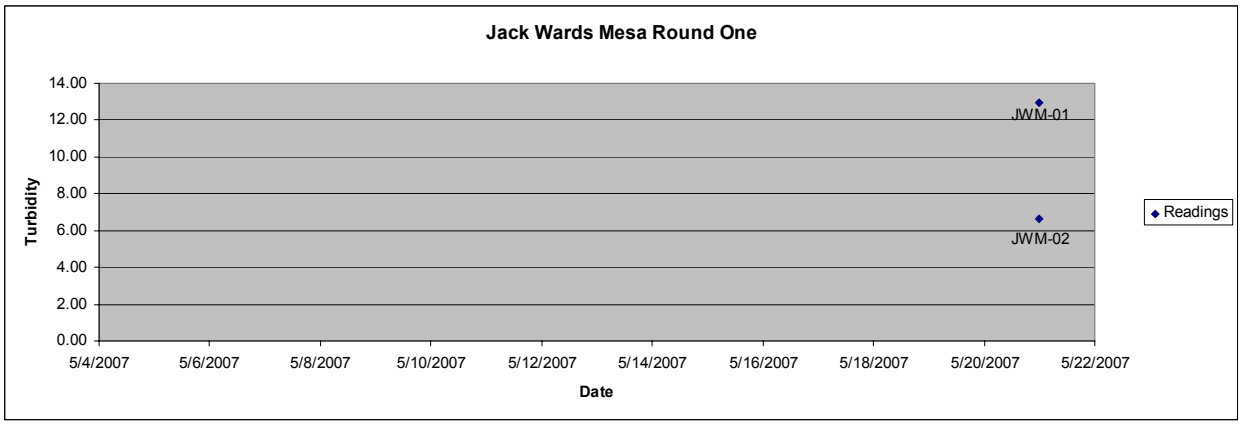

Jack Wards Mesa Round Four
DO
12.60
12.40
12.20
12.00
11.80
11.60
11.40
JWM-02
JWM-01
10/30/2007
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
Date
Readings

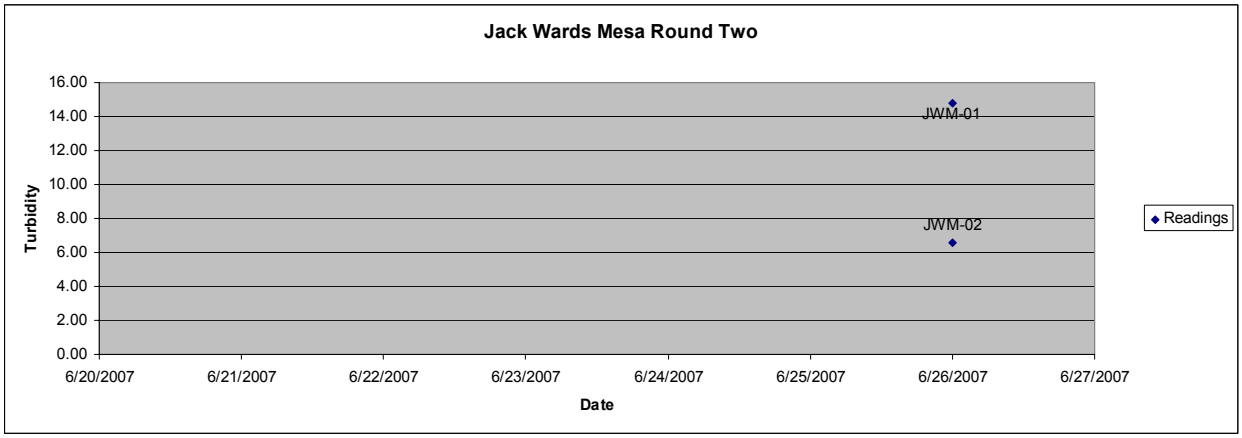

Jack Wards Mesa Round One
Atmospheric Pressure
0.952
0.950
0.948
0.946
0.944
0.942
0.940
0.938
JWM-02
JWM-01
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date
Readings

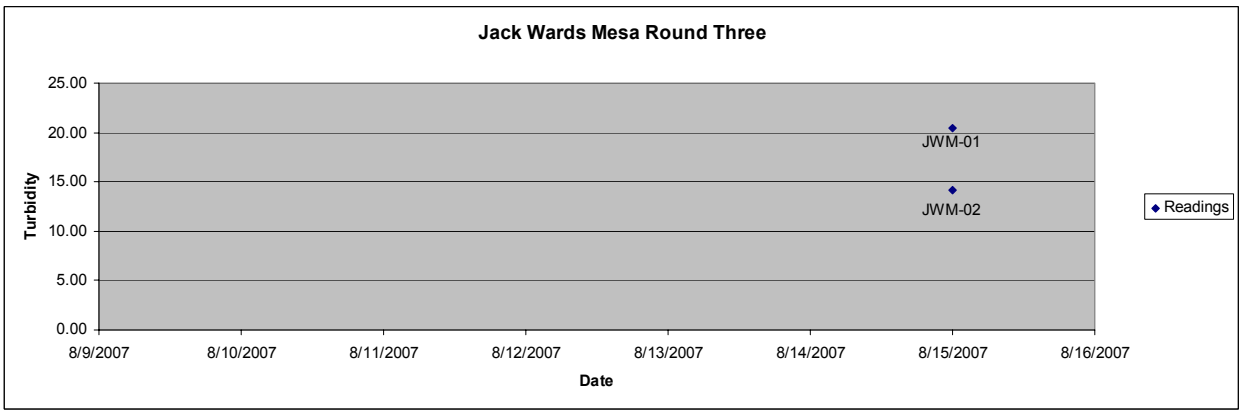

Jack Wards Mesa Round Two
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
JWM-01
JWM-02
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

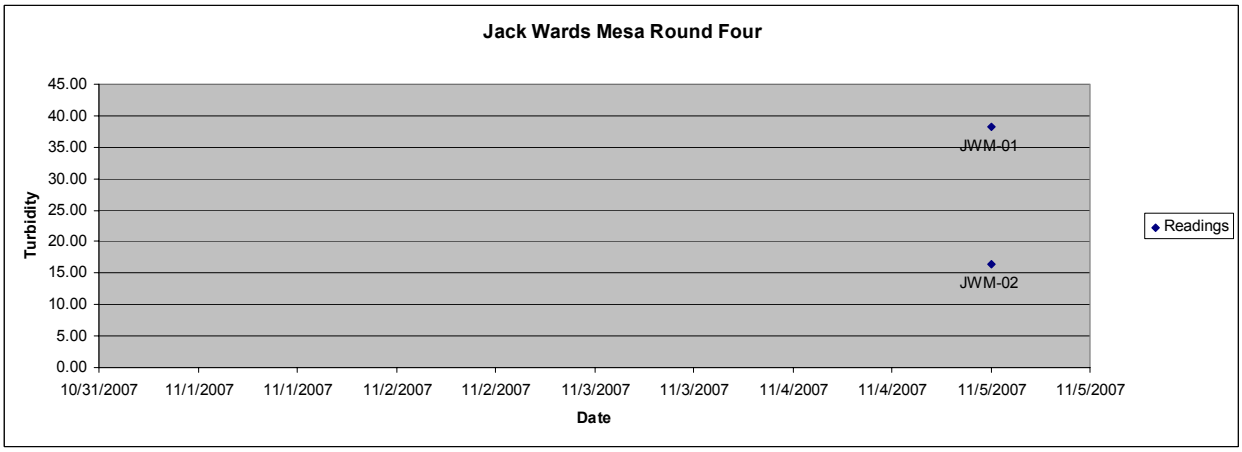

Jack Wards Mesa Round Three
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
JWM-01
JWM-02
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date
Readings


Jack Wards Mesa Round Four
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
JWM-01
JWM-02
10/31/2007
11/1/2007
11/1/2007
11/2/2007
11/2/2007
11/3/2007
11/3/2007
11/4/2007
11/4/2007
11/5/2007
11/5/2007
Date
Readings

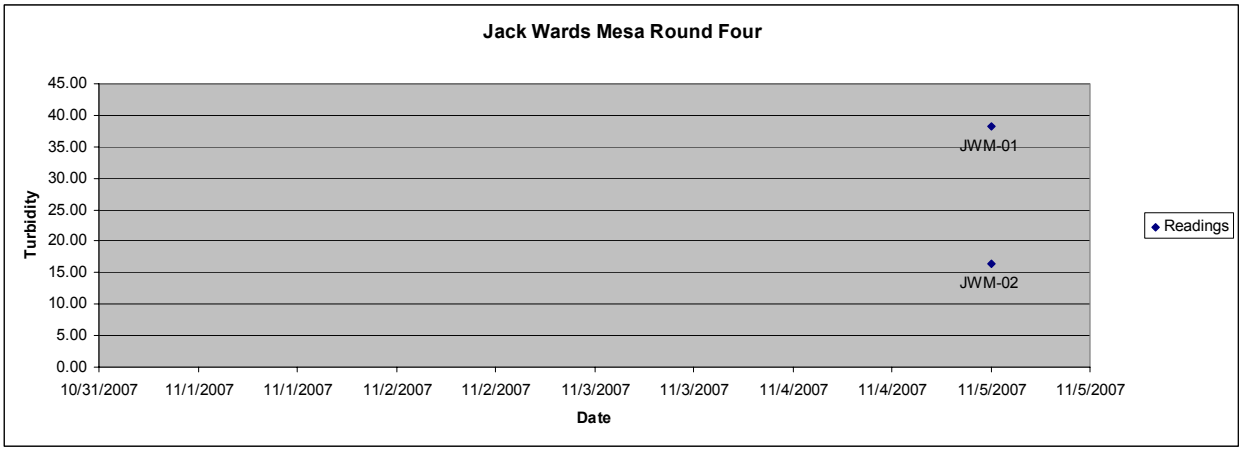

Jack Wards Mesa Round One
Turbidity
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-01
JWM-02
5/4/2007
5/6/2007
5/8/2007
5/10/2007
5/12/2007
5/14/2007
5/16/2007
5/18/2007
5/20/2007
5/22/2007
Date
Readings

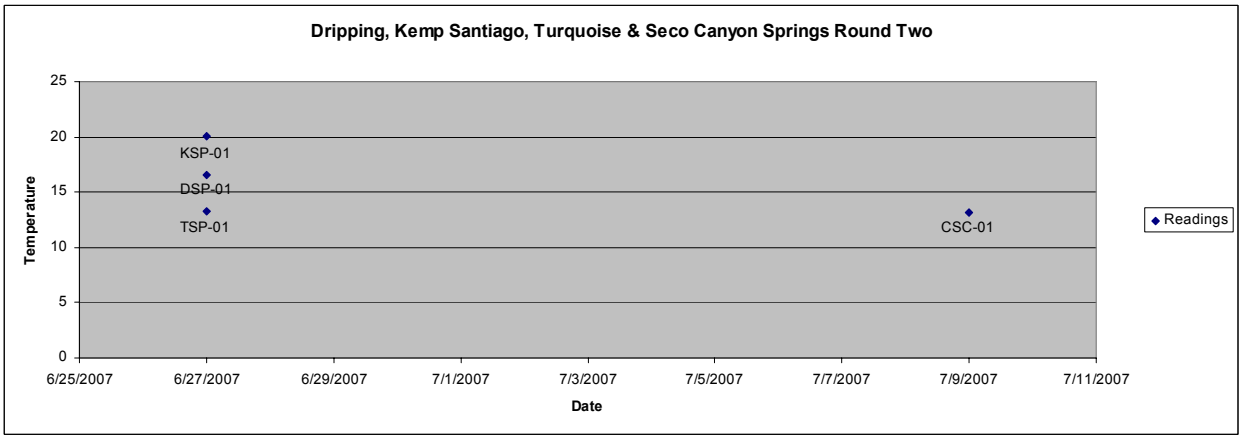

Jack Wards Mesa Round Two
Turbidity
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
JWM-01
JWM-02
6/20/2007
6/21/2007
6/22/2007
6/23/2007
6/24/2007
6/25/2007
6/26/2007
6/27/2007
Date
Readings

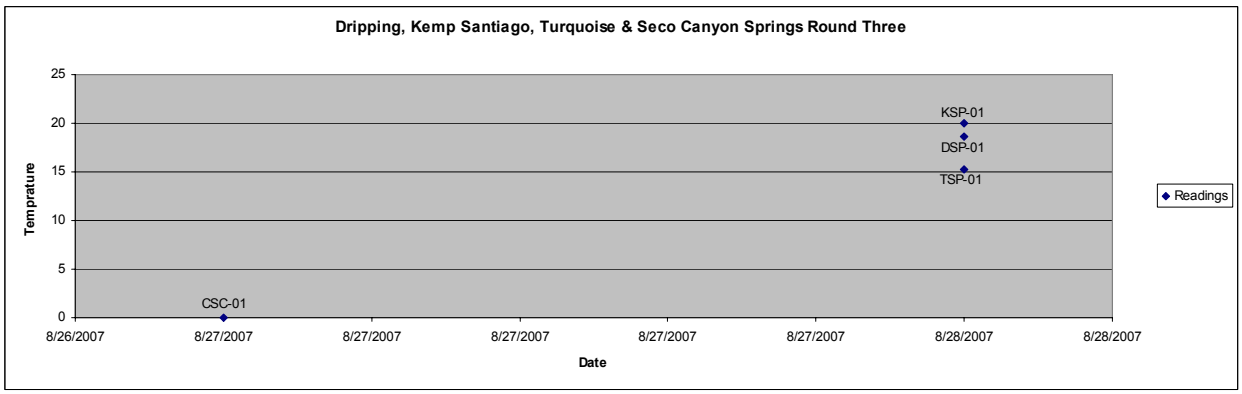

Jack Wards Mesa Round Three
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
JWM-01
JWM-02
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
8/16/2007
Date
Readings

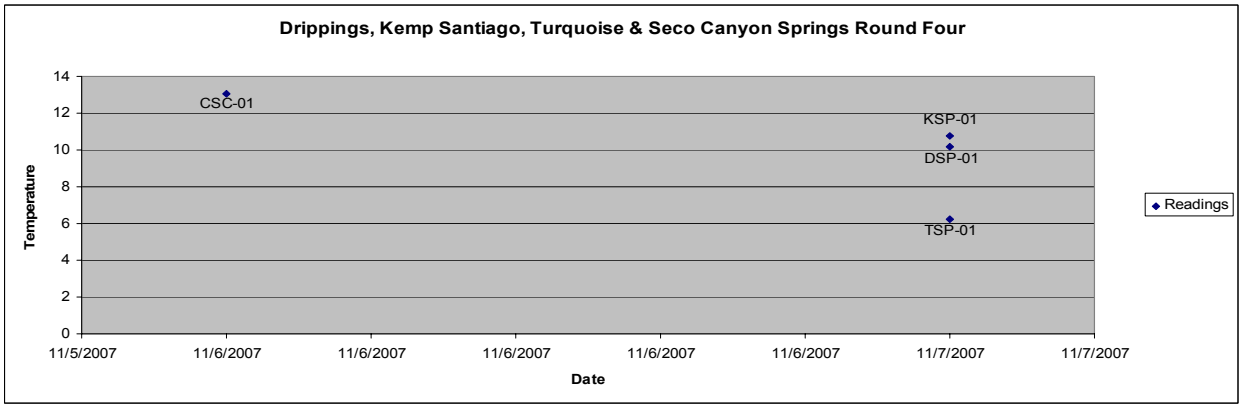

Jack Wards Mesa Round Four
Turbidity
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
JWM-01
JWM-02
10/31/2007
11/1/2007
11/1/2007
11/2/2007
11/2/2007
11/3/2007
11/3/2007
11/4/2007
11/4/2007
11/5/2007
11/5/2007
Date
Readings

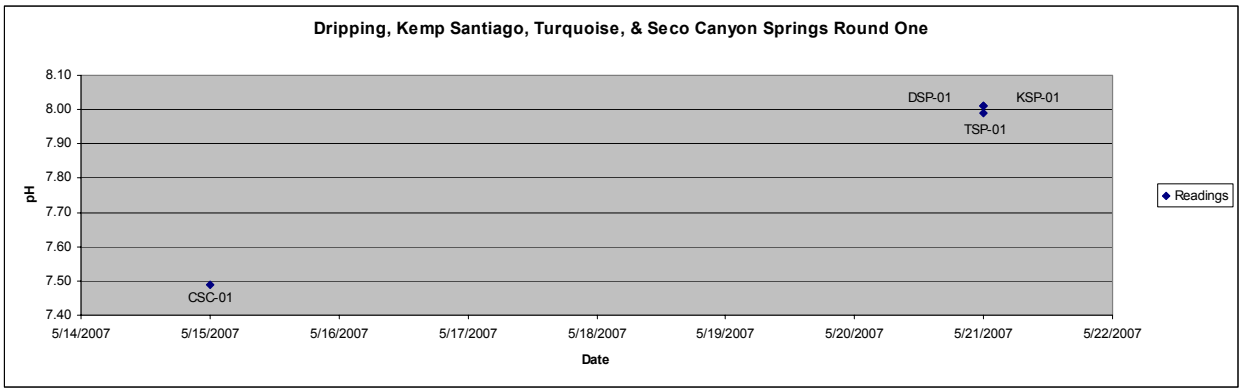
Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs

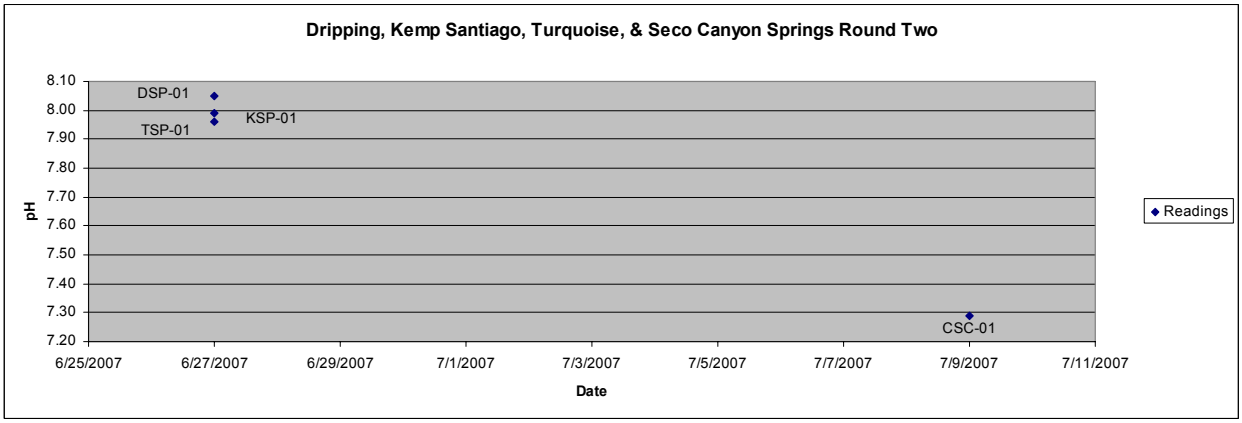


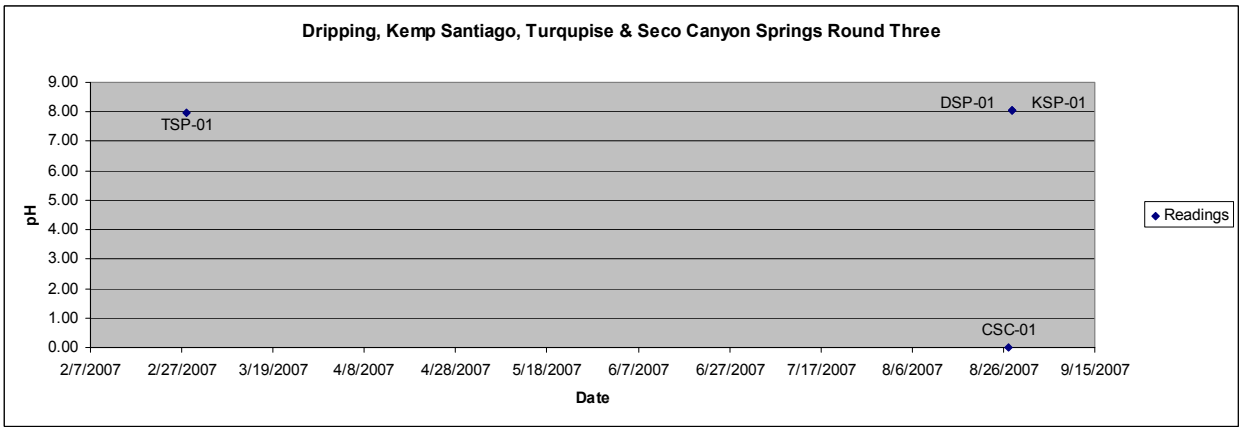


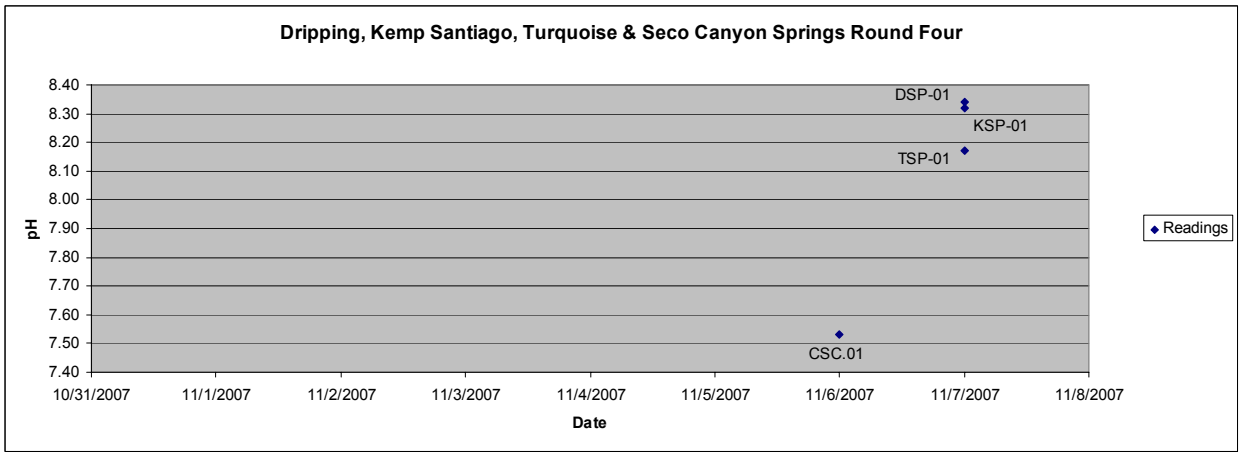


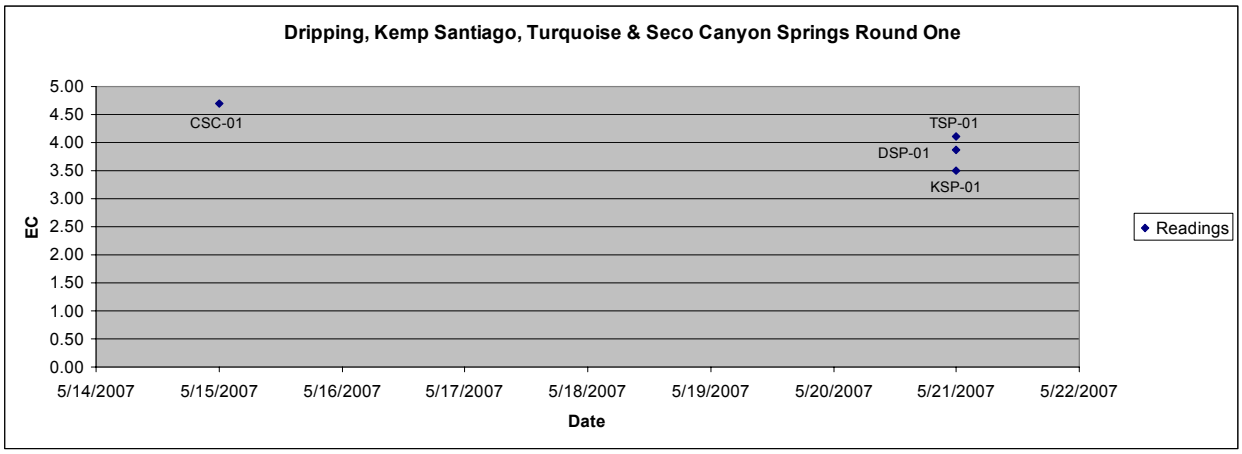


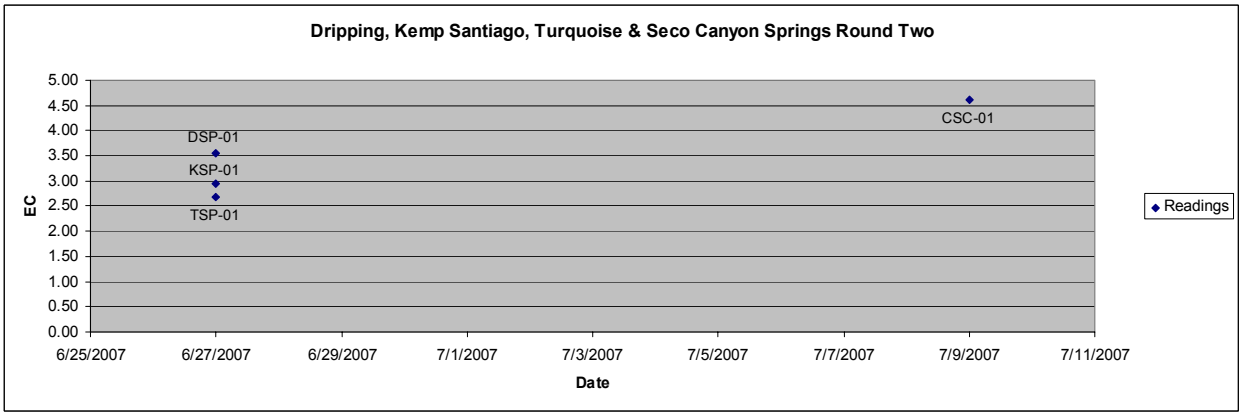

Dripping, Kemp Santiago, Turquoise, & Seco Canyon Springs Round One
8.10
8.00
7.90
7.80
7.70
7.60
7.50
7.40
pH
DSP-01
KSP-01
TSP-01
CSC-01
Readings
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date

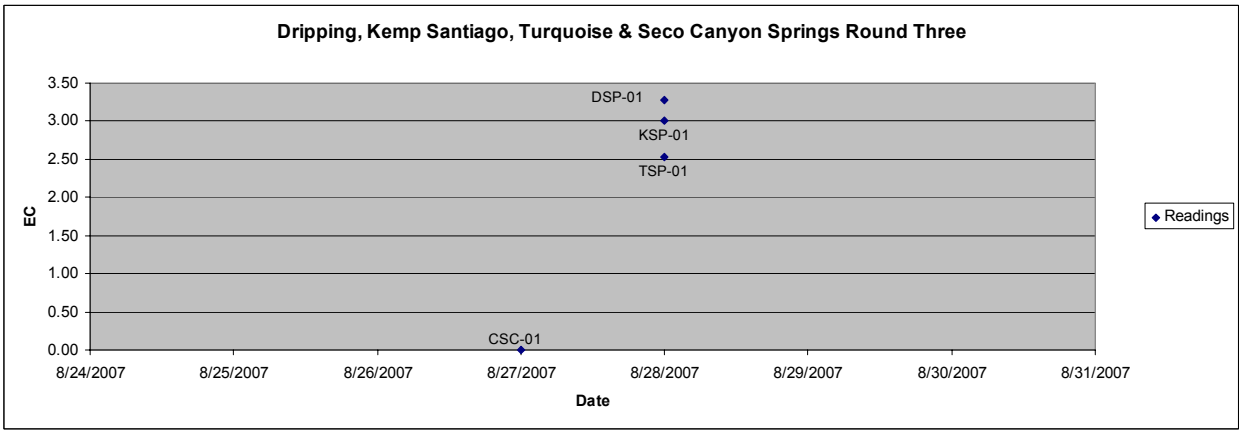

Dripping, Kemp Santiago, Turquoise, & Seco Canyon Springs Round Two
8.10
8.00
7.90
7.80
7.70
7.60
7.50
7.40
7.30
7.20
pH
DSP-01
KSP-01
TSP-01
CSC-01
Readings
6/25/2007
6/27/2007
6/29/2007
7/1/2007
7/3/2007
7/5/2007
7/7/2007
7/9/2007
7/11/2007
Date

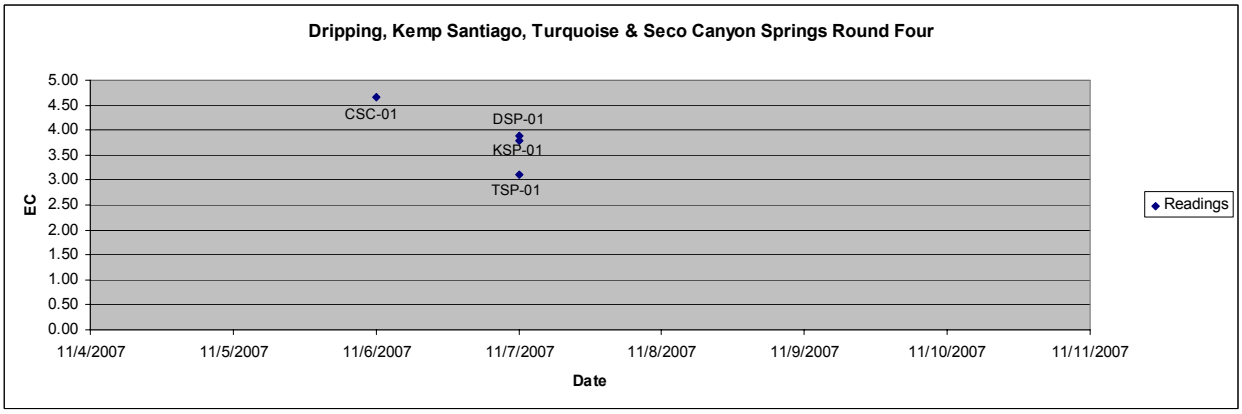

Dripping, Kemp Santiago, Turqupise & Seco Canyon Springs Round Three
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
TSP-01
DSP-01
KSP-01
CSC-01
Readings
2/7/2007
2/27/2007
3/19/2007
4/8/2007
4/28/2007
5/18/2007
6/7/2007
6/27/2007
7/17/2007
8/6/2007
8/26/2007
9/15/2007
Date

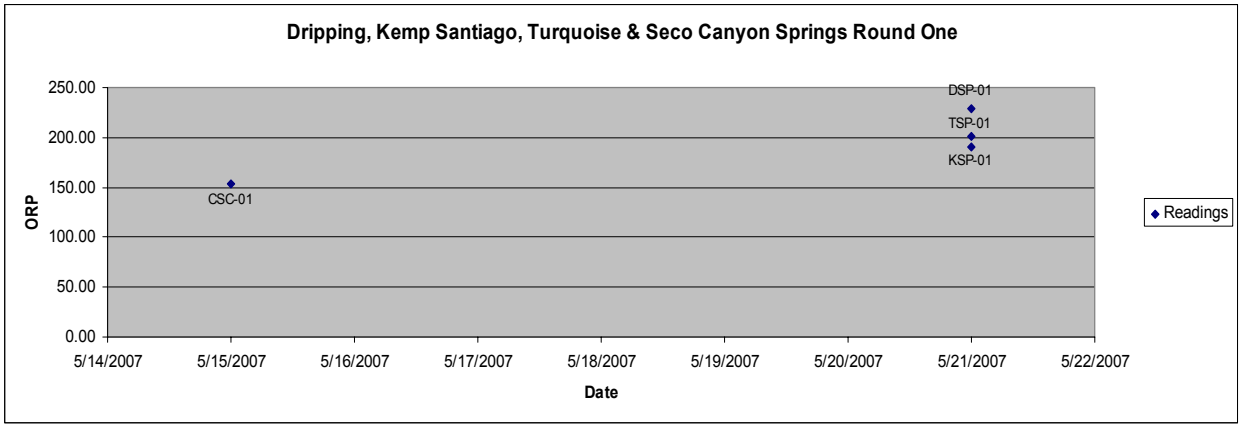

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
8.40
8.30
8.20
8.10
8.00
7.90
7.80
7.70
7.60
7.50
7.40
pH
DSP-01
KSP-01
TSP-01
CSC.01
Readings
10/31/2007
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
11/8/2007
Date

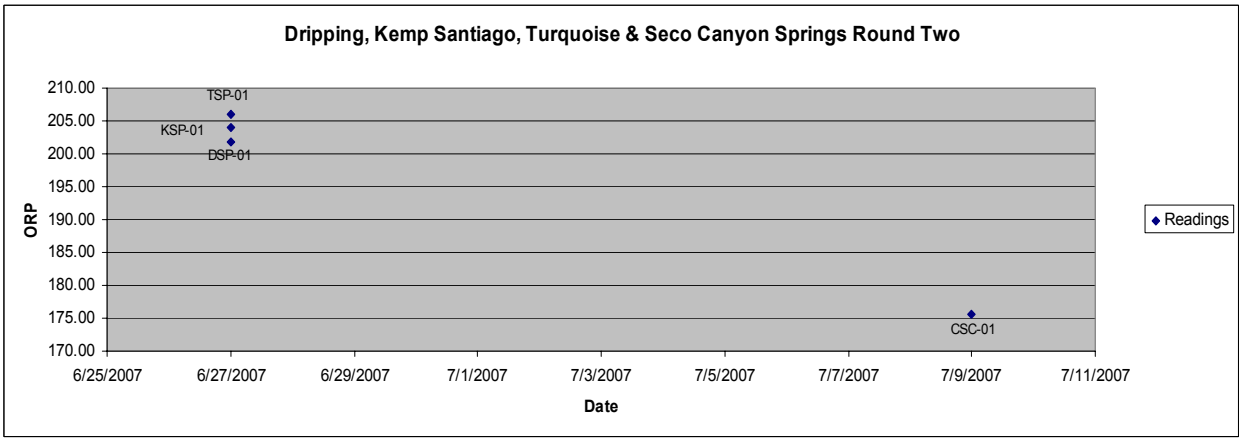

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round One
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EC
CSC-01
TSP-01
DSP-01
KSP-01
Readings
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date

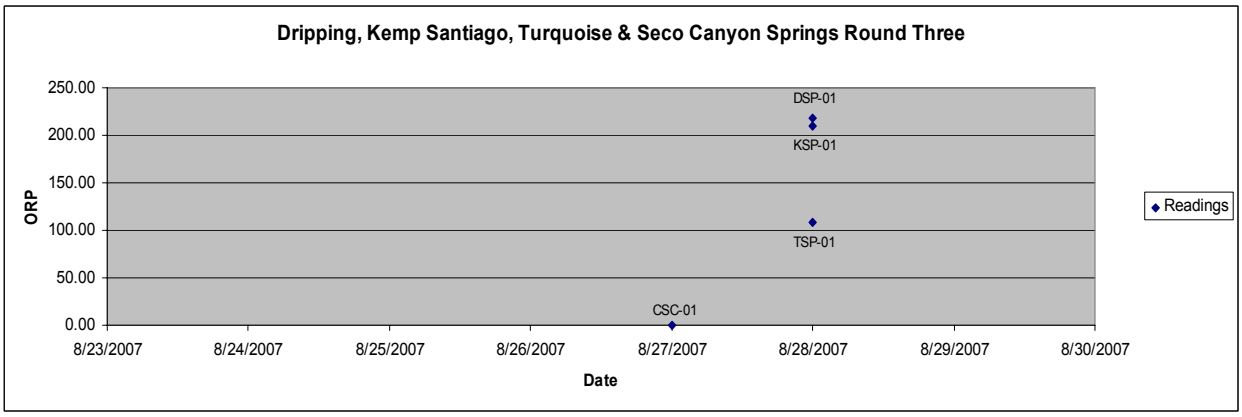

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Two
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EC
CSC-01
DSP-01
KSP-01
TSP-01
Readings
6/25/2007
6/27/2007
6/29/2007
7/1/2007
7/3/2007
7/5/2007
7/7/2007
7/9/2007
7/11/2007
Date

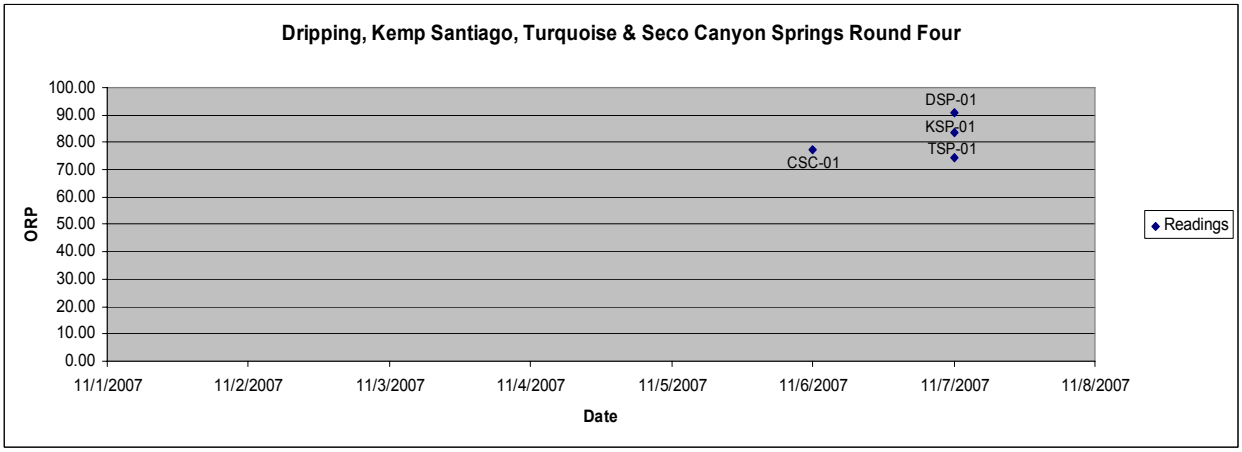

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Three
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EC
DSP-01
KSP-01
TSP-01
CSC-01
Readings
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
8/29/2007
8/30/2007
8/31/2007
Date

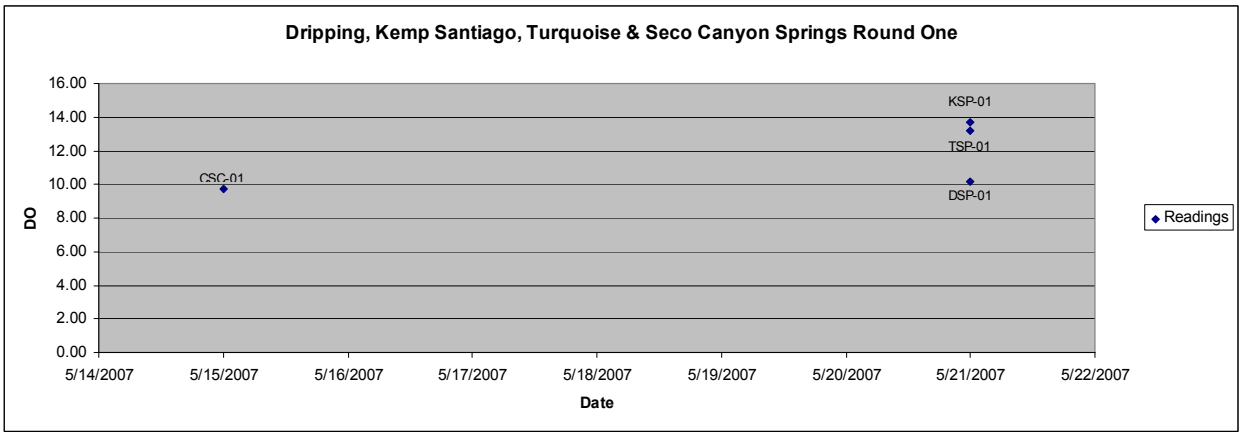

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
EC
CSC-01
DSP-01
KSP-01
TSP-01
Readings
11/4/2007
11/5/2007
11/6/2007
11/7/2007
11/8/2007
11/9/2007
11/10/2007
11/11/2007
Date

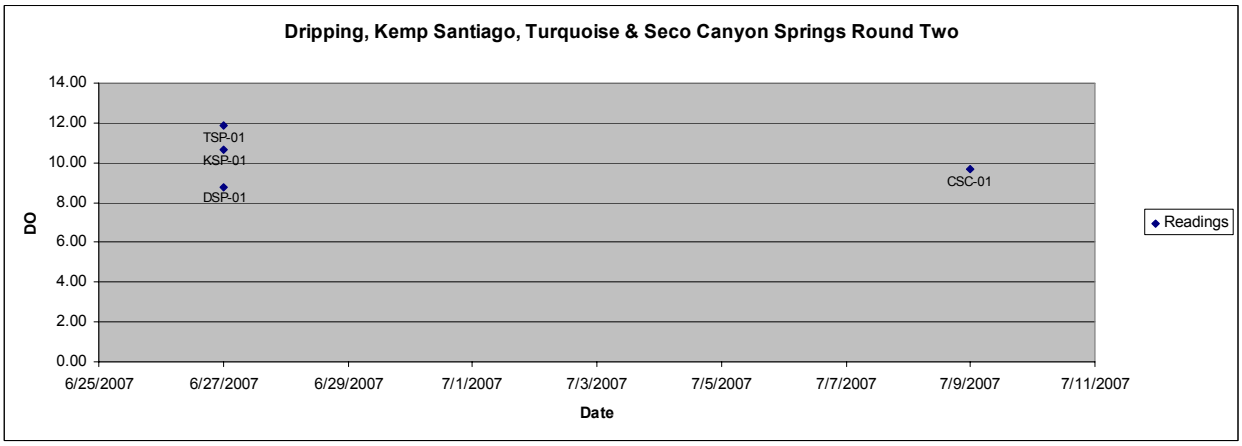

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round One
ORP
250.00
200.00
150.00
100.00
50.00
0.00
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date
CSC-01
DSP-01
TSP-01
KSP-01
Readings

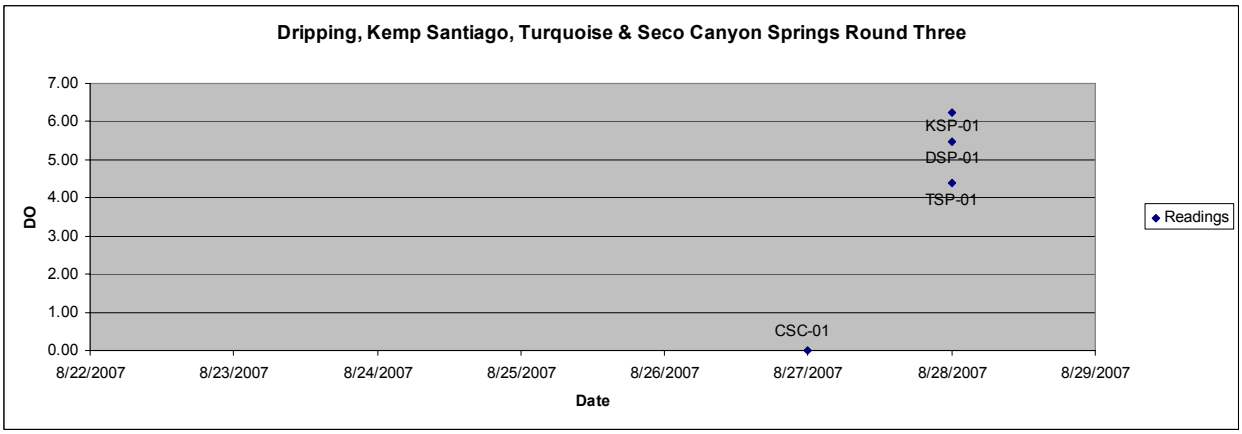

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Two
ORP
210.00
205.00
200.00
195.00
190.00
185.00
180.00
175.00
170.00
6/25/2007
6/27/2007
6/29/2007
7/1/2007
7/3/2007
7/5/2007
7/7/2007
7/9/2007
7/11/2007
Date
TSP-01
KSP-01
DSP-01
CSC-01
Readings

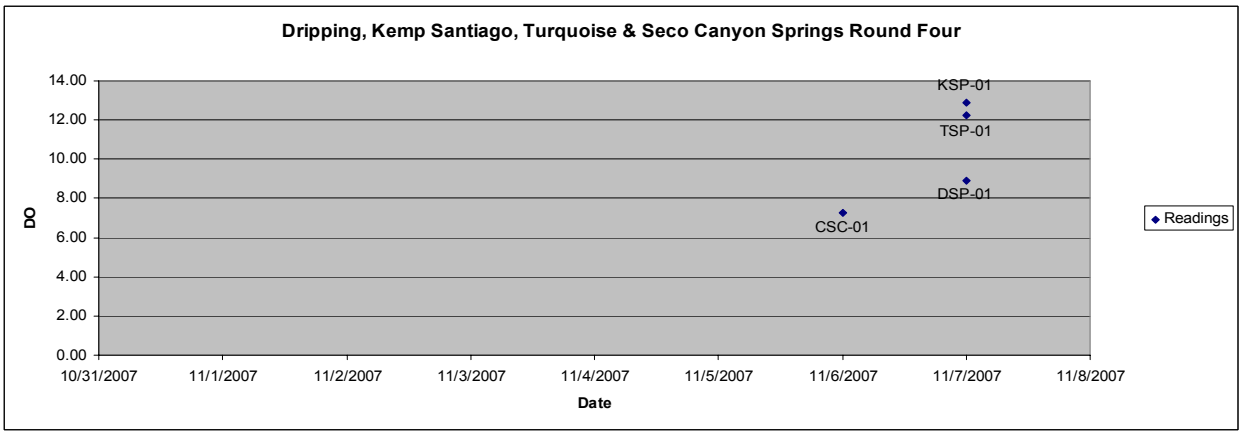

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Three
ORP
250.00
200.00
150.00
100.00
50.00
0.00
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
8/29/2007
8/30/2007
Date
DSP-01
KSP-01
TSP-01
CSC-01
Readings

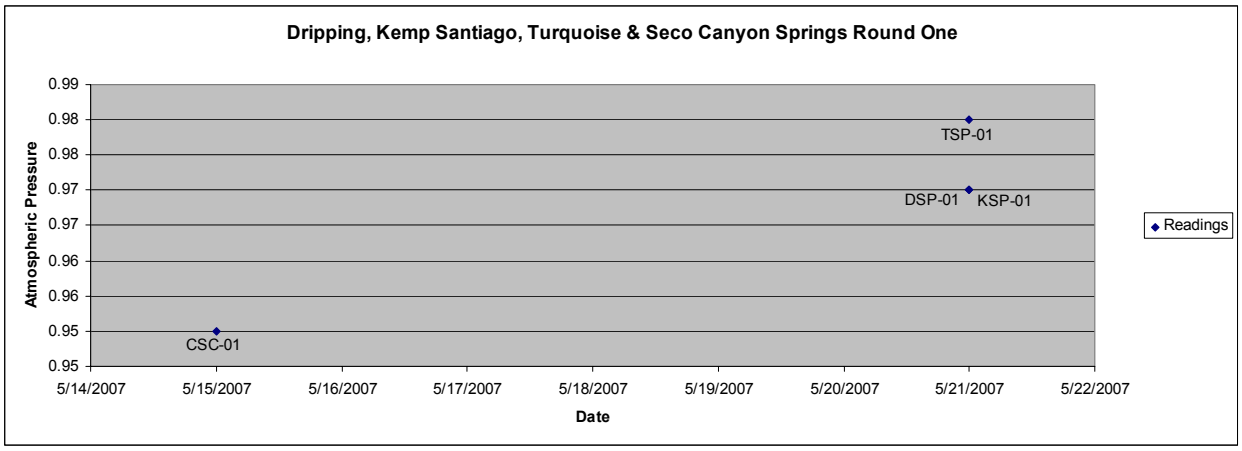

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
ORP
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
11/8/2007
Date
DSP-01
KSP-01
TSP-01
CSC-01
Readings

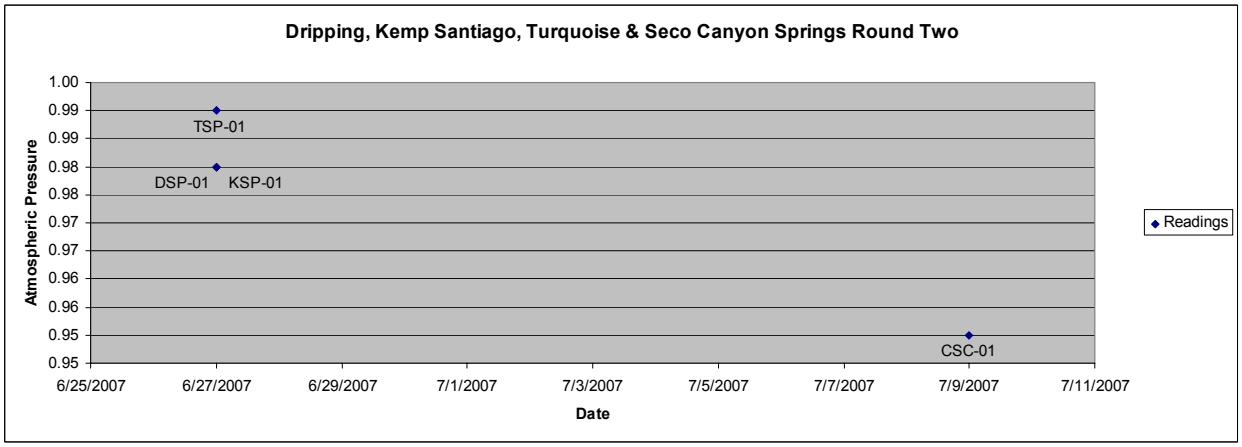

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round One
DO
Date
CSC-01
KSP-01
TSP-01
DSP-01
Readings

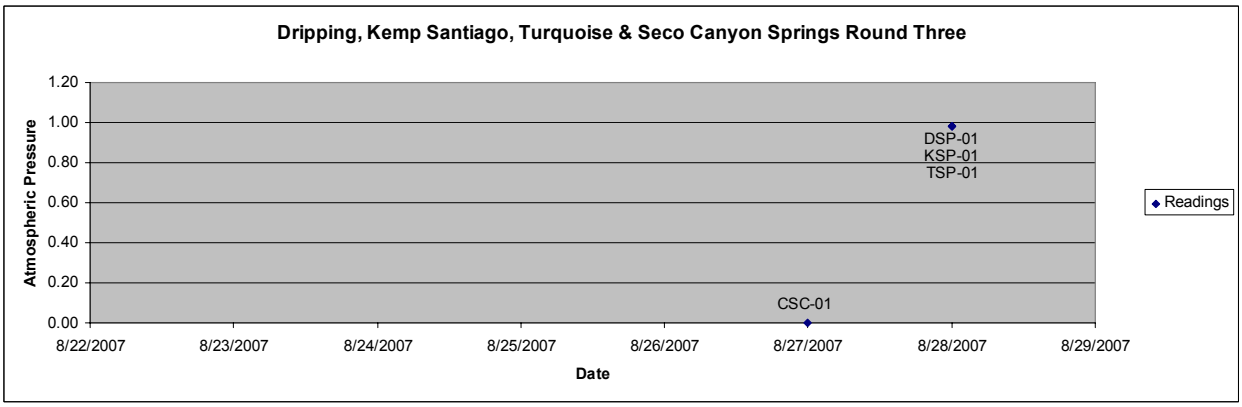

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Two
DO
Date
TSP-01
KSP-01
DSP-01
CSC-01
Readings

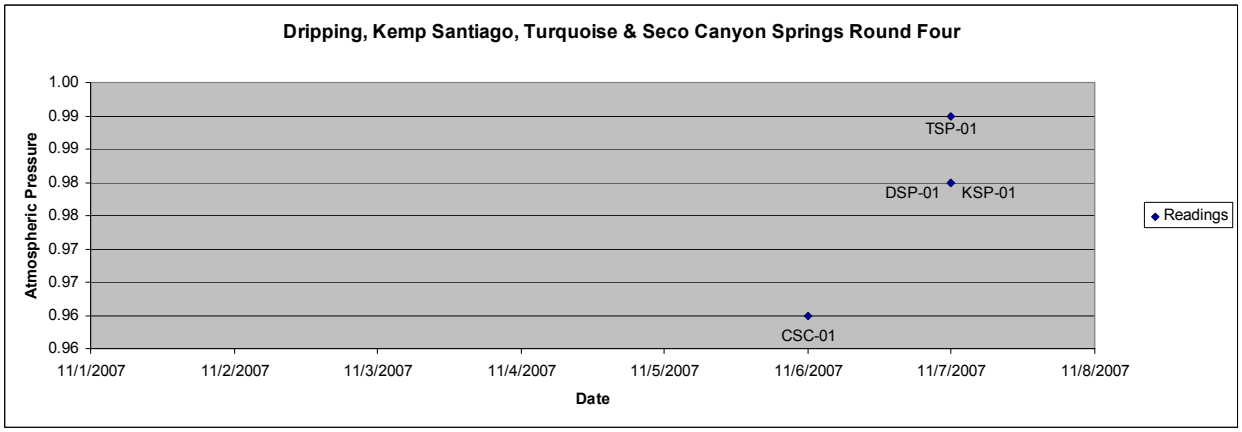

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Three
DO
Date
KSP-01
DSP-01
TSP-01
CSC-01
Readings

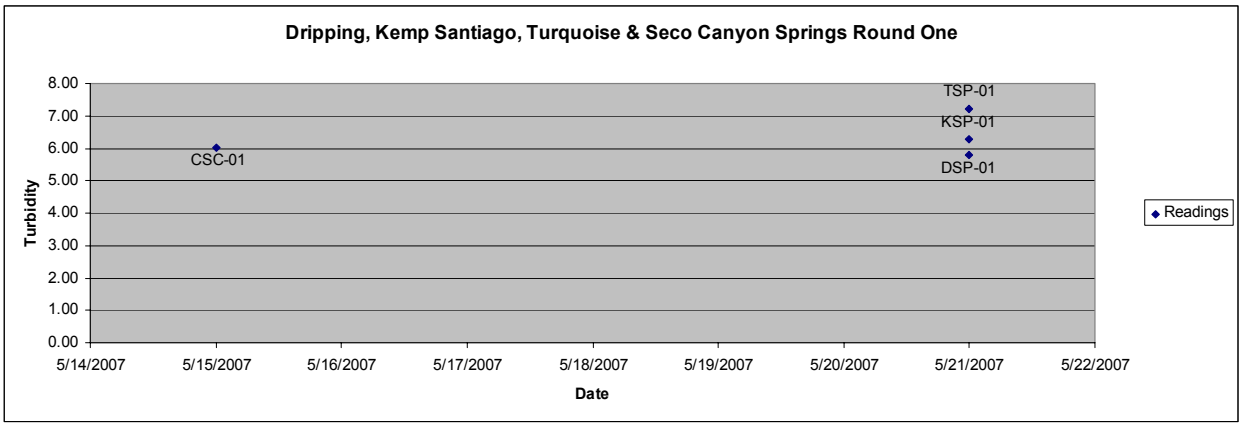

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
DO
Date
KSP-01
TSP-01
DSP-01
CSC-01
Readings

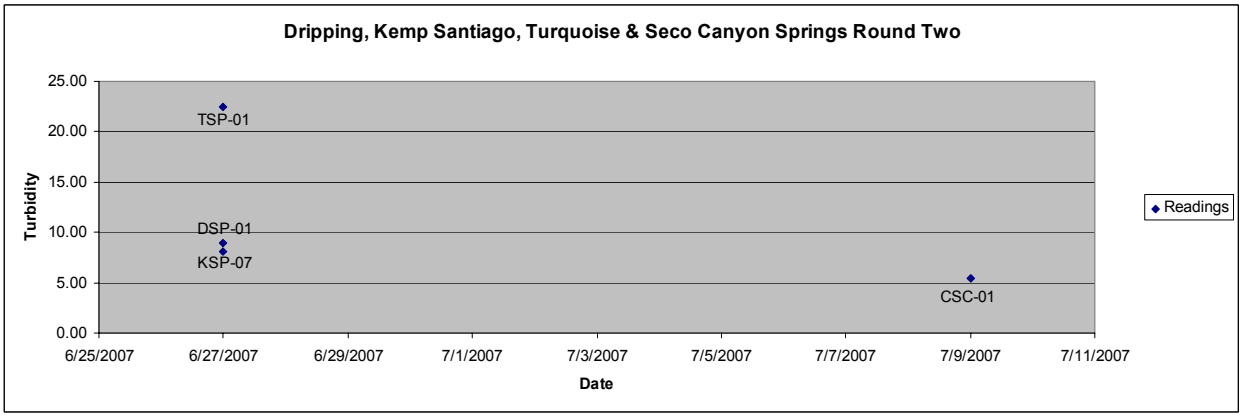

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round One
Atmospheric Pressure
0.99
0.98
0.98
0.97
0.97
0.96
0.96
0.95
0.95
TSP-01
DSP-01
KSP-01
CSC-01
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date
Readings

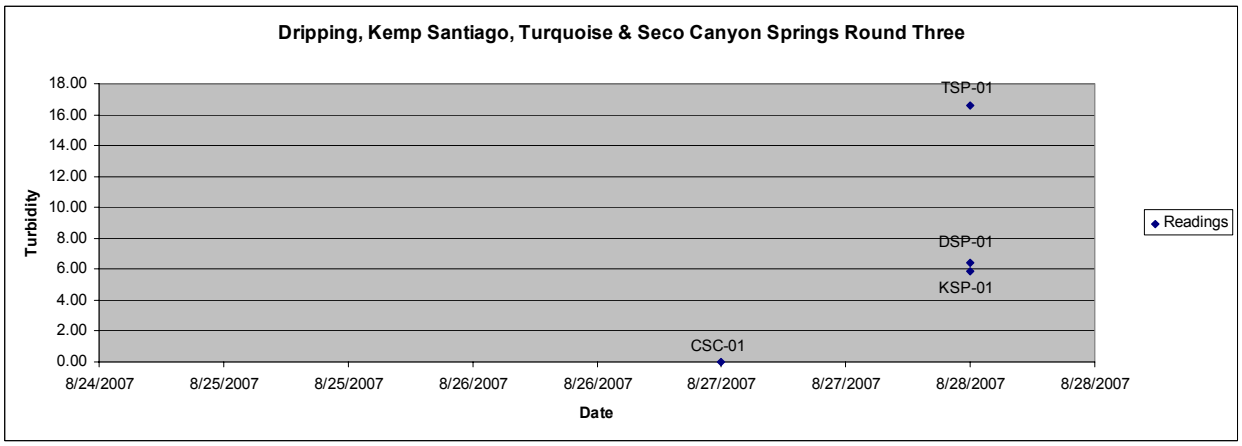

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Two
Atmospheric Pressure
1.00
0.99
0.99
0.98
0.98
0.97
0.97
0.96
0.96
0.95
0.95
TSP-01
DSP-01
KSP-01
CSC-01
6/25/2007
6/27/2007
6/29/2007
7/1/2007
7/3/2007
7/5/2007
7/7/2007
7/9/2007
7/11/2007
Date
Readings

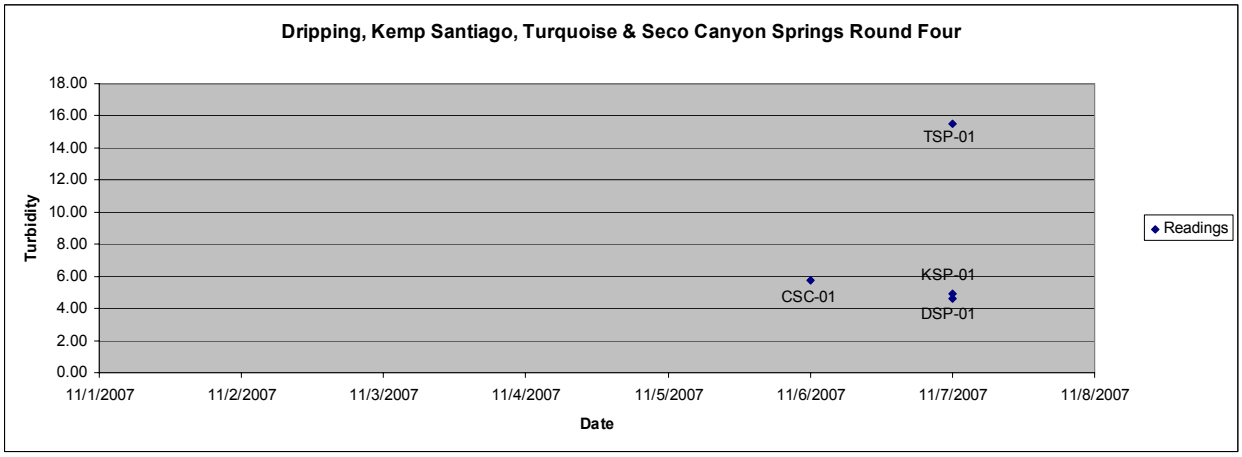

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Three
Atmospheric Pressure
1.20
1.00
0.80
0.60
0.40
0.20
0.00
DSP-01
KSP-01
TSP-01
CSC-01
8/22/2007
8/23/2007
8/24/2007
8/25/2007
8/26/2007
8/27/2007
8/28/2007
8/29/2007
Date
Readings


Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
Atmospheric Pressure
1.00
0.99
0.99
0.98
0.98
0.97
0.97
0.96
0.96
TSP-01
DSP-01
KSP-01
CSC-01
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
11/8/2007
Date
Readings

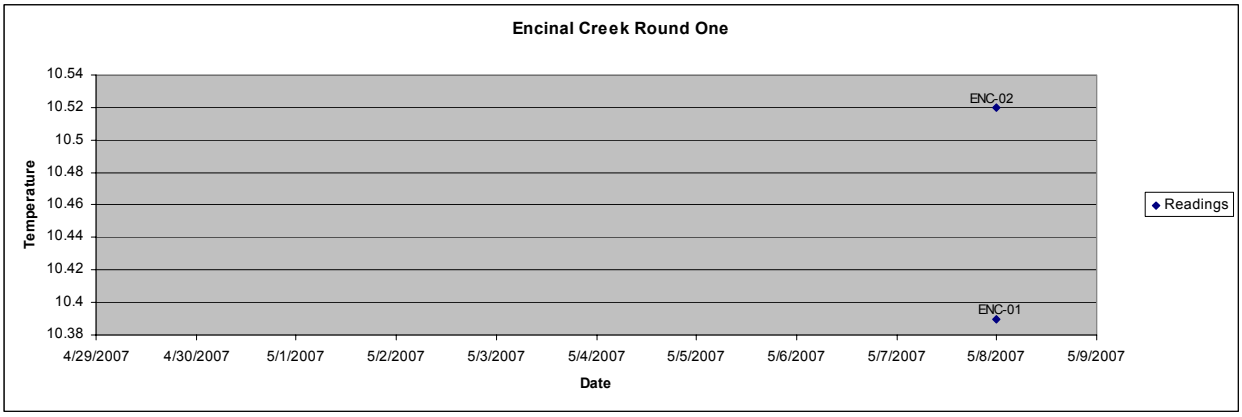

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round One
Turbidity
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
CSC-01
TSP-01
KSP-01
DSP-01
5/14/2007
5/15/2007
5/16/2007
5/17/2007
5/18/2007
5/19/2007
5/20/2007
5/21/2007
5/22/2007
Date
Readings

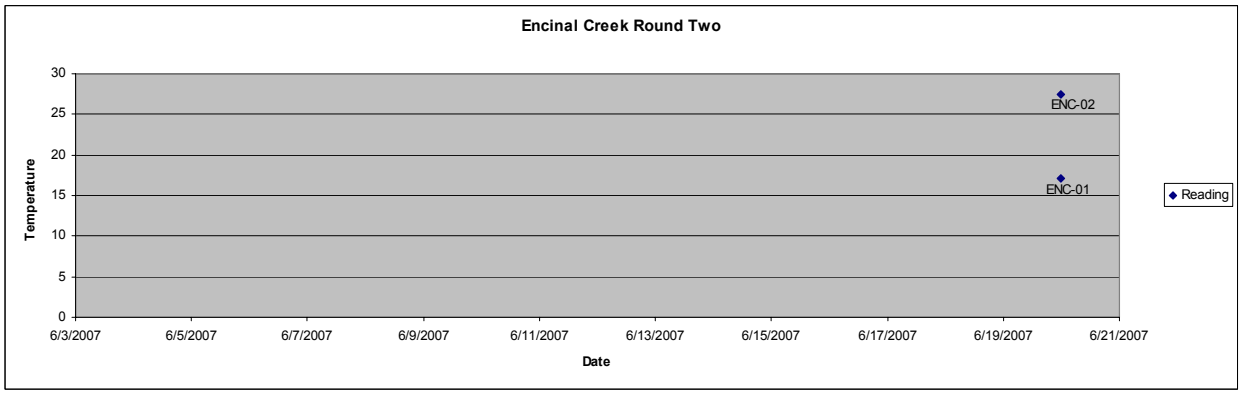

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Two
Turbidity
25.00
20.00
15.00
10.00
5.00
0.00
TSP-01
DSP-01
KSP-07
CSC-01
6/25/2007
6/27/2007
6/29/2007
7/1/2007
7/3/2007
7/5/2007
7/7/2007
7/9/2007
7/11/2007
Date
Readings

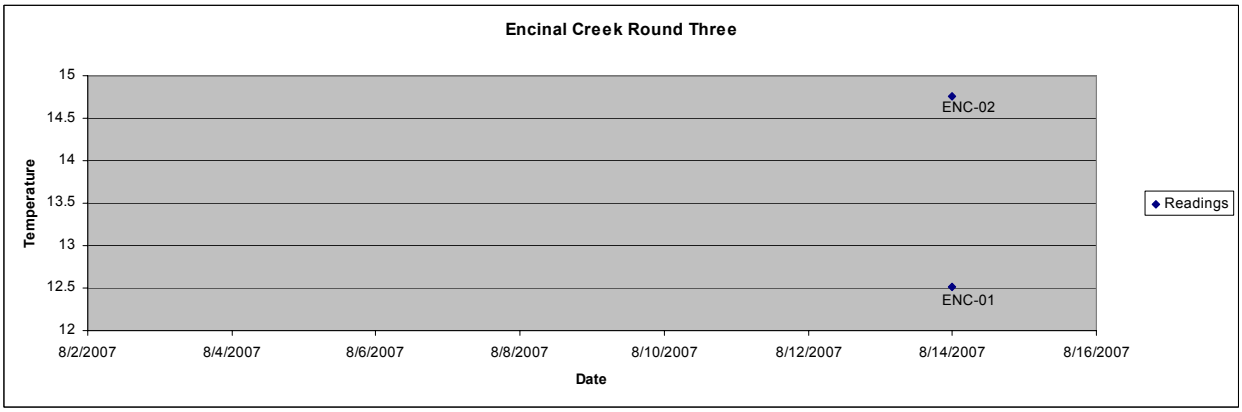

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Three
Turbidity
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
TSP-01
DSP-01
KSP-01
CSC-01
8/24/2007
8/25/2007
8/25/2007
8/26/2007
8/26/2007
8/27/2007
8/27/2007
8/28/2007
8/28/2007
Date
Readings

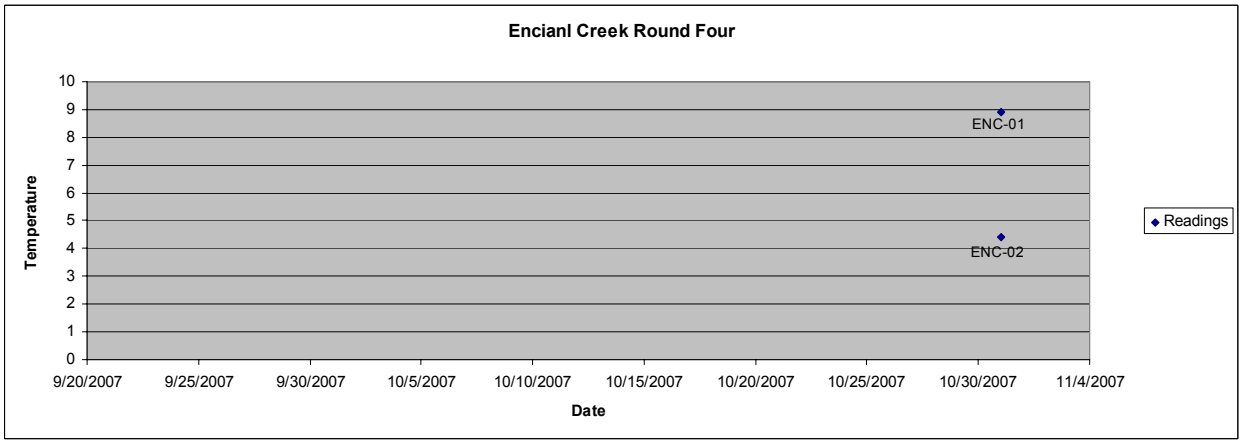

Dripping, Kemp Santiago, Turquoise & Seco Canyon Springs Round Four
Turbidity
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
TSP-01
KSP-01
CSC-01
DSP-01
11/1/2007
11/2/2007
11/3/2007
11/4/2007
11/5/2007
11/6/2007
11/7/2007
11/8/2007
Date
Readings

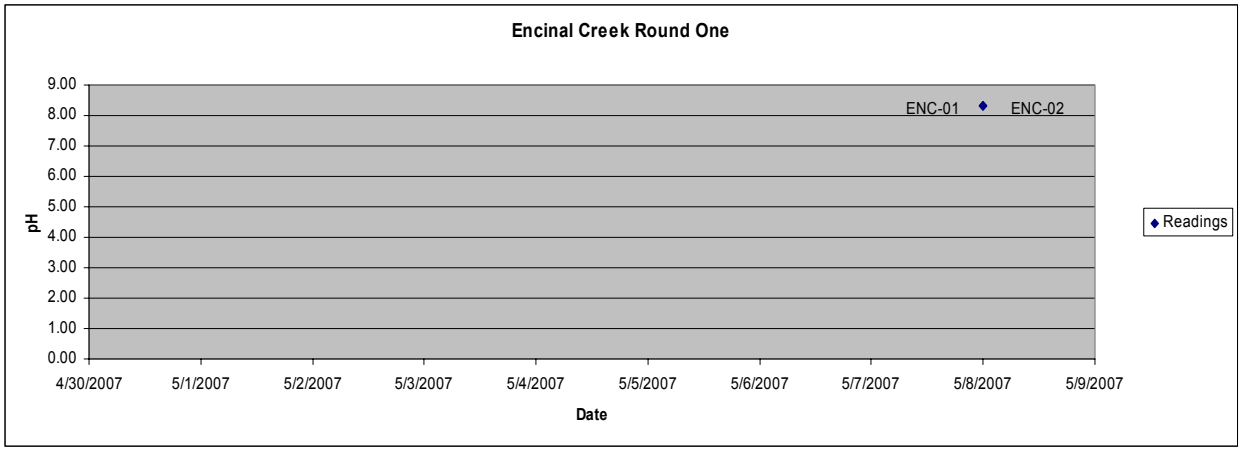
Encinal Creek

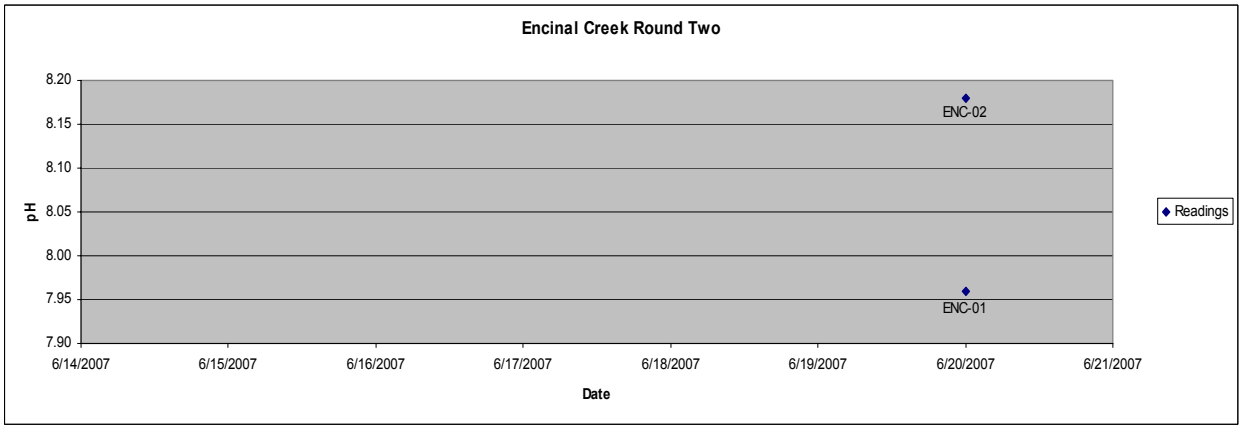


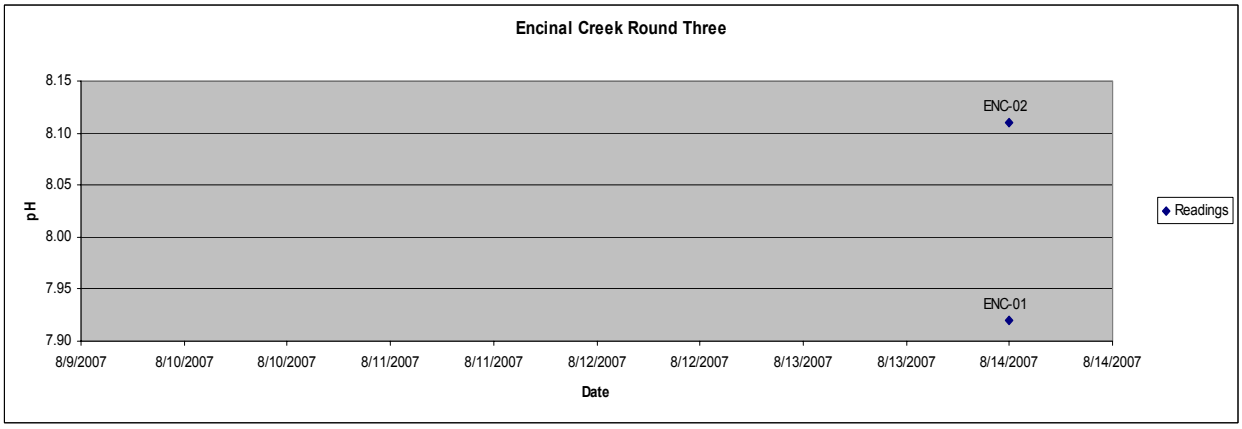


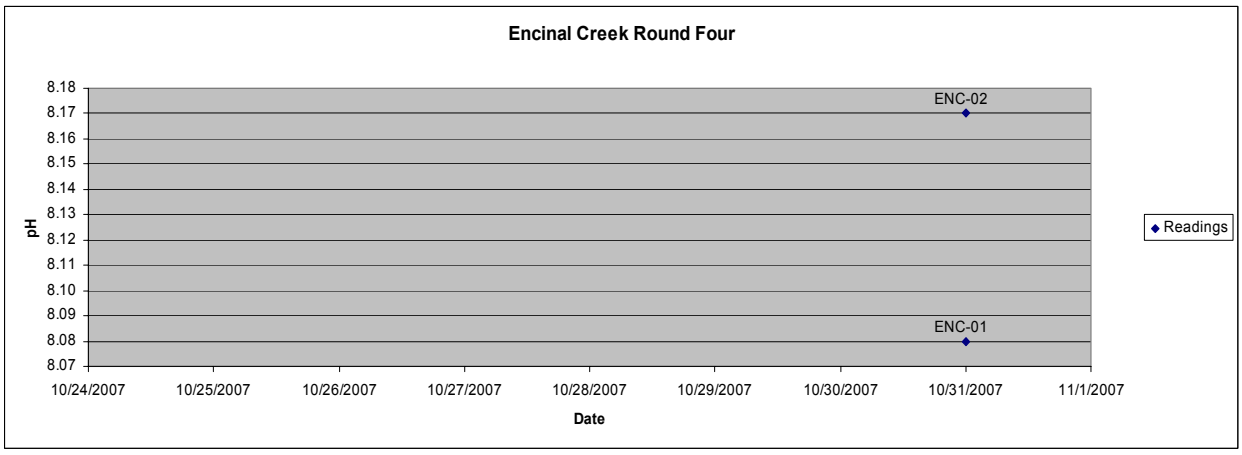


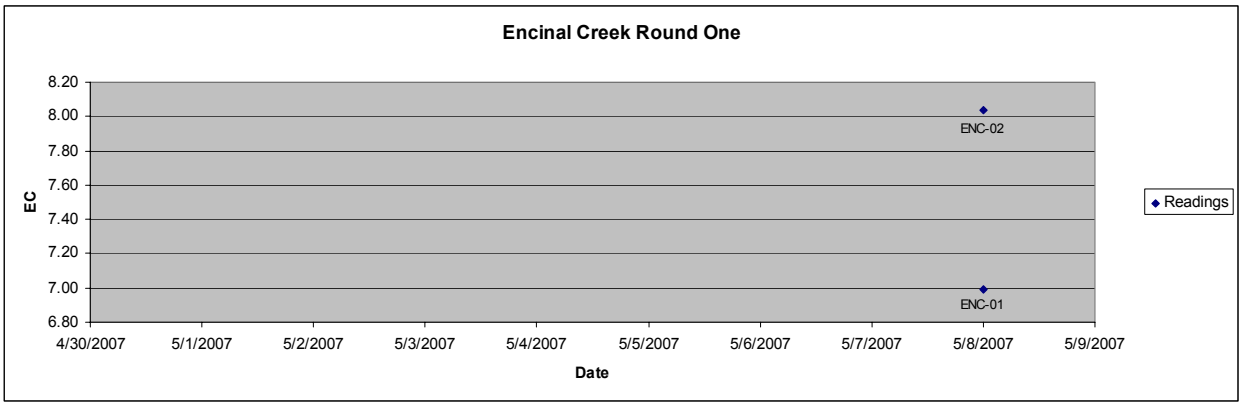


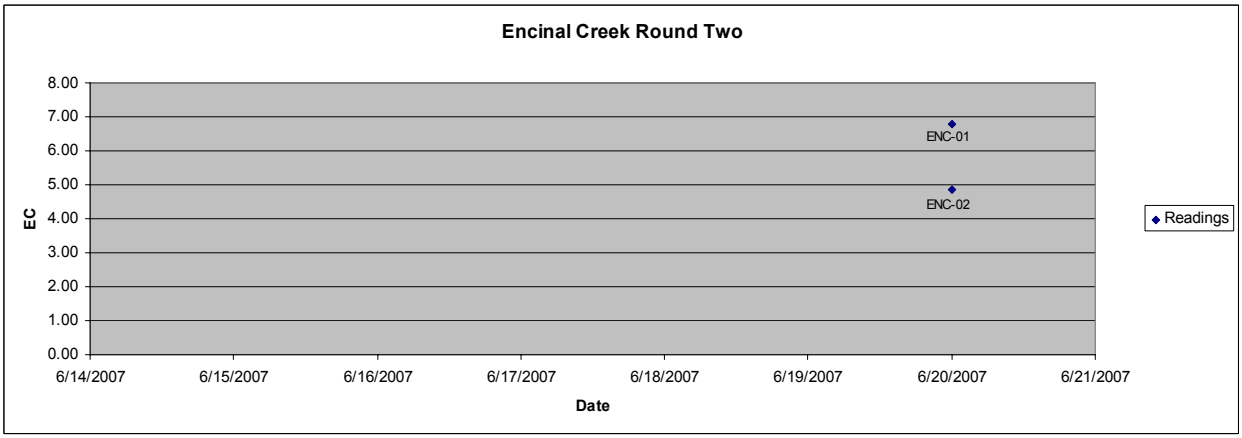

Encinal Creek Round One
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
pH
ENC-01
ENC-02
Readings
4/30/2007
5/1/2007
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date

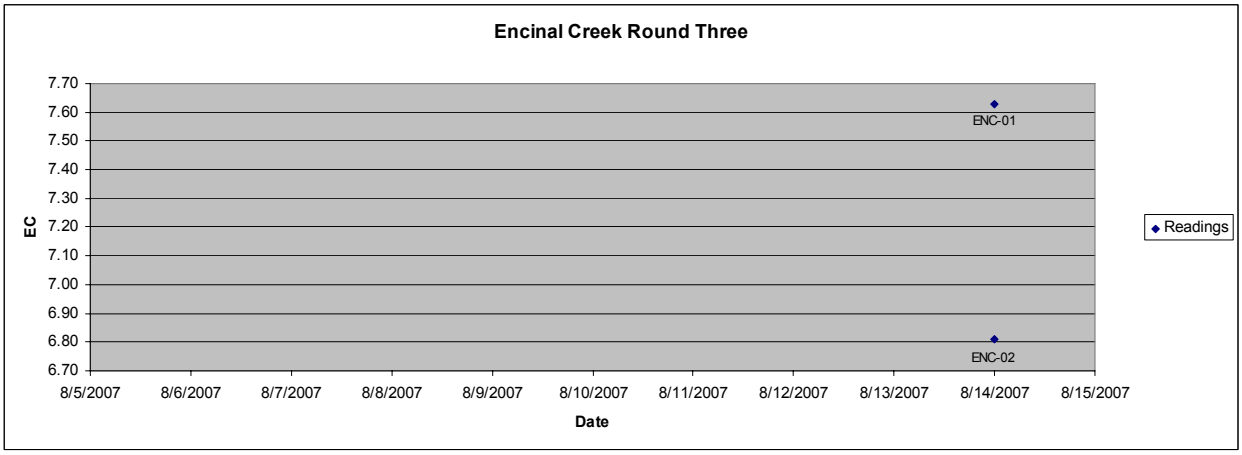

Encinal Creek Round Two
8.20
8.15
8.10
8.05
8.00
7.95
7.90
pH
ENC-02
ENC-01
Readings
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date

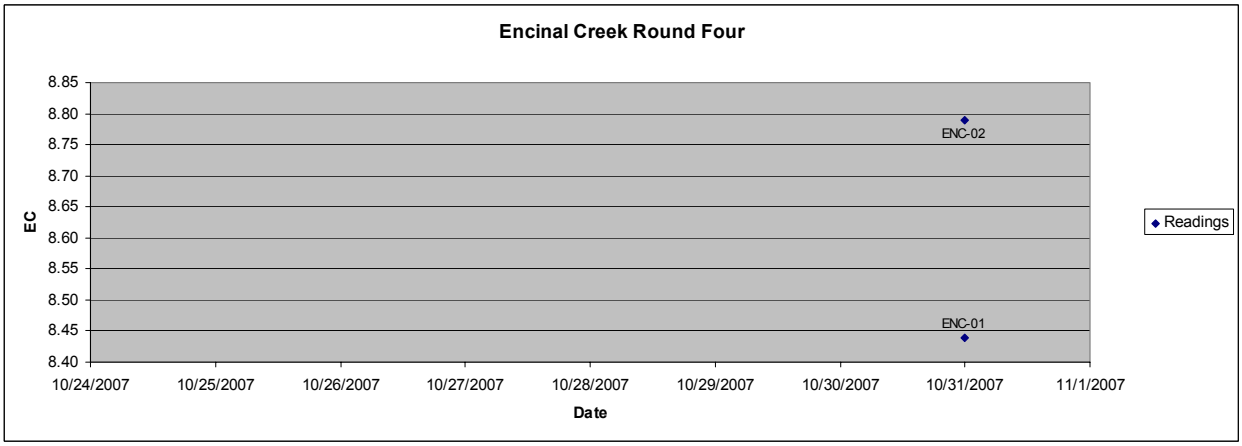

Encinal Creek Round Three
8.15
8.10
8.05
8.00
7.95
7.90
pH
ENC-02
ENC-01
Readings
8/9/2007
8/10/2007
8/10/2007
8/11/2007
8/11/2007
8/12/2007
8/12/2007
8/13/2007
8/13/2007
8/14/2007
8/14/2007
Date

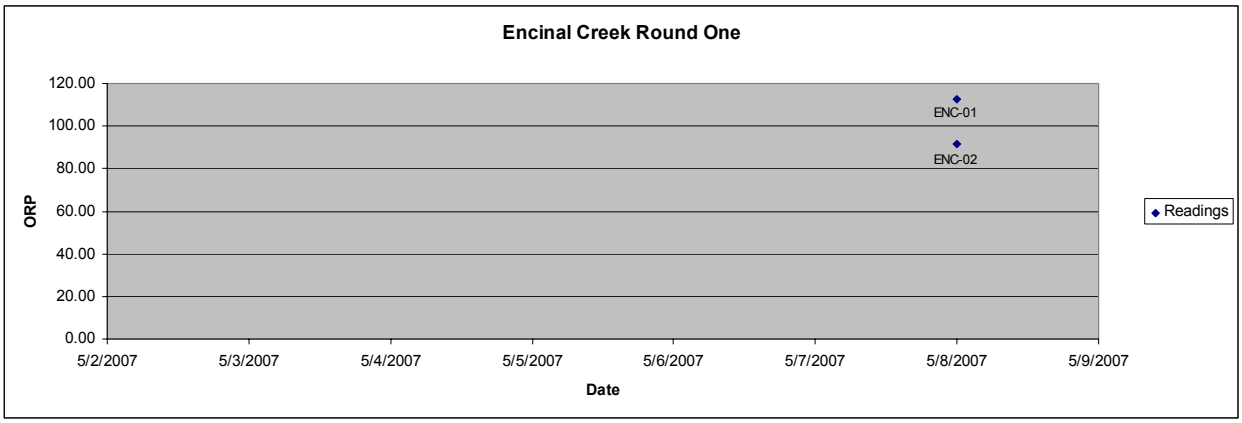

Encinal Creek Round Four
8.18
8.17
8.16
8.15
8.14
8.13
8.12
8.11
8.10
8.09
8.08
8.07
pH
ENC-02
ENC-01
Readings
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date

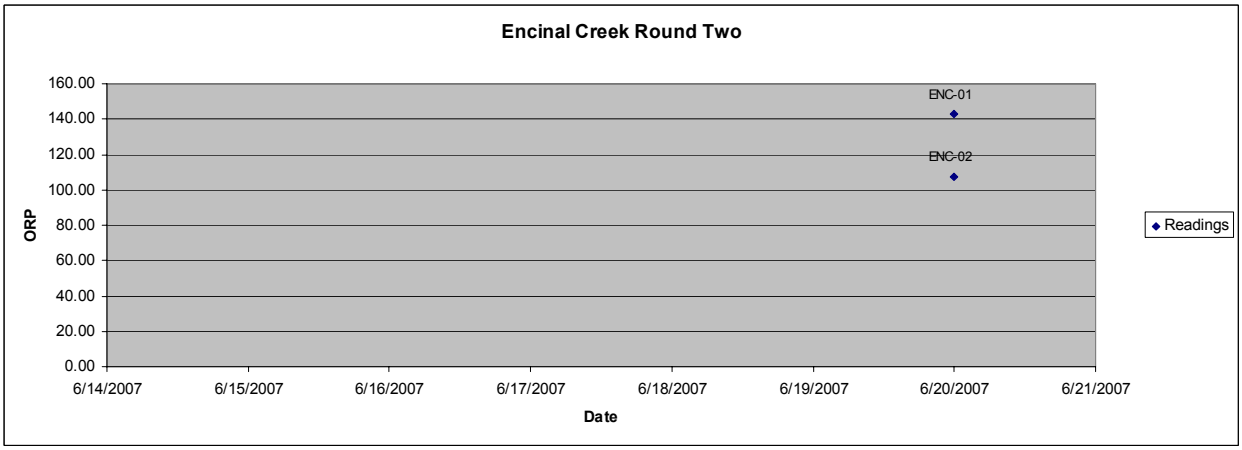

Encinal Creek Round One
8.20
8.00
7.80
7.60
7.40
7.20
7.00
6.80
EC
ENC-02
ENC-01
4/30/2007
5/1/2007
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date
Readings

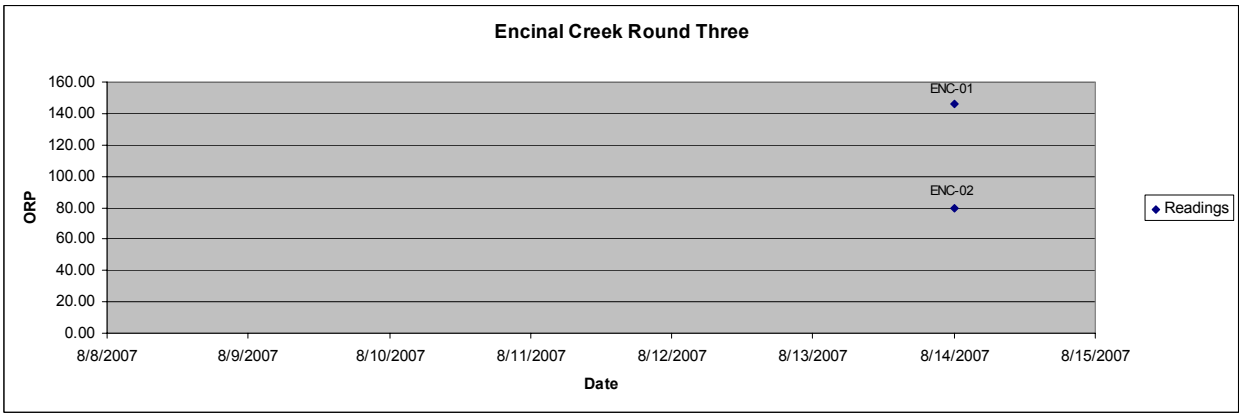

Encinal Creek Round Two
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
EC
ENC-01
ENC-02
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date
Readings

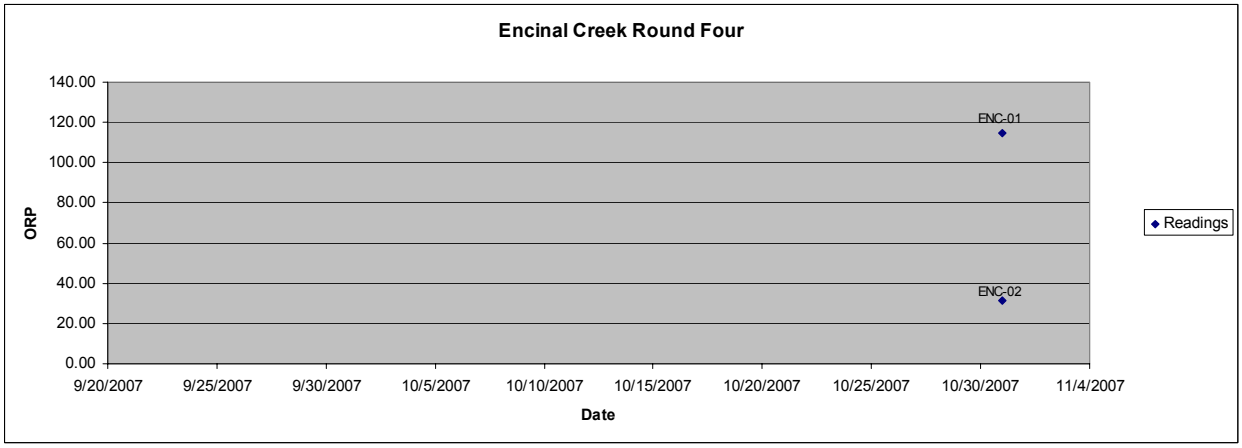

Encinal Creek Round Three
7.70
7.60
7.50
7.40
7.30
7.20
7.10
7.00
6.90
6.80
6.70
EC
ENC-01
ENC-02
8/5/2007
8/6/2007
8/7/2007
8/8/2007
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
Date
Readings

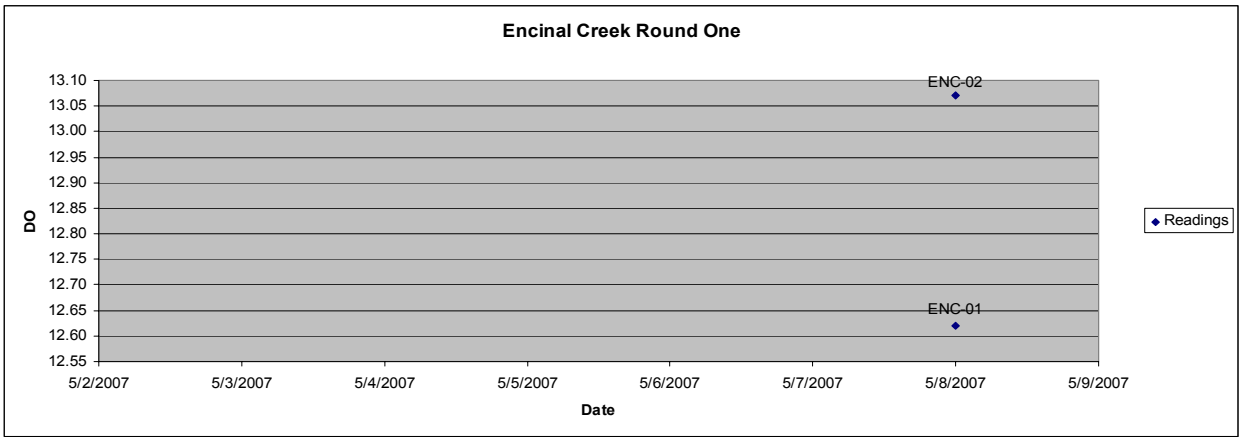

Encinal Creek Round Four
8.85
8.80
8.75
8.70
8.65
8.60
8.55
8.50
8.45
8.40
EC
ENC-02
ENC-01
10/24/2007
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
Readings

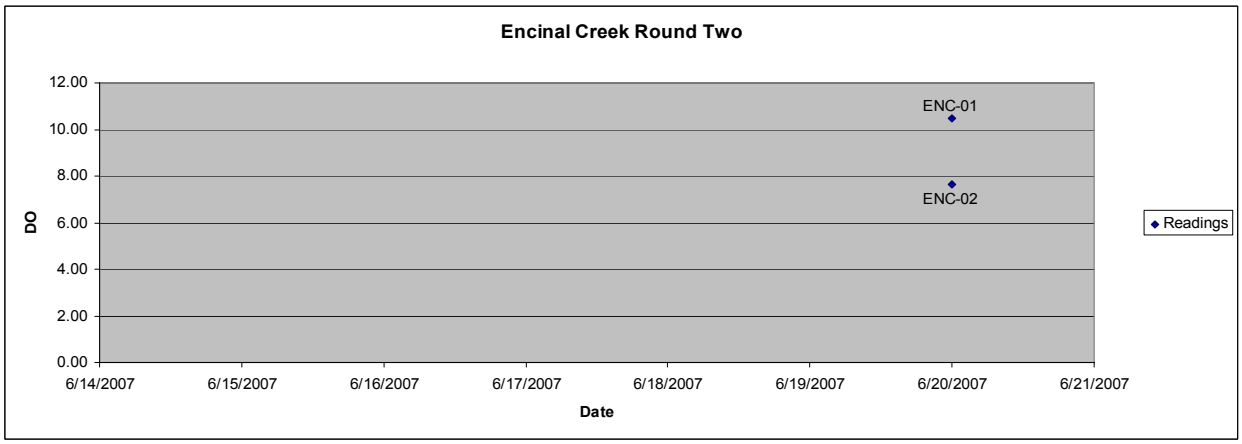

Encinal Creek Round One
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date
Readings

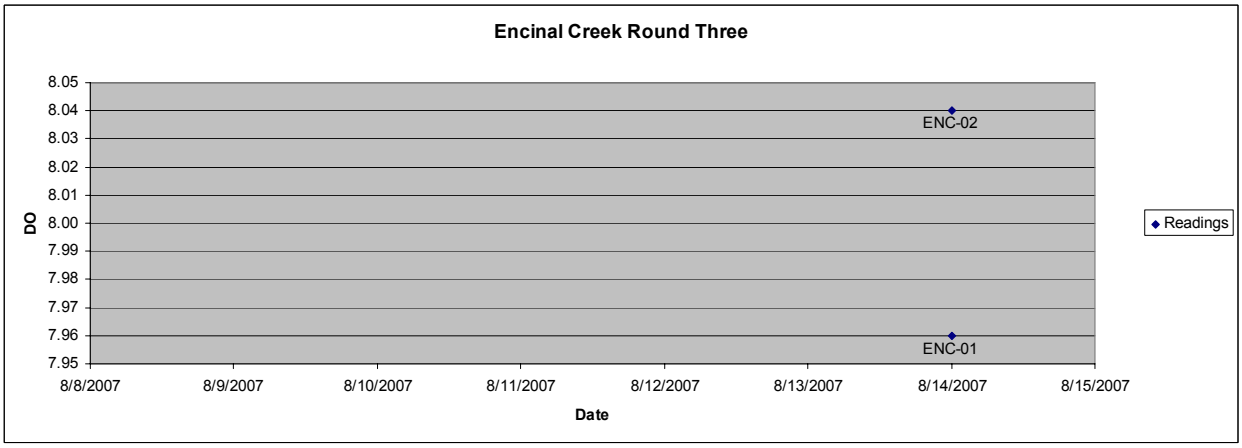

Encinal Creek Round Two
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date
Readings

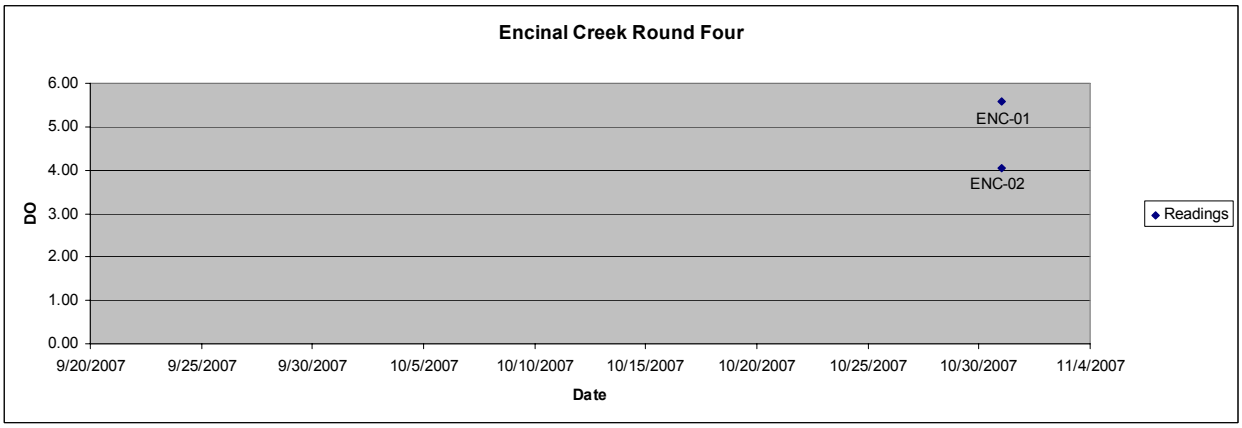

Encinal Creek Round Three
160.00
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
8/8/2007
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
Date
Readings

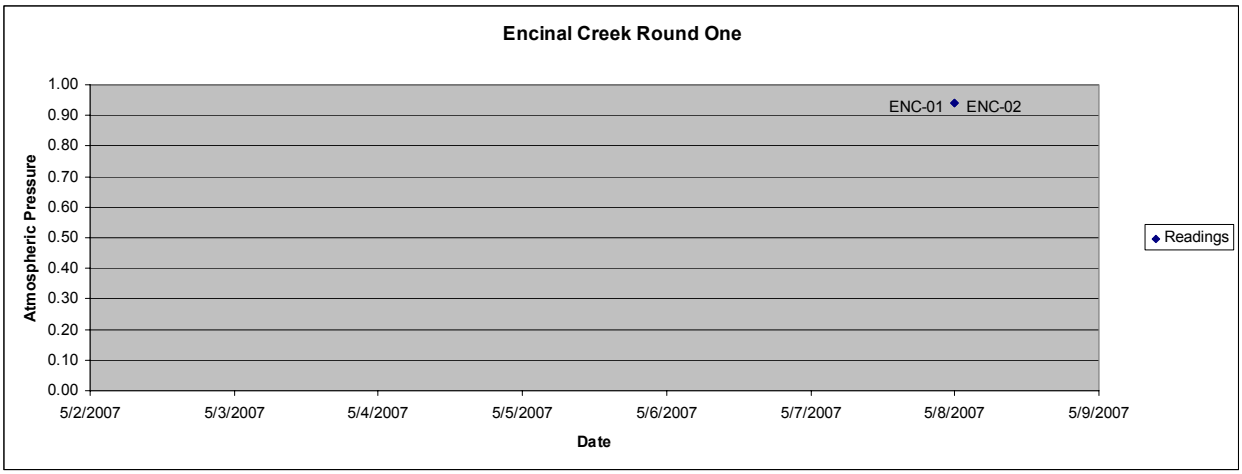

Encinal Creek Round Four
140.00
120.00
100.00
80.00
60.00
40.00
20.00
0.00
ORP
ENC-01
ENC-02
9/20/2007
9/25/2007
9/30/2007
10/5/2007
10/10/2007
10/15/2007
10/20/2007
10/25/2007
10/30/2007
11/4/2007
Date
Readings

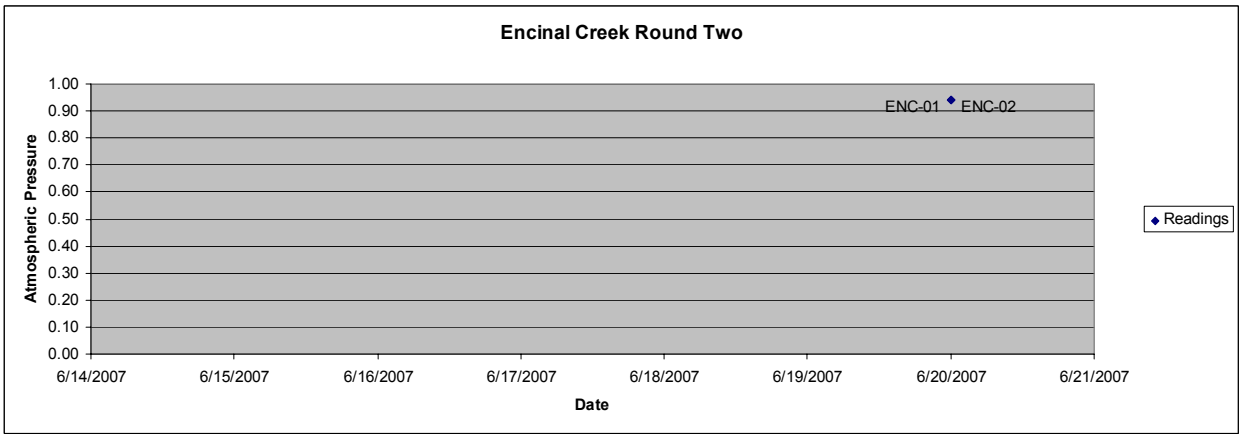

Encinal Creek Round One
13.10
13.05
13.00
12.95
12.90
12.85
12.80
12.75
12.70
12.65
12.60
12.55
DO
ENC-02
ENC-01
Readings
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date

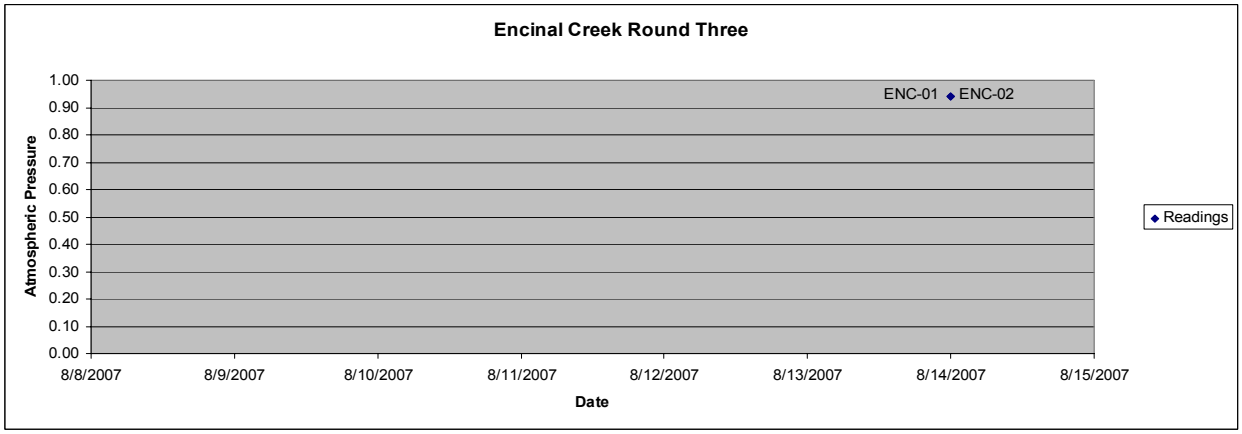

Encinal Creek Round Two
12.00
10.00
8.00
6.00
4.00
2.00
0.00
DO
ENC-01
ENC-02
Readings
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date

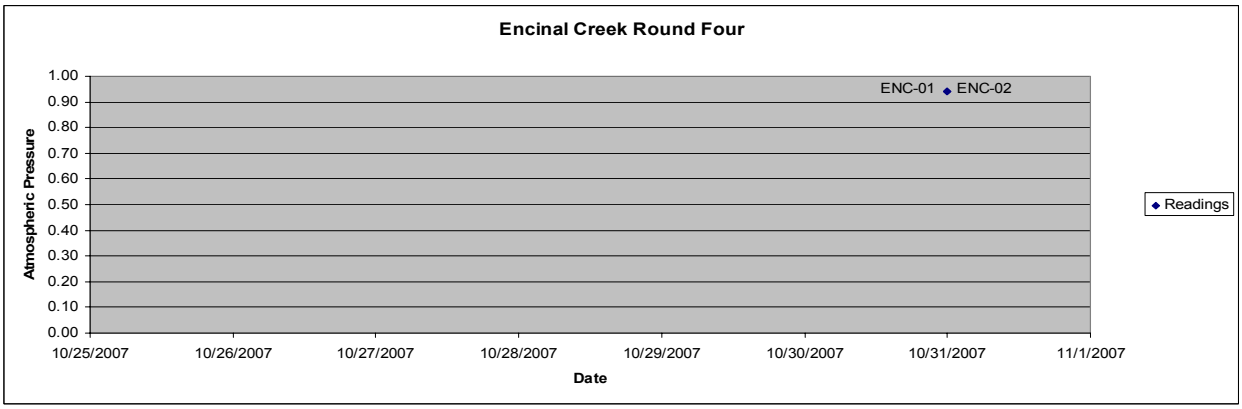

Encinal Creek Round Three
8.05
8.04
8.03
8.02
8.01
8.00
7.99
7.98
7.97
7.96
7.95
DO
ENC-02
ENC-01
Readings
8/8/2007
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
Date

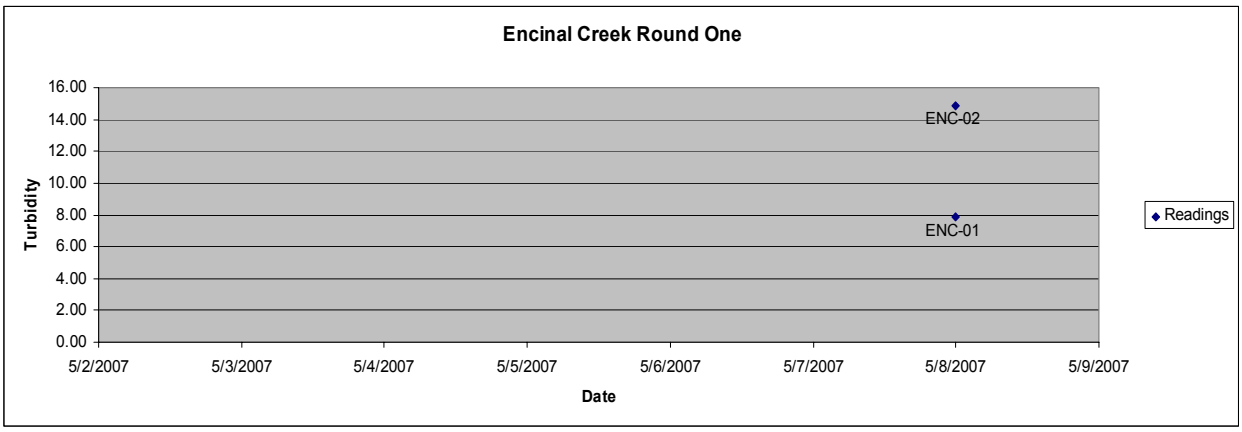

Encinal Creek Round Four
6.00
5.00
4.00
3.00
2.00
1.00
0.00
DO
ENC-01
ENC-02
Readings
9/20/2007
9/25/2007
9/30/2007
10/5/2007
10/10/2007
10/15/2007
10/20/2007
10/25/2007
10/30/2007
11/4/2007
Date

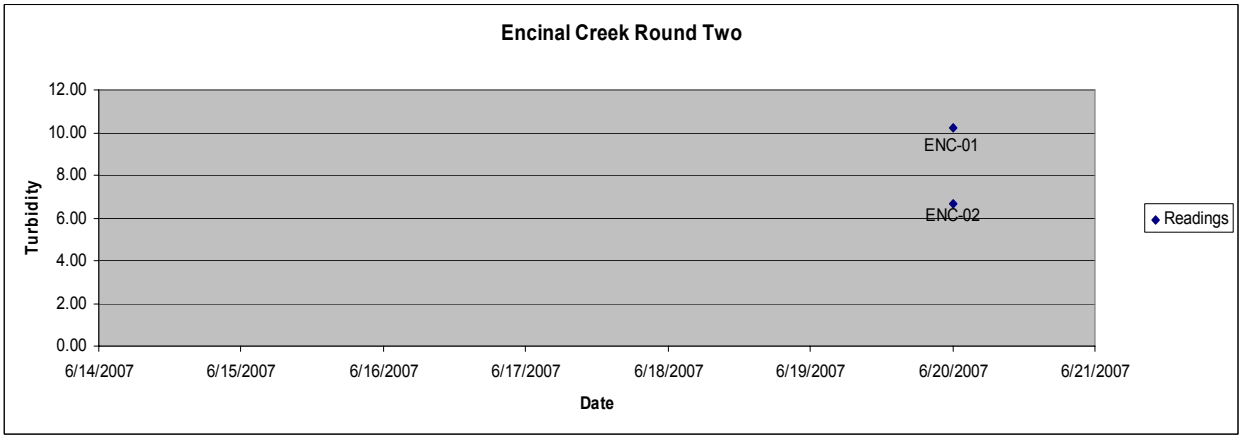

Encinal Creek Round One
ENC-01
ENC-02
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date
Readings

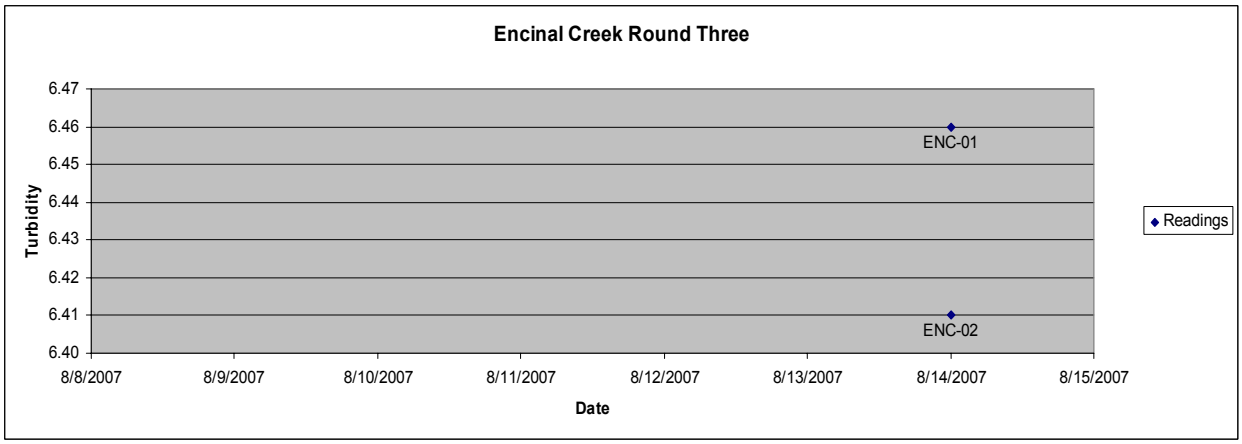

Encinal Creek Round Two
ENC-01
ENC-02
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date
Readings

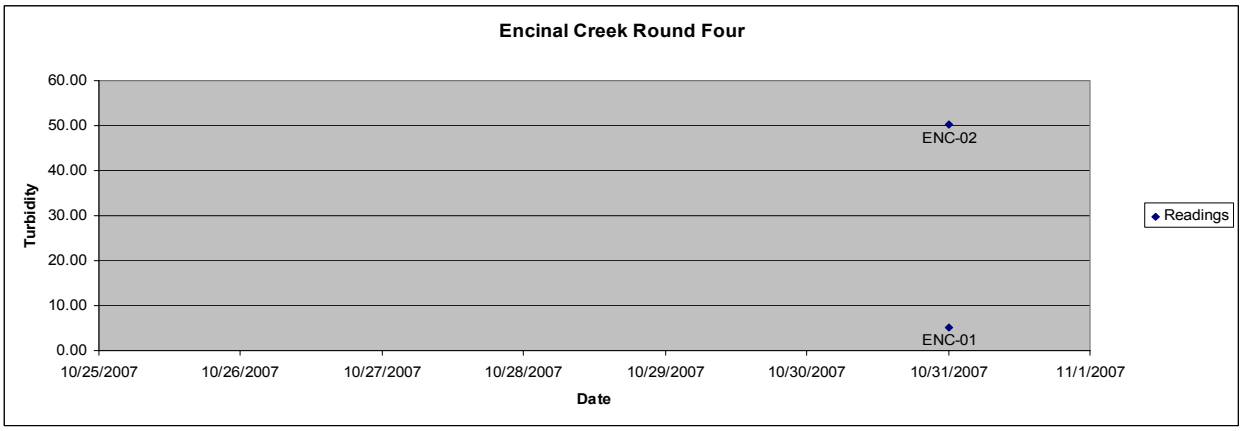

Encinal Creek Round Three
ENC-01
ENC-02
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
8/8/2007
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
Date
Readings


Encinal Creek Round Four
ENC-01
ENC-02
Atmospheric Pressure
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date
Readings


Encinal Creek Round One
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Turbidity
ENC-02
ENC-01
Readings
5/2/2007
5/3/2007
5/4/2007
5/5/2007
5/6/2007
5/7/2007
5/8/2007
5/9/2007
Date


Encinal Creek Round Two
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Turbidity
ENC-01
ENC-02
Readings
6/14/2007
6/15/2007
6/16/2007
6/17/2007
6/18/2007
6/19/2007
6/20/2007
6/21/2007
Date


Encinal Creek Round Three
6.47
6.46
6.45
6.44
6.43
6.42
6.41
6.40
Turbidity
ENC-01
ENC-02
Readings
8/8/2007
8/9/2007
8/10/2007
8/11/2007
8/12/2007
8/13/2007
8/14/2007
8/15/2007
Date


Encinal Creek Round Four
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Turbidity
ENC-02
ENC-01
Readings
10/25/2007
10/26/2007
10/27/2007
10/28/2007
10/29/2007
10/30/2007
10/31/2007
11/1/2007
Date

Evaportranspiration

Apart from precipitation, evapotranspiration is the next major component in the hydrologic budget. Evapotranspiration involves the process of evaporation from open bodies of water, wetlands, snow cover, and bare soil and the process of transpiration from vegetation. The principal climatic factors influencing evapotranspiration are solar radiation and wind speed. In the conterminous United States, evapotranspiration averages about 67 percent of the average annual precipitation and ranges from 40 percent of the precipitation in the Northwest and Northeast to about 100 percent of the precipitation in the Southwest.

Estimates of the mean annual evapotranspiration have been derived from hydrologic budgets for each State. These estimates indicate that statewide evapotranspiration within the United States ranges from about 10 inches per year in the Southwest to about 35 inches per year in the Southeast. However, in selected areas of the Southwest where moisture is available and solar radiation is high, evapotranspiration rates in salt cedar are estimated to be about 56 inches per year.

Seasonal trends in evapotranspiration follow the seasonal trends in air temperature-maximum rates occur during the summer months, and minimum rates during the winter months. Advanced Very High Resolution Radiometer instruments installed on polar-orbiting satellites provide relative measurements of plant vigor, density of vegetation cover, and the seasonal duration of vegetation growth. These measurements also monitor the spatial and temporal persistence of drought for large areas.

Changes in evapotranspiration during a drought depend largely on the availability of moisture at the onset of a drought and the severity and duration of a drought. Evaporation from open bodies of water during a drought increases, but transpiration by plants, particularly shallow-rooted plants, generally decreases (*U.S. Geological Survey Water-Supply Paper 2375, p. 99-104.*.).

Discussion

The 30 sites currently monitored within the Pueblo of Laguna Indian Reservation lands cover the full spectrum of environments, climates, terrains, and water quality. The locations range from an Alpine zone in the upper elevations where pine, spruce, aspen, and fur are the dominate tree types to Northern Chihuahuan Desert grasslands characterized by plateaus, rolling hills, and basin floors where the soils are relatively deep. Blue Grama, *Bouteloua gracilis*, is the dominant species here. Surface water sources within the Pueblo of Laguna lands vary greatly as well. The higher elevations are characterized by braided high velocity, cold-water streams and the low elevations are characterized by ephemeral streams called arroyos. Springs are the soul source of water on several of these surface water bodies, many of which dry up completely during the summer months. The flora and fauna associated with these zones vary with elevation, terrain, and uses. In many instances, only plants are associated with the surface water bodies, (Arroyos) and many of the springs, which are isolated and dry up during the summer or reduced to shallow pools with little to no aquatic life. Evaluations of current sites monitored revealed two streams and one spring hold the possibility of supporting fish species and have enough water year round to support these aquatic ecosystems. These are the Rio Paguate, Water Canyon Creek and Dipping Vat Spring on the Rio San Jose at RSJ04. Cultural and Traditional uses of these water bodies and all water bodies on the Pueblo of Laguna Indian Reservation Lands will be denoted as a “Yes” or “No” answer and under no circumstances will details of Cultural and Traditional use be elaborated upon. Do any water bodies monitored during the Calendar year 2007 of the CWA § 106 Water Quality Program have Cultural and Traditional uses? Yes.

Analytical data for the calendar year 2007 is not complete and may not be added in this report. Round one through Round three data from the Master Data base will be attached as an appendix to this report, if data from Round 4 has been received and compiled then it will be included if not then it will be added as an addendum at a later date. The analytical data collected in round one shows major changes in water samples collected from all sites. The sites designated as Back Ground have little to not interference from up stream sources and derive flow from snowmelt and rain. It is suspected that any metal levels may be elevated due to development practices implemented by the U.S. Forest Service; this development also limits the influence of biological influences such as wildlife, aquatic species, and the environment. Additionally the New Mexico Bureau of Geology and Mineral Resources in conjunction with the U.S. Geological Survey are up-dating geological maps in the Mt. Taylor volcanic field. These 7.5 minute quadrangle maps overlap on to Pueblo of Laguna lands. One of the objectives of this mapping is to better understand the movement of surface water and groundwater due to the complex nature of a composite volcanic field and its interaction on the surrounding bedrock. This will help the Pueblo of Laguna better identify recharge zones and aquifer connections and the complex relationship between surface water and groundwater within the reservation lands. More analytical sampling is required to determine if any problems exist in the waters of the Pueblo of Laguna. Determinations of naturally occurring constituents are still being compiled and evaluations for additional analytical parameters for up

coming years evaluated. Further study for naturally occurring and man made organic volatile and semi-volatile compound still need to be determined. This would require a substantial increase in the analytical budget and would be proposed for the surface water systems that are currently used by the Pueblo of Laguna for drinking and ceremonial use and feed the shallow alluvial aquifers where groundwater is drawn for the domestic drinking water supply system.

Turbidity has proven problematic; most locations have water that is above 50 NTU. This was remedied with the purchase of a new YSI 650 Multi-parameter probe and 6820 Multi-parameter Sonde which can read Additionally Turbidity as well as all physical parameters is not possible in arroyos when there is flow as this is normally flood induced and the velocity of the water is very strong. Attempts were made to collect from bridges; however, the sediment load was so great that and the particle size were slightly greater than the diameter of the collection tube that it plugged the tube.

The addition of a 4th round of sampling in the 2007 QAPP has added other problematic factors in allowing less that none week between rounds and little to no room for delays due to weather and were compounded further by the delays in the §106 granting process to Tribes this year. This delay caused nearly a month to be lost from the sample and data collection process thus requiring the program to seek a 6 month no cost extension into the next fiscal year. This was not the fault of the Pueblo of Laguna but the fault of the U.S. Environmental Protection Agency and since the Tribes are held accountable for there delays so must the U.S. Environmental Protection Agency.

In summary there is data both physical and analytical to determine problem areas on surface water bodies across the Pueblo of Laguna reservation lands. The Rio Paguate has good quality water above the mine however, below the mine the quality drops dramatically. The level of Isotopic Uranium in the water peaked this year at 240.935 µg/L. This level impacts not only the Rio Paguate but the Rio San Jose below there convergence points and the Rio Puerco then the Rio Grande. The Rio Moquino has showed measurable levels of Isotopic Uranium all year long with a peak level of 31.139 µg/L. The quality of water in the Water Canyon Creek has remained fairly constant throughout the year. The main problem with this stream system is the diversion of 100% of the flow by the Cubero Land Grant Community. Encinal Creek has also remained fairly constant throughout the year as well; the only problem is limited flow. The two points at Jack Ward Mesa have varied greatly all year, it is expected that this is due to geology and natural causes. The Rio San Jose has varied greatly as well and this is due to numerous factors. The Rio Puerco and Rio Salado vary greatly as well, however this is mostly do to the presence of absence of water. There has been very limited flow all year and the Rio Salado has remained dry and is 100% contained by the Marquez Land Grant Community. The numerous springs including background have not fluctuated as greatly but difference can be attributed to the drought conditions experienced this year which impact quality, flow and quantity.

Arroyo Cutting

An arroyo is a nearly vertically walled, flat floored stream channel that forms in fine, cohesive, easily eroded material. Arroyos can cut as deeply as 65 feet into the valley floor, are often wider than 165 feet, and can be hundreds of miles long. Arroyos exist throughout the western United States, but are most common in arid and semi-arid climates in the Southwest. The rapid widening and deepening of arroyos have both changed the physical environment and been a costly nuisance in the west since European settlement began in the mid 1800's.

Causes of Arroyo Formation

Three factors may cause arroyo formation, but the relative contribution of each is difficult to discern. The main factor is thought to be a change in climate that produced unusually heavy rainfall. Land-use practices, such as grazing, may have enhanced arroyo formation in the southwest during the most recent period of erosion (A.D. 1865-1915). A natural cycle of erosion and deposition caused by internal adjustments to the channel system is a third possibility (Graf, 1988; Schumm and Hadley, 1957).

Climate

Flooding caused by heavy rain may produce arroyos. Although climate records in the southwest were not systematically kept before about 1900, recent studies have found evidence for unusually heavy rainfall in Tucson, Arizona during the late 1800's (Betancourt and Turner, 1993). This rainfall was caused by strong and frequent ENSO (El Nino Southern Oscillation) events, suggesting that heavy rain was a regional phenomenon. Thus, the climate of the Southwest during the most recent period of arroyo entrenchment was conducive to large floods (Hereford, 1993). Drainages may have been especially vulnerable to arroyo cutting, if unusually wet ENSO conditions occurred immediately following a period of below normal precipitation. During a dry period, the enervated vegetation would not have its normal capacity to protect the soil from rain-drop impact or to absorb and slow runoff.

Land use

With the settlement of the West came the rapid introduction of cattle, sheep, and horses. From 1870 to 1890 the number of livestock in New Mexico increased from 300,000 to 2,300,000 (Peterson, 1950). Similar increases were reported in other Western states during this time. Valley floors, which were the most dependable forage areas for the animals, were quickly overgrazed. The fragile vegetation was consumed, and the soil was compacted and left extremely susceptible to erosion. To further exacerbate

the soil conditions, both humans and livestock created trails along stream channels and nearby hillsides forming small ditches, leaving the land surface susceptible to arroyo formation.

Nevertheless, earlier periods of arroyo formation predated the introduction of livestock, and thus overgrazing cannot be solely responsible. Spanish and Mexican ranchers, moreover, introduced large numbers of livestock in the 1700's without associated erosion. For these reasons, other factors such as climate change may have played a more important role in arroyo formation.

Effects of Arroyo Cutting

Swamps in the Southwest during the Last Century

Observations before 1865 describe verdant river bed marshes, known as cienegas, containing beaver ponds, fish, and tall grasses which were nourished by high water tables (Bryan, 1925). These marshes have since been drained by arroyos, altering the flora and fauna of the area by widening and deepening the original stream channel.

Decreased Agricultural Productivity

Arroyo formation can be very destructive to agriculture. As soon as arroyo cutting begins, the surrounding water table is lowered making irrigation difficult. Arroyos can quickly remove as much as 25% of their valley floor (Cooke and Reeves, 1976, p. 3), covering downstream agricultural land with unwanted flood-borne sediment. This sediment does not improve the fertility of the underlying alluvial soil because it contains large quantities of sand and gravel that originate from subsoil and deposits of soil forming materials (Cooperrider and Hendricks, 1937).

Flooding

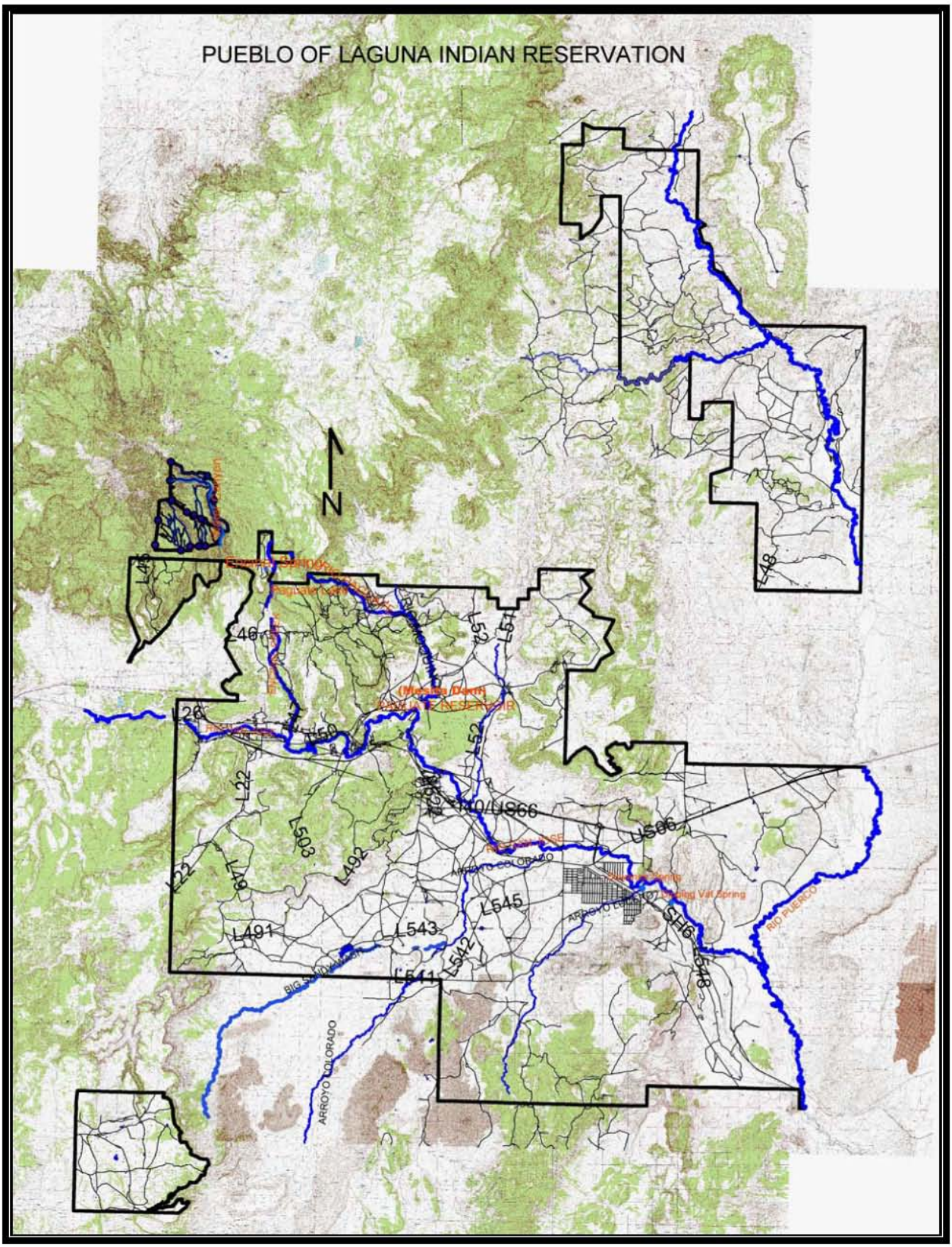
The often excessive deposits of sediment from upstream arroyo formation can decrease flood protection by reducing the natural regulatory functions of stream channels. Sediment from upstream arroyo erosion fills channels that otherwise would store flood water. Arroyos also increase flood severity by changing the geometry of the stream channel. Development of an arroyo in a previously braided or meandering drainage straightens and shortens the channel which limits flood water dispersal and increases velocity.

Displacement of People

Because of the loss of land to arroyos and the increased difficulties of farming, humans have occasionally been forced to either change their agricultural practices or to relocate. Where farming practices were depended on irrigation, problems of increasingly fluctuating and decreasingly reliable water sources, and difficulties of transferring water to fields, drove out farmers or forced a change to grazing (Gregory and

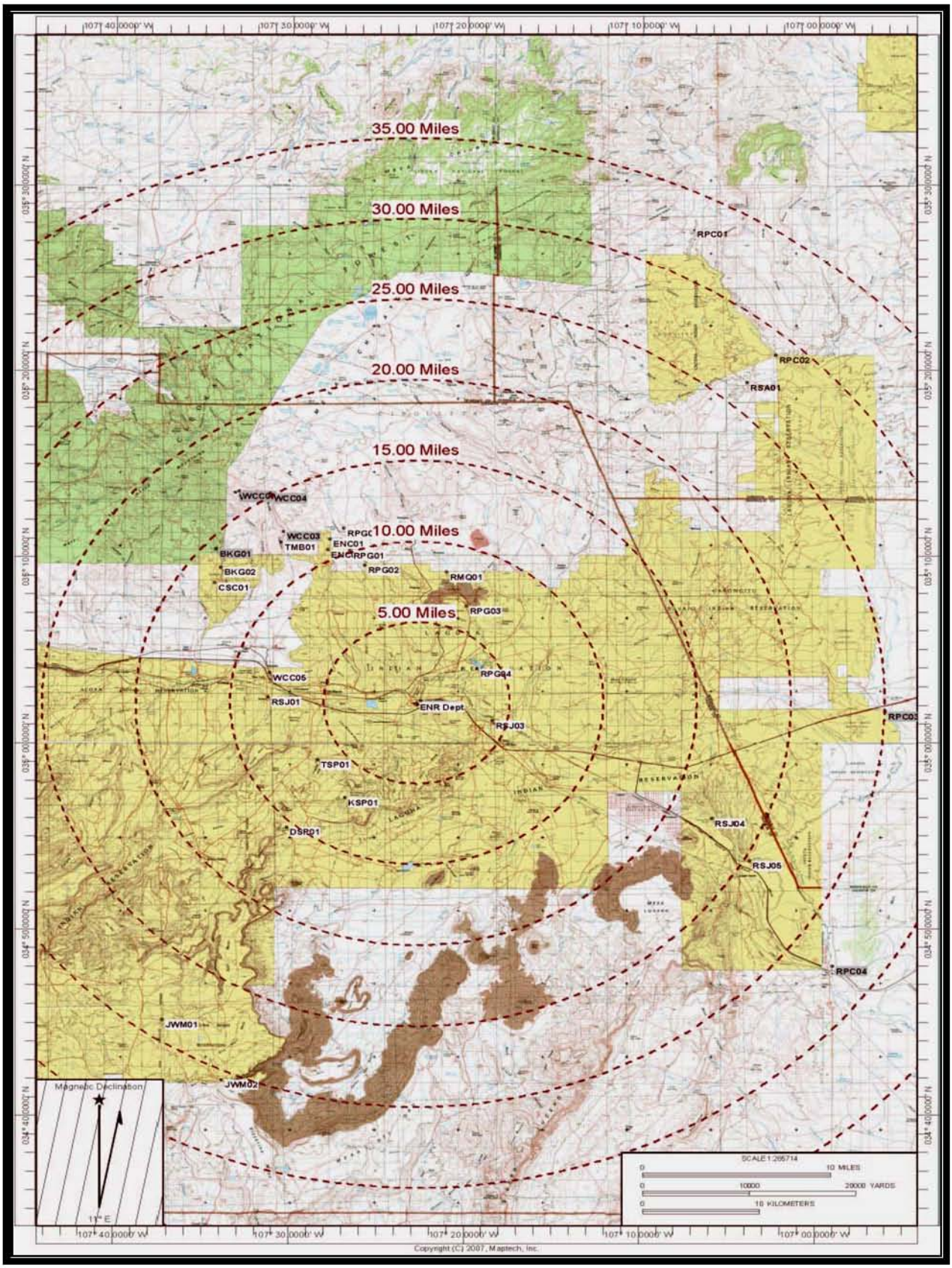
Moore, 1931). Other damages include destruction to roads, railroads, bridges, culverts, fences, and irrigation works. In the late 1880's, the entrenchment of the Rio Puerco in New Mexico forced the desertion of the towns of San Ignacio, San Fernando y Blas, and San Francisco (Bryan, 1925). Prehistoric arroyo cutting may have been one of the main factors leading to abandonment of southern Utah and northern Arizona by the Anasazi (Hereford et al., 1995).[2]

[2] USGS Rio Puerco On-line Web site http://esp.cr.usgs.gov/rio_puerco



Not to Scale

CY 2005 CWA § 106 Water Quality Program Sampling & Monitoring Locations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10000
20000 YARDS
15 KILOMETERS
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Macroinvertebrates and Fish Habitats

The Rio San Jose and the Rio Puerco watersheds, which are both sub-watersheds of the Rio Grande Basin system, receive water from sources passing through or originating on Pueblo of Laguna Indian lands. The stream systems which comprise these watersheds vary with regard to the size of the basin, elevation, seasonal flow rates, ownership and resource management schemes, and of course, aquatic bio-diversity.

There are perennial, spring-fed and snow run-off, cold-water streams which support native and introduced trout species (Genus: *Salmo)*, of New Mexico and the elements of primary production, which these trout feed on. These stream systems vary from one (foot) in diameter, to approximately 12 feet in diameter, with varying levels of stream depth and flow rates. There is also variation in the pools, riffles, eddies, as well as, available fish cover and habitat. Additionally, there have been occurrences of catfish (Genus: *Ictalurus*) and Bluegill (Genus: *Lepomis*) in the Rio Paguate and Rio San Jose stream systems.

There are also areas of the stream systems, which have become "choked" with vegetation and silt. These choked areas of the stream system are primarily upstream of the Pueblo of Laguna's external boundary fence. Within the Pueblo of Laguna's boundaries, in the Water Canyon stream system, there are a series of high elevation, small, in-line ponds, which vary in size, depth, and habitat. There are some seasonal occurrences of algal blooms in this pond series, which effects aquatic life. Inhabitants of these high-mountain ponds include, but are not limited to, mudpuppies (Genus: *Necturus*), Gastropods (snails), crayfish (Order: Decapoda), and Leopard Frogs (Genus: *Rana*), and these ponds are regularly visited by bear, deer, mountain lion, turkey, ducks and elk.

The Pueblo of Laguna's Environmental and Natural Resource Teams are presently designing a complete aquatic biodiversity inventory to be conducted as funding becomes available.

Conclusions

The Pueblo of Laguna Surface Water Quality Monitoring program has experienced set back but has meet or exceeded all goals for the § 106 Clean Water Act Grant for FY 2006-2007. The water quality specialist and colleges have collected four rounds of analytical samples and attempted to collect bi-monthly physical parameter data. In addition, all quarterly reports have been submitted for this grant year, with the exception of this Year End Report. Analytical data is still arriving and only data for round one to three is complete and attached to this report. The result of the analytical sampling and physical parameter monitoring is indicating great diversity within the waters of the Pueblo of Laguna. Variations in surface water bodies with hydrologic links to groundwater to many cases are becoming evident, which has been suspected but not confirmed.

As discussed in the introduction section the hydrogeology of the Pueblo of Laguna Reservation lands is unique and complex. Pristine conditions are no longer possible due to the extensive mining that occurred in the Grants Mineral Belt. Contamination from mining activities, population centers, National Laboratories, highways, detonation of nuclear weapons within the state of New Mexico, etc., have wide reaching effects and directly impact the air quality which in turn affects meteoric waters which are part of the hydrologic cycle. The first atomic bombs detonated were within the State of New Mexico, the first at Los Alamos National Laboratory and the second at the Trinity Site on the White Sands Missile Range. Much of the uranium needed for these weapons was mined from Pueblo lands and the effects of which are still being discovered.

The use of surface water by the Pueblo of Laguna people had not changed much since New Mexico became a State in 1912. These uses include irrigation of farmland, livestock watering, drinking water supplies, and cultural and traditional uses. Introduction of drinking water and waste water systems by the Indian Health Service have had dramatic effects on the limited, high quality water supplies on Pueblo lands from their introduction in the 1960's. Demand for drinking water has grown logarithmically since its introduction with similar detrimental effects on source areas. Impacts from septic and sewage lagoons is not fully know but is expected to have been negative. Demands for water in the semi-arid climate of the southwest are growing both on and off the reservation. Large metropolitan areas demands for clean drinking water have exceeded the capability of the source supply and these areas are now looking towards Indian lands to fulfill their needs, with no regard to the needs of the Tribes own needs for the same resource. It is extremely important for Tribes, specifically the Pueblo of Laguna to protect and determine the quality of its waters both surface and subsurface. It is also important to understand the impact of contaminants on the hydrologic cycle, and how these contaminants will influence human health and the environment.

The Pueblo of Laguna is in the beginning stages of this process and will continue to assess the surface waters within its boundaries to protect the health of its people, culture and society for future needs for all

life.

This concludes all activities reportable for FY 2007.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: John E. Antonio

Title: Governor

Date: _____

Appendix A

First Quarterly Report

Appendix B

Second Quarterly Report

Appendix C

Third Quarterly Report

Appendix D

Master Data Base-Analytical, Physical Data Parameters
and
Ambient Toxicity Data

Second Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

January to March 2007

Assistance Agreement No. I-96620101-0

27000325

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- A new multi parameter probe was purchased this year, a YSI 6000 series, which has the capability to do turbidity reading along with all the other physical parameter data collected in the past.
- The CWA § 106 Water Quality Program Grant was completed, signed and submitted to the U.S. EPA Region VI office for review and funding negotiation. The delay in requesting grant proposals this year caused a sever backlog in program activities.
- A new revised QAPP submitted to Region VI on December 18, 2006 approved by a letter dated February 23, 2007 and received in March 2007, details work for this years sampling and data collection activities.
- Training is an on going process, will be included in work activities as needed for refresher and improving job performance, and planned for next quarter, the 2007 Water Quality Monitoring and Assessment Seminar in Bandera, TX.
- The State of New Mexico Indian Affairs Department and Office of the State Engineer recognized the Pueblo of Laguna with a Certificate of Recognition for Reservation Wide Surface Water Monitoring under CWA § 106 at the State Legislature on February 2, 2007, see attached copy.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Delays in getting approval of the QAPP have caused delays in the start of program activities. Weather, snow and rain, and the flooding of last year as well as a delay by EPA in seeking grant proposals severely affected the start of sampling and data collection activities.

- Collection of analytical and physical parameter data was not feasible during the first quarter of the new fiscal year. The new QAPP address these types of delays as well as others unique to the Pueblo of Laguna.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- No new data from any federal agencies exists. As a point of fact, the water uses and sources vary greatly between tribes. In most cases, this information is not relevant or viable to the needs or uses here at the Pueblo of Laguna.

- The Partners for Success (PFS) program under the Pueblo of Laguna Department of Educations had been providing for the CWA § 106 program, however they were not funded and are not able to provide an intern to the program. This is an invaluable asset, which is no longer viable. Collection of Analytical Samples and Physical Data Collection are not possible by a single person. The QAPP requires at least two people for all field activities. The GAP program has been able to provide a part time technician but this does not alleviate the problem. When the GAP technician is unavailable, the ENR Director has filled in as a field technician so program activities can proceed with out interruption. This shortage of staffing is creating a very serious problem and if not alleviated will disrupt the function of program activities to the point that work may not precede at all affecting deliverables and all program activities. For this program to operate fully two full time positions are required and one part time, to assist with sampling and field activities will be required for full program implementation.

- Assistance to the CWA § 106 program from GAP is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on new Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and off reservation sources of water that affect the Pueblo of Laguna. Training on the new Multi-Parameter Probe will continue with each of the rounds of sampling. Budget deficiencies have forced the use of more physical parameter data collection as a replacement for analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line have not increased but been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe. The Hanna Probe is no longer used for turbidity measurement, however, tubing, PVC and silicone, are still needed for analytical sample collection as well as ppe.

- As part of the Tribal Re-organization, programs are still being re-arranged and established in their new locations. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect and process GPS/GIS data on the sites and process the data. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- Round one sampling will begin in Mid April and continue into May.

This concludes all activities reportable for the second Quarter of FY 2007.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: for John E. Antonio

Title: Governor

Date: _____

2007

STATE OF NEW MEXICO INDIAN AFFAIRS DEPARTMENT

AWARDS TO:

PUEBLO OF LAGUNA

IN RECOGNITION OF PROGRESS WITH WATER:

The Pueblo of Laguna is awarded this Certificate for Reservation wide surface water monitoring under CWA Section 106, restoration activities and planning to create several acres of wetlands on the Rio San Jose, on-going work by the Laguna Water Utility for the protection of the Pueblos drinking water systems, educational outreach and field trips on water quality protection and water resources on the Pueblo.

SECRETARY OF INDIAN AFFAIRS
BENNY SHENDO JR

NEW MEXICO STATE ENGINEER
JOHN R. D'ANTONIO

27000330
27000165

Third Quarter Progress Report

Pueblo of Laguna
Environmental and Natural Resources Department

CWA § 106 Water Quality Program

April to June 2007

Assistance Agreement No. I-96620101-0

27000331

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- Attended the Water Quality-Monitoring Seminar in Bandera, TX.
- Still waiting on notification regarding the CWA § 106 Water Quality Program Grant. The Pueblo of Laguna submitted all required documentation to the U.S. EPA Region VI office for review and funding negotiation.
- Sampling and Physical Data collection for Round's One and Two are completed and Round Three begin in late July. Minor technical difficulties occurred in the beginning of Round One in recording and logging data, these issues were resolved with the assistance of the dealer and manufacture.
- Training is an on going process, will be included in work activities as needed for refresher and improving job performance however, due to budget shortfalls training will be sought in house for from local entities that do not require travel or training fees such as the BIA, IHS, ITEC, OETA etc.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

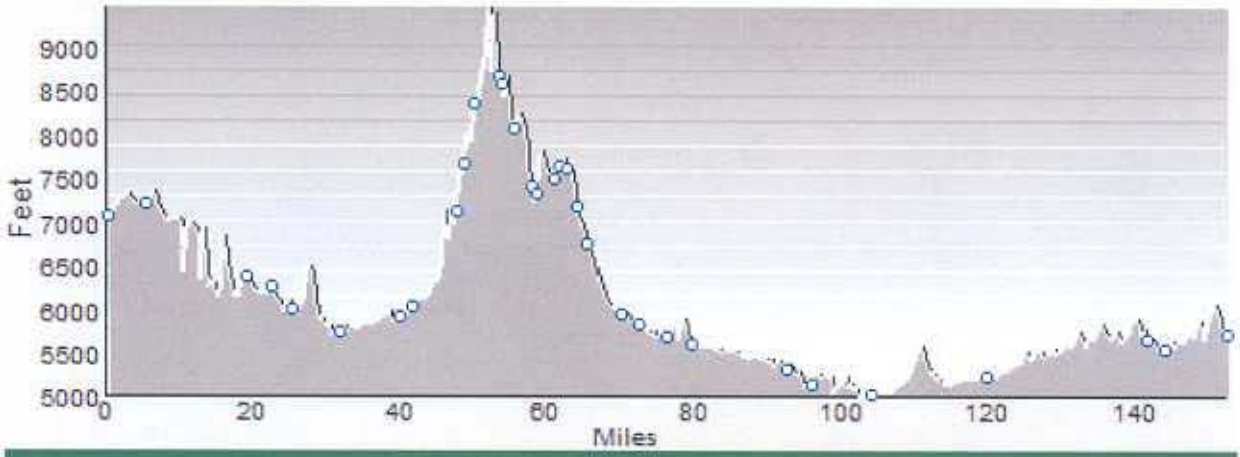
B. Implementation of Program QAPP

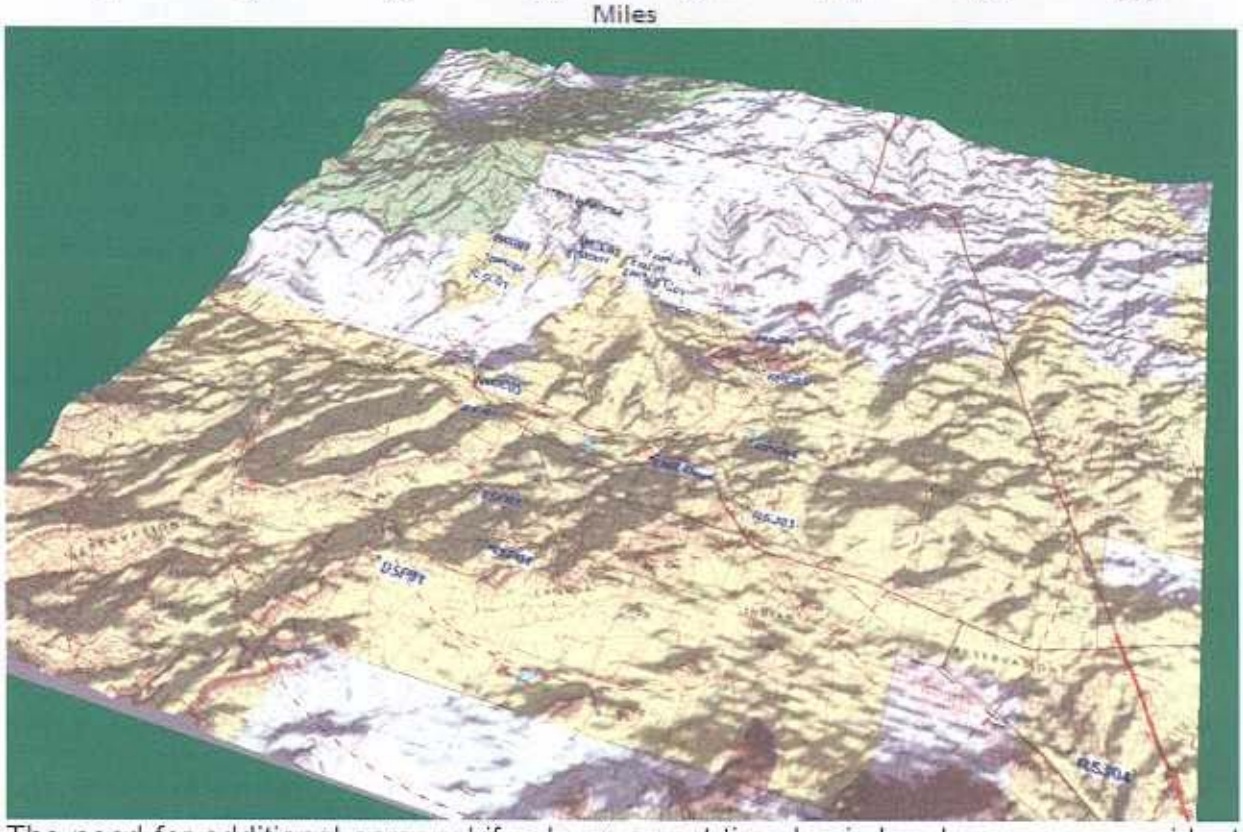
C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Sample and Physical Data collection activities have begun and two complete rounds of samples and physical data will be completed by the end of this quarter. The third round will have begun with a completion date in late August. Round four will begin in October with completion in November of this coming year. The monsoon season for New Mexico usually occurs in from July to September and may cause activities to be delayed or cancelled. The weather in this area is not conducive to sampling in the

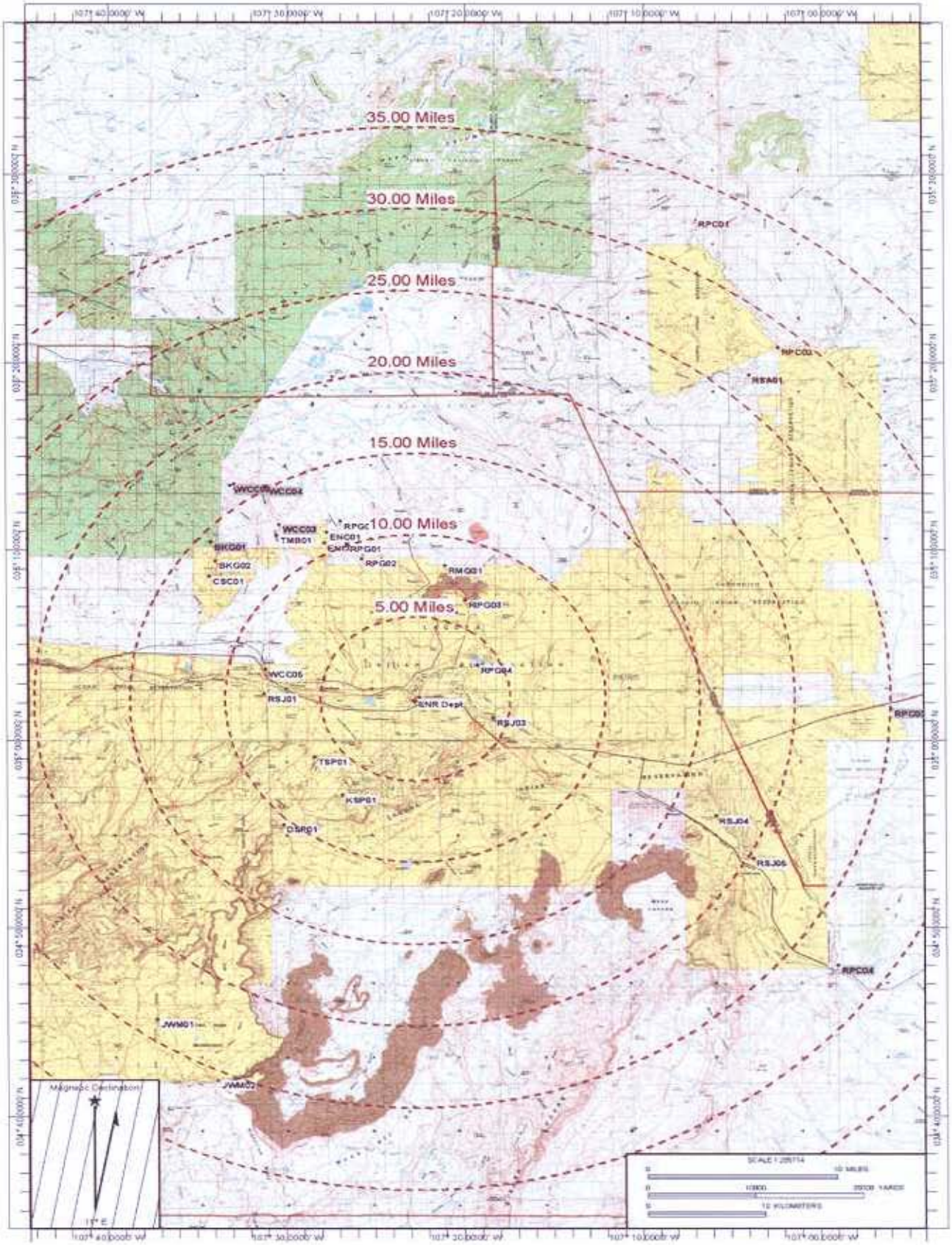
winter and early spring months. Snow pack in the higher elevations makes sample collection very hazardous with freezing of water bodies in the lower elevations. Ice is not thick enough to stand on and without access to the liquid water below physical data and samples cannot be collected. See the attached elevation plot of sampling locations in relation to feet above sea level and distance in miles from south to north trend.





- The need for additional personal if only on a part time basis has become very evident. The Pueblo of Laguna Higher Education, Partners for Success and One Step program have been able to provide the program with interns in the past but not this year. Funding short falls have reduces the function and capability of the program to assist the Surface Water Quality program. Additionally the cost of fuel has become an issue as well, the bulk of the water quality sampling locations for the Pueblo of Laguna are not

easily accessible nor are they close together. Since the 106 grant does not allow for the purchase of a vehicle one must be leased from GSA and both the lease payments and fuel cost are becoming more than the grant budget planned for. The program cannot function without staff nor can it get safely to and from the field without an off-road equipped vehicle, which are not fuel-efficient. These issues are address in the QAPP and are being flowed however; additional funding will be required to complete the program in the near future. See attached sampling location map on the next page.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WCC05
RSJ01
ENR Dept
RSJ03
TSP01
KSP01
DSR01
RSJ04
RSJ05
RPC04
JWM01
JWM02
Magnetic Declination

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- No new data from any federal agencies exists. As a point of fact, the water uses and sources vary greatly between tribes. In most cases, this information is not relevant or viable to the needs or uses here at the Pueblo of Laguna.
- Assistance to the CWA § 106 program from GAP is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties.
- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on new Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and off reservation sources of water that affect the Pueblo of Laguna. Training on the new Multi-Parameter Probe will continue with each of the rounds of sampling. Budget deficiencies have forced the use of more physical parameter data collection as a replacement for analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line have not increased but has been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe. Changes to water quality standards by the State of New Mexico will affect the Pueblo of Laguna and training on these standards and the impact to Pueblo of Laguna waters are vital. Time, resources and funding will be required to address these impacts.

- In accordance with the new QAPP, existing sites have been relocated and or renamed in an attempt to quantify, qualify, and verify conditions of surface water on the Rio San Jose and Background sources. Other locations were adjusted to capture actual flow in the surface water body; these are the Rio Puerco and Rio Salado. The Rio Paguate, Water Canyon Creek and Encinal Creek have flow year round but may diminish in the summer months. The Rio Moquino usually dries up during the summer and if this occurs notation well be made in the logbook and field sheets. The surface water spring sampling locations have been renamed to reflect the actual name of the spring using the naming scheme used for all the other points.

This concludes all activities reportable for the Third Quarter of FY 2007.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: John E. Antonio

Title: Governor

Date: 6-28-07

Physical Data Parameters for Round One 2007 (Average Values)

Site	Date	Temperature	pH	Sp Conductance	Conductivity	Resistivity	Salinity	DO %	DO Concentration	Atmospheric Pressure	OPR	Turbidity
Location		°C		mS/c	mS/c	KOhm/cm	ppt	%	mg/L	Atm	mV	NTU
RMQ-01	4/16/2007	e/m	e/m	e/m	e/m	e/m	e/m	e/m	e/m	e/m	e/m	e/m
RPG-02	4/17/2007	6.23	8.35	e/m	e/m	0.31	e/m	e/m	12.86	0.96	203.54	15.80
RPG-022	4/17/2007	6.23	8.35	e/m	e/m	0.31	e/m	e/m	12.86	0.96	203.54	15.80
RPG-03	4/18/2007	7.85	8.37	e/m	e/m	1.39	e/m	e/m	16.63	0.98	188.53	43.03
RPG-04	4/19/2007	12.35	8.16	e/m	e/m	0.77	e/m	e/m	17.17	0.99	211.50	6.07
RSJ-01	4/24/2007	5.91	8.60	e/m	e/m	0.72	e/m	e/m	21.42	0.98	200.33	74.00
RSJ-011	4/24/2007	5.91	8.60	e/m	e/m	0.72	e/m	e/m	21.42	0.98	200.33	74.00
RSJ-02	4/25/2007	8.52	8.27	e/m	e/m	0.57	e/m	e/m	17.49	0.99	226.38	55.70
RSJ-04	4/26/2007	13.68	8.08	e/m	e/m	0.29	e/m	e/m	17.11	1.00	228.10	10.50
WCC-05	5/7/2007	6.58	8.75	e/m	e/m	2.32	e/m	e/m	15.61	0.98	168.87	17.07
ENC-01	5/8/2007	10.39	8.34	e/m	e/m	6.99	e/m	e/m	12.62	0.94	112.67	7.87
ENC-02	5/8/2007	10.52	8.34	e/m	e/m	8.04	e/m	e/m	13.07	0.94	91.80	14.90
RSJ-03	5/8/2007	15.90	8.34	e/m	e/m	0.31	e/m	e/m	13.47	1.00	214.20	24.03
RSJ-05	5/8/2007	18.34	8.36	e/m	e/m	0.21	e/m	e/m	15.14	1.01	203.00	23.93
TMB-01	5/14/2007	18.48	8.20	e/m	e/m	3.70	e/m	e/m	10.57	0.95	142.00	10.20
WCC-01	5/14/2007	12.80	7.82	e/m	e/m	15.16	e/m	e/m	12.56	0.91	188.00	10.57
WCC-03	5/14/2007	15.05	8.07	e/m	e/m	11.08	e/m	e/m	12.26	0.94	178.63	18.87
CSC-01	5/15/2007	12.74	7.49	e/m	e/m	4.70	e/m	e/m	9.72	0.95	154.87	6.03
BKG-01	5/15/2007	11.90	7.55	e/m	e/m	4.30	e/m	e/m	3.82	0.95	75.57	5.77
BKG-02	5/15/2007	11.25	7.24	e/m	e/m	5.60	e/m	e/m	6.4	0.94	98.80	13.10
DSP-01	5/21/2007	13.52	8.01	e/m	e/m	3.88	e/m	e/m	10.13	0.97	229.33	5.80
TSP-01	5/21/2007	11.22	7.99	e/m	e/m	4.11	e/m	e/m	13.16	0.98	200.80	7.20
KSP-01	5/21/2007	15.80	8.01	e/m	e/m	3.49	e/m	e/m	13.68	0.97	190.23	6.27
WCC-02	5/14/2007	9.67	9.01	e/m	e/m	16.35	e/m	e/m	17.89	0.91	192.67	9.23
WCC-04	5/14/2007	13.87	7.80	e/m	e/m	13.92	e/m	e/m	12.53	0.92	200.63	17.67
RPC-01	5/22/2007	17.90	8.22	e/m	e/m	1.35	e/m	e/m	10.77	0.98	191.27	950.93
RPC-02	5/22/2007	15.37	8.35	e/m	e/m	2.44	e/m	e/m	11.6	0.99	175.60	525.30
RSA-01	5/22/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-04	5/8/2007	17.45	8.25	e/m	e/m	0.92	e/m	e/m	13.03	1.01	192.97	218.90
RPC-03	5/8/2007	18.33	8.23	e/m	e/m	0.93	e/m	e/m	12.35	1.00	165.93	380.50
JWM-01	5/21/2007	17.33	9.13	e/m	e/m	0.21	e/m	e/m	18.03	0.94	201.23	12.93
JWM-02	5/21/2007	15.31	8.74	e/m	e/m	1.96	e/m	e/m	13.13	0.95	215.93	6.63

e/m indicates there was an equipment malfunction and physical Parameter Data was not collected. Only the data recorded by hand is avaliable

Analytical Data Parameters for Round One 2007

Isotopic Uranium µg/L				Total Nitrogen mg/L				Total Phosphorous	Fecal Coli Form
U^{234}	U^{235}	U^{238}	Total U	Ammonia	NO_2	NO_3	TKN	mg/L	CFU/ 100 mL
0.0017	0.2324	30.9042	31.1382	ND	ND	0.960	0.2	ND	10.0
				ND	ND	ND	ND	0.04	ND
				ND	ND	ND	ND		
0.0007	-0.0224	4.9375	4.9158	ND	ND	ND	0.3	0.02	36.0
0.0035	0.5557	57.1089	57.6681	ND	ND	ND	0.6	0.02	ND
				ND	ND	ND	0.5	0.16	27.0
				ND	ND	ND	0.4		
				ND	ND	ND	ND	0.16	ND
0.0011	0.1515	10.6960	10.8486	ND	ND	0.420	ND	ND	ND
				ND	ND	ND	0.2	0.05	18.0

Physical Data Parameters for Round Two 2007 (Average Values)

Site	Date	Temperature	pH	Sp Conductance	Conductivity	Resistivity	Salinity	DO %	DO Concentration	Atmospheric Pressure	OPR	Turbidity
Location		°C		mS/c	mS/c	KOhm/cm	ppt	%	mg/L	Atm	mV	NTU
RMQ-01	6/4/2007	17.48	8.52	1.72	1.47	0.680	0.87	141.18	13.44	0.98	182.04	27.52
RPG-02	6/5/2007	13.97	8.56	0.22	0.18	5.830	0.11	124.38	12.87	0.96	187.64	22.73
RPG-03	6/6/2007	16.79	8.28	3.18	2.68	0.37	1.67	149.97	14.41	0.98	216.65	6.96
RPG-04	6/7/2007	16.53	9.44	1.80	1.51	0.66	0.92	135.74	13.18	0.98	201.36	6.50
RSJ-01	6/12/2007	13.63	8.63	1.54	1.2	0.83	0.78	132.64	13.72	0.98	124.92	100.27
RSJ-011	6/12/2007	13.63	8.63	1.54	1.2	0.83	0.78	132.64	13.72	0.98	124.92	100.27
RSJ-02	6/13/2007	14.94	8.11	1.62	1.31	0.77	0.82	86.16	8.66	0.99	202.49	142.81
RSJ-04	6/18/2007	17.31	8.26	4.26	3.63	0.27	2.28	165.35	15.66	1.00	156.57	9.15
WCC-05	6/19/2007	15.35	8.80	0.66	0.54	1.85	0.32	135.21	13.51	0.98	176.43	16.68
ENC-01	6/20/2007	17.14	7.96	0.17	0.15	6.79	0.08	108.8	10.48	0.94	142.70	6.64
ENC-02	6/20/2007	27.39	8.18	0.20	0.21	4.84	0.09	96.86	7.66	0.94	107.12	10.23
RSJ-03	7/2/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
TMB-01	6/26/2007	14.36	8.56	0.25	0.2	5.06	0.12	116.12	11.87	0.95	144.67	12.87
WCC-01	6/26/2007	16.20	8.04	0.11	0.09	10.79	0.05	108.57	10.67	0.91	194.59	11.90
WCC-03	6/26/2007	13.61	8.40	0.17	0.14	7.38	0.08	119.10	12.38	0.95	188.63	6.89
CSC-01	7/9/2007	13.11	7.29	0.28	0.22	4.62	0.13	82.39	8.65	0.95	175.58	5.40
BKG-01	7/9/2007	12.01	7.38	0.25	0.19	5.26	0.12	47.29	5.09	0.94	125.66	5.60
BKG-02	7/9/2007	13.22	7.74	0.32	0.25	3.99	0.16	21.57	2.26	0.94	35.60	5.98
DSP-01	6/27/2007	16.51	8.05	0.34	0.28	3.56	0.16	90.16	8.79	0.98	201.78	8.94
TSP-01	6/27/2007	13.25	7.96	0.48	0.37	2.69	0.23	113.76	11.9	0.99	206.01	22.45
KSP-01	6/27/2007	20.10	7.99	0.37	0.34	2.94	0.18	117.35	10.64	0.98	204.08	8.12
WCC-02	6/26/2007	17.78	9.63	0.11	0.10	10.14	0.05	124.43	11.83	0.91	175.66	9.82
WCC-04	6/26/2007	14.97	8.17	0.13	0.10	9.63	0.06	116.95	11.8	0.93	209.74	6.80
RPC-01	7/10/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-02	7/10/2007	21.54	8.41	1.39	1.30	0.77	0.70	56.19	4.94	1.00	190.13	85.51
RSA-01	7/10/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-04	7/2/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-03	7/2/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RSJ-05	7/2/2007	23.09	8.39	6.28	6.05	0.16	3.43	165.10	13.86	1.01	194.83	18.02
JWM-01	6/26/2007	19.06	8.49	6.66	5.90	0.17	3.66	160.53	14.54	0.95	-109.12	14.80
JWM-02	6/26/2007	18.60	8.75	0.63	0.55	1.82	0.31	152.07	14.2	0.95	142.92	6.56
RSJ-044	6/18/2007	17.31	8.26	4.26	3.63	0.27	2.28	165.35	15.66	1.00	156.57	9.15

Analytical Data Parameters for Round Two 2007

Isotopic Uranium µg/L				Total Nitrogen mg/L				Total Phosphorous	Fecal Coli Form
U^{234}	U^{235}	U^{238}	Total U	Ammonia	NO_2	NO_3	TKN	mg/L	CFU/ 100 mL
0.0006	0.1800	6.2195	6.4001	ND	ND	ND	0.3	ND	230.0
				ND	ND	ND	0.2	0.06	182.0
0.0129	1.9570	238.9649	240.935	ND	ND	ND	0.3	ND	18.0
0.0013	0.2475	18.7835	19.0323	ND	ND	ND	0.7	0.03	36.0
				ND	ND	0.525	0.3	0.30	818.0
				ND	ND	ND	ND		
				ND	ND	0.340	0.5	0.12	54.1
0.0010	0.1311	13.5455	13.6776	ND	ND	0.595	0.2	0.03	ND
				ND	ND	ND	0.4	0.04	350.0
				ND	ND	0.585	0.4		

Physical Data Parameters for Round Three 2007 (Average Values)

Site	Date	Temperature	pH	Sp Conductance	Conductivity	Resistivity	Salinity	DO %	DO Concentration	Atmospheric Pressure	OPR	Turbidity
Location		°C		mS/c	mS/c	KOhm/cm	ppt	%	mg/L	Atm	mV	NTU
RMQ-01	7/23/2007	21.02	8.48	2.06	1.90	0.53	1.05	196.19	17.38	0.99	188.78	49.15
RPG-02	7/27/2007	16.85	8.56	0.27	0.23	4.44	0.13	123.39	11.95	0.96	186.35	18.35
RPG-03	7/25/2007	17.52	8.12	0.46	0.39	2.54	0.22	123.25	11.77	0.99	205.25	86.57
RPG-04	7/26/2007	22.73	9.50	2.21	2.11	0.48	1.14	94.75	8.12	0.99	135.12	7.27
RPG-044	7/26/2007	22.73	9.50	2.21	2.11	0.48	1.14	94.75	8.12	0.99	135.12	7.27
RSJ-01	7/30/2007	21.29	8.67	1.36	1.26	0.79	0.68	146.74	12.96	0.98	194.59	294.28
RSJ-011	7/30/2007	21.29	8.67	1.36	1.26	0.79	0.68	146.74	12.96	0.98	194.59	294.28
RSJ-02	8/7/2007	20.23	7.75	1.25	1.13	0.88	0.63	62.12	5.6	0.99	184.60	28.15
RSJ-04	8/9/2007	21.18	8.41	3.05	2.82	0.35	1.59	142.18	12.52	1.01	204.55	24.62
WCC-05	8/13/2007	20.74	8.43	0.73	0.67	1.48	0.36	53.39	4.77	0.99	169.60	6.88
ENC-01	8/14/2007	12.52	7.92	0.17	0.13	7.63	0.08	74.73	7.96	0.94	146.19	6.46
ENC-02	8/14/2007	14.76	8.11	0.18	0.15	6.81	0.09	79.39	8.04	0.94	79.44	6.41
RSJ-03	8/14/2007	24.91	8.65	1.35	1.35	0.74	0.67	83.21	6.86	1.00	185.91	27.06
RSJ-05	8/14/2007	24.98	8.55	2.49	2.49	0.40	1.28	94.98	7.8	1.01	192.84	103.03
RPC-03	8/29/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-04	8/14/2007	27.03	8.36	1.99	2.06	0.48	1.01	100.65	7.97	1.01	170.85	107.97
TMB-01	8/15/2007	15.80	8.53	0.24	0.20	4.99	0.12	94.01	9.31	0.95	157.26	10.11
WCC-01	8/15/2007	17.61	8.24	0.12	0.10	9.69	0.06	103.71	9.9	0.91	192.17	7.05
WCC-03	8/15/2007	15.46	8.55	0.17	0.14	7.07	0.08	110.08	10.99	0.94	195.00	6.39
WCC-02	8/15/2007	19.68	9.26	0.12	0.11	9.25	0.06	124.26	11.37	0.91	183.93	11.68
WCC-04	8/15/2007	16.88	8.65	0.14	0.12	8.65	0.06	108.91	10.55	0.93	215.66	6.27
CSC-01	8/27/2007	E/M	E/M	E/M	E/M	E/M	E/M	E/M	E/M	E/M	E/M	E/M
BKG-01	8/27/2007	12.80	7.44	0.25	0.19	5.29	0.12	27.66	2.93	0.94	112.34	9.03
BKG-02	8/27/2007	13.80	7.73	0.32	0.25	3.94	0.15	16.96	1.75	0.95	16.50	7.88
DSP-01	8/28/2007	18.62	8.03	0.35	0.31	3.28	0.17	58.52	5.47	0.98	218.72	6.43
TSP-01	8/28/2007	15.31	7.96	0.49	0.40	2.53	0.24	43.82	4.38	0.98	179.98	16.60
KSP-01	8/28/2007	19.98	8.05	0.37	0.33	3.00	0.18	68.59	6.23	0.98	210.20	5.90
JWM-01	8/15/2007	20.60	8.08	6.94	6.36	0.16	3.82	68.68	6.01	0.95	-54.46	20.46
JWM-02	8/15/2007	21.14	9.22	0.55	0.51	1.95	0.27	174.13	15.46	0.95	150.70	14.14
RPC-01	8/29/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-02	8/29/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RSA-01	8/29/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water

e/m indicates there was an equipment malfunction and physical Parameter Data was not collected.

Analytical Data Parameters for Round Three 2007

Isotopic Uranium µg/L				Total Nitrogen mg/L				Total Phosphorous	Fecal Coli Form
U^{234}	U^{235}	U^{238}	Total U	Ammonia	NO_2	NO_3	TKN	mg/L	CFU/ 100 mL
0.0007	0.1556	8.5515	8.7078	ND	ND	ND	0.80	0.16	36.0
				ND	ND	ND	7.00	0.08	108.0
0.0012	0.3211	26.1511	26.4734	0.21	ND	0.700	9.00	0.76	14000.0
0.0010	0.1902	13.4533	13.6445	ND	ND	ND	1.00	0.07	ND
				ND	ND	ND	ND		
				ND	ND	ND	0.30	0.33	364.0
				ND	ND	ND	0.30		
				ND	ND	0.355	ND	0.14	455.0
0.0009	0.2306	10.2558	10.4873	0.24	ND	0.395	0.40	0.03	45.0
				ND	ND	ND	ND	0.09	490.0

Physical Data Parameters for Round Four 2007 (Average Values)

Site	Date	Temperature	pH	Sp Conductance	Conductivity	Resistivity	Salinity	DO %	DO Concentration	Atmospheric Pressure	OPR	Turbidity
Location		°C		mS/c	mS/c	KOhm/cm	ppt	%	mg/L	Atm	mV	NTU
RMQ-01	10/15/2007	7.66	8.79	1.90	1.27	0.79	0.97	6.06	0.72	0.98	149.52	11.45
RPG-02	10/16/2007	6.99	8.59	0.28	0.18	5.46	0.13	4.19	0.51	0.95	203.52	7.89
RPG-022	10/16/2007	6.99	8.59	0.28	0.18	5.46	0.13	4.19	0.51	0.95	203.52	7.89
RPG-03	10/17/2007	8.83	8.44	3.46	2.39	0.42	1.82	-24.39	-2.80	0.98	207.55	19.75
RPG-033	10/17/2007	8.83	8.44	3.46	2.39	0.42	1.82	-24.39	-2.80	0.98	207.55	19.75
RPG-04	10/22/2007	6.98	8.10	2.72	1.78	0.56	1.41	56.23	6.76	1.00	183.44	29.75
RSJ-01	10/23/2007	2.73	8.75	3.11	1.78	0.56	1.60	88.98	11.93	0.99	206.52	32.35
RSJ-02	10/24/2007	6.22	7.99	2.19	1.40	0.71	1.12	65.25	8.02	1.00	188.94	36.73
RSJ-04	10/29/2007	13.54	8.41	4.34	3.39	0.29	2.33	75.78	7.78	1.02	156.11	10.59
WCC-05	10/30/2007	1.49	8.68	0.77	0.42	2.35	0.37	71.82	10.05	0.98	162.34	4.97
ENC-01	10/31/2007	8.89	8.08	0.17	0.12	8.44	0.08	48.14	5.58	0.94	114.82	5.01
ENC-02	10/31/2007	4.43	8.17	0.19	0.11	8.79	0.09	31.24	4.05	0.94	31.38	50.33
RSJ-03	10/31/2007	9.35	8.39	4.92	3.45	0.29	2.65	39.85	4.49	1.00	62.64	13.19
RSJ-05	10/31/2007	11.43	8.64	5.61	4.16	0.24	3.05	55.76	5.97	1.01	103.39	18.15
RPC-03	10/31/2007	16.52	9.64	2.45	2.05	0.49	1.27	92.40	8.95	1.01	88.58	37.83
RPC-04	10/31/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
TMB-01	11/5/2007	9.99	8.58	0.25	0.18	5.70	0.12	58.96	6.65	0.95	98.70	8.85
WCC-01	11/5/2007	3.96	8.24	0.11	0.07	15.13	0.07	48.65	6.38	0.91	83.58	7.44
WCC-03	11/5/2007	5.88	8.49	0.17	0.11	9.12	0.08	16.10	2.01	0.94	77.32	11.95
WCC-02	11/5/2007	5.74	10.24	0.11	0.07	14.23	0.05	88.69	11.11	0.91	77.88	7.99
WCC-04	11/5/2007	4.32	8.48	0.13	0.08	12.88	0.06	19.67	2.56	0.93	94.58	17.79
CSC-01	11/6/2007	13.03	7.53	0.28	0.21	4.67	0.13	68.84	7.24	0.96	77.22	5.74
BKG-01	11/6/2007	12.83	7.62	0.24	0.19	5.33	0.12	43.19	4.56	0.94	23.67	11.24
BKG-02	11/6/2007	12.27	7.90	0.32	0.24	4.10	0.15	33.61	3.60	0.95	36.49	5.80
DSP-01	11/7/2007	10.15	8.34	0.36	0.26	3.88	0.17	79.04	8.88	0.98	90.93	4.60
TSP-01	11/7/2007	6.26	8.17	0.50	0.32	3.10	0.24	99.11	12.24	0.99	74.37	15.53
KSP-01	11/7/2007	10.74	8.32	0.36	0.26	3.78	0.18	116.28	12.89	0.98	83.41	4.90
JWM-01	11/5/2007	8.53	9.10	7.04	4.83	0.21	3.88	100.67	11.48	0.95	132.74	38.15
JWM-02	11/5/2007	6.63	9.43	0.65	0.42	2.38	0.32	101.41	12.40	0.95	101.65	16.36
RPC-01	11/12/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water
RPC-02	11/12/2007	3.87	7.93	5.73	3.42	0.29	3.08	104.98	13.52	1.00	136.33	55.34
RSA-01	11/12/2007	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water	No Water

Analytical Data Parameters for Round Four 2007

Isotopic Uranium µg/L				Total Nitrogen mg/L				Total Phosphorous	Fecal Coli Form
U^{234}	U^{235}	U^{238}	Total U	Ammonia	NO_2	NO_3	TKN	mg/L	CFU/ 100 mL
6.33E-07	6.33E-07	5.16E-03	0.01	ND	ND	ND	0.50	ND	ND
				ND	ND	ND	0.20	0.03	48.00
								0.60	
1.58E-05	1.60E-03	3.09E-01	0.31	0.41	ND	ND	0.20	0.09	153.00
								0.03	
1.00E-05	1.34E-03	1.68E-01	0.17	0.24	ND	ND	1.40	0.10	280.00
				ND	ND	ND	0.30	0.06	81.00
				ND	ND	ND	0.30	0.03	18.00
1.18E-06	1.60E-04	1.46E-02	0.01	ND	ND	0.750	0.20	0.02	9.01
				ND	ND	0.280	ND	0.08	280.00

Year End Program Report FY 06
SURFACE WATER MONITORING PROGRAM

Pueblo of Laguna
Environmental and Natural Resources Department

P.O. Box 194
Laguna, New Mexico

December 31, 2006

27000346

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Introduction

This report is the culmination of three rounds of sampling, three quarterly reports and the efforts of work done for the Pueblo of Laguna FY 2006 Surface Water Monitoring Program, and U.S. Environmental Protection Agency-Region VI in the Clean Water Act § 106 Surface Water Quality Monitoring Program.

The Pueblo of Laguna (KA-WAIKA) is a federally recognized Indian Tribe located in West-Central New Mexico on the Colorado Plateau. The Pueblo is one of the 19 federally recognized Pueblos in the state. The name of the Laguna Pueblo People is derived from the Spanish word for Lake (Lagoon). As well, the name in the Keresan language is KA-WAIKA-MAH and the literal translation is "people from the lake" or "people of the lake". The Laguna People have always been farmers both Naabamu and irrigated, and livestock tenders but most of all, we prize the human attribute of thought. KA-WAIKA was the first of the Pueblos to adopt a written Constitution in 1908. This constitution was replaced under the Indian Reorganization Act of 1934, revised in 1958, and amended once again in 1984.

Laguna Reservation lands comprise approximately 550,000 acres in Trust and approximately 150,000 acres of State, Bureau of Land Management tracts, and US Forest Service Lands for a total of nearly 700,000 total, situated within four New Mexican counties; Cibola, Valencia, Bernalillo and Sandoval. There are six main villages within the reservation boundaries: Seama (Tse-ah-mah) (the western-most), Paguate (Gwee-stchgee), Encinal (Buu-nee-guy-ah), Paraje (Tse-muu-nah), Laguna (Ka-waika), and Mesita (Haa-tsah) (the eastern-most). There are also several sub-divisions and scattered homes between the main villages. "The Village of Laguna is, and shall continue to be, the Capital of the Pueblo of Laguna",[1] which is located approximately 55 miles west of Albuquerque on Interstate-40.

The lithological setting of the Pueblo of Laguna Indian reservation is distinctive and the landscapes are frequently a complex response to variations in rock types and to primary and secondary structures within the formations and units in this section of the Colorado Plateau. Secondary structures are heavily influenced by diastrophic and exogenic processes. The deformation, uplift, doming and at times intense lateral deformation produce large-scale secondary structures that respond to geomorpholoigical processes in complex variations which create our distinctive terrain. Lithological controls over landforms produce a large number of variations and these variations may be associated with a wide range of discrete regions that can be identified from distinctive outcrops of a few square meters to over hundreds of square kilometers. It is important of recognize some of the major geomorphic features associated with arenaceous, argillaceous, calcareous, igneous, and metamorphic rock types. These will impact the rate of weathering which influences the rates at which weathered material is removed from its location of

[1] Pueblo of Laguna, Constitution of the Pueblo of Laguna, June 6, 1984, page4

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break-up to deposition. Weathering is unfixed mix of both chemical and mechanical processes. All these factors impact fluid movements. A liquid is transported thorough open channels where the flow is confined and although the depth, velocity, and flow in the channel can be measured the study can be rendered hazardous in arid and semi arid climates. Uplift mechanisms can be categorized for purposes of simplicity as eustatic, isostatic, tectonic and orogenic. These mechanisms are all factors in the development of drainage basins and stream channels. Denudation chronology, direct observation and measurement, mathematical simulations and application of the ergodic hypothesis are some of the methods used to try to visualize the long-term evolution of the landforms. Morphgenetics are important to consider regarding questions concerning climatic geomorphology. The morphometrics portions are greatly impacted by climatic influences. These influenced may either be directly related through precipitation intensity or indirectly through vegetation. The morphogenetic region in which the Pueblo of Laguna is located is classified as Semi-Arid. The geomorphic processes associated with this region are listed as follows:

- Frost Weathering (minimal except at higher latitudes)
- Mechanical Weathering (minimal to moderate, especially thermal and salt)
- Chemical Weathering (minimal to moderate)
- Mass Wasting (moderate but infrequent)
- Fluvial Processes (Maximum but episodic in the form of sheet wash, gullying and ephemeral stream action giving high overall erosion rates)
- Glacial Scour (nil)
- Wind Action (Moderate to Maximum)

The morphological features associates with this region are listed as follows:

- Pediments (1° to 4°)
- Cliffs and angular talus slopes (25° to 35°)
- Inselbergs
- Integrated ephemeral stream systems
- Arroyos
- Badlands
- Alluvial fan
- Local dunes

The following diagram was first demonstrated by Hjulström, which was elaborated by Sundborg (1956) which relates critical velocity to the sediment size at which erosion of sedimentary particles will begin for both wind and water.

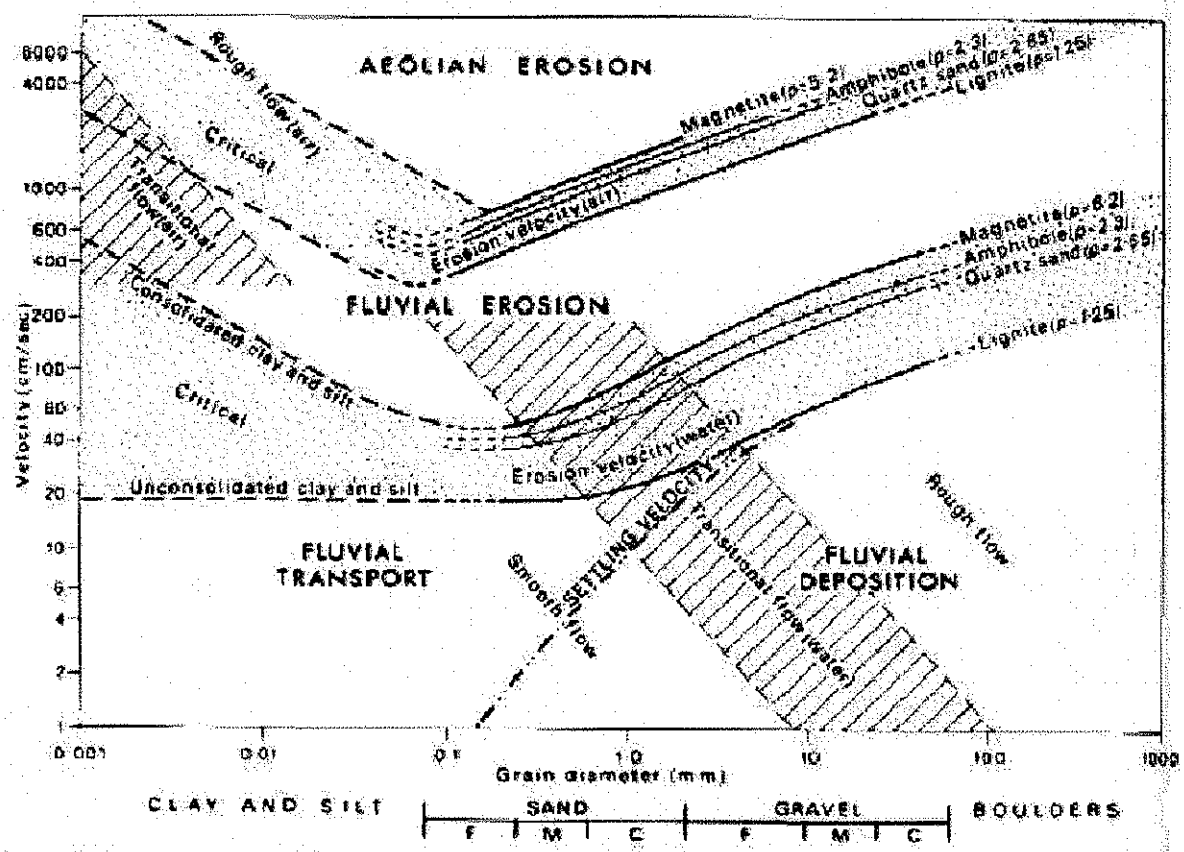

Figure 12.14 Curves showing relations of grain size to critical fluvial and aeolian erosion velocity for uniform materials of differing densities. The critical fluvial erosion velocity refers to a height of 1 m above the river bed. The two critical zones around these curves and the settling velocity curve for particles in water delimit the four regimes of fluvial deposition, fluvial transport, fluvial erosion and aeolian erosion.
Source: Sundborg, 1956, figure 16, p. 197.

Potable and non-potable water is in very limited supply at the POL, making it a highly valuable resource. Drinking water comes from its shallow surficial aquifers, drinking water wells are screened in the shallow alluvial aquifers along surface water pathways. Therefore, the POL's drinking water aquifers and supply system is vulnerable to contamination from surface sources. There are two primary watersheds that drain the POL lands: the Rio Puerco and the Rio San Jose. The Rio San Jose drains from the west towards the east, joining up with the Rio Puerco, which drains from the north towards the south. The Rio Puerco then goes on to a confluence with the Rio Grande. Together, the Rio San Jose and the Rio Puerco form a part of the Rio Grande basin. The Rio Puerco is one of the main tributaries of the Rio Grande, entering the river near Bernardo, New Mexico. It supplies more than 70% of the suspended sediment entering the Rio Grande above Elephant Butte reservoir. The Pueblo's lands are in the eastern and central portions of these watersheds.

The U.S. EPA's Index of Watershed Indicators classifies the POL's watersheds as having "More Serious Problems – Low Vulnerability to Pollutant Stressors", and assigns the watersheds a score of 5 on a scale of 1-10. The problems stem primarily from erosion, loss of riparian vegetation, intrusion of non-native

species (i.e. Salt Cedar) and high sediment loads. However, there are a few possibilities for the discharge of pollutants. There have been no fish advisories for these watersheds. A uranium mine on the Pueblo has been mostly reclaimed. However, discharges from this mine, as well as from similar mines and mills upstream of the POL, could have affected the Pueblo's watersheds. Currently, there are two regulated point source effluent dischargers, one on the Rio San Jose at the Dancing Eagle Casino and on the Rio Puerco at the Route 66 Casino. There is always the likelihood of spills and accidental releases on the U.S. Interstate Highway 40 and Railroad systems, which bisect the POL's lands.

Physical and Analytical Parameters Locations

The Pueblo of Laguna Water Quality Specialist, Environmental Director, Environmental Technician and Partners for Success Summer hire collected three rounds of analytical samples and monthly physical parameter data for 31sites on the POL lands. The locations are summarized in the following table.

No.	Site Name	Site ID	Latitude	Longitude	Analytical Method	Area of the Reservation
1.0	Background #1	BKG01	35°10'52.45"	107°34'12.36"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Seco Canyon
2.0	Background #2	BKG02	35°10'28.10"	107°34'21.80"	Physical Parameters	Seco Canyon
3.0	Encinal #2	ENC02	35°10'52.96"	107°28'00.76"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Paguate Purchase
4.0	Rio Moquino #1	RMQ01	35°09'11.81"	107°21'18.57"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Paguate Purchase
5.0	Rio Paguate #1	RPG01	35°04'03.78"	107°19'36.30"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Paguate Purchase
6.0	Rio Paguate #3	RPG03	35°07'08.70"	107°19'58.93"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Paguate Purchase
7.0	Rio San Jose #1	RSJ01	35°03'15.26"	107°32'39.40"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Reservation Proper
8.0	Rio San Jose #2	RSJ02	35°03'25.50"	107°32'39.60"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Reservation Proper
9.0	Rio San Jose #3	RSJ03	35°01'13.29"	107°18'35.99"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Reservation Proper
10.0	Rio San Jose #4	RSJ04	34°55'58.24"	107°06'16.86"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Sedillo Grant
11.0	Timber Creek	TMB01	35°10'05.65"	107°31'48.73"	Physical Parameters	Mt. Taylor Ranch
12.0	Water Canyon #1	WCC01	35°13'34.52"	107°32'58.55"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Mt. Taylor Ranch
13.0	Water Canyon #3	WCC03	35°12'39.56"	107°31'12.89"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Mt. Taylor Ranch
14.0	Rio Puerco #1	RPC01	35°27'39.07"	107°07'06.43"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Sanchez/Major's Ranch
15.0	Rio Puerco #3	RPC03	35°01'38.98"	106°56'26.92"	Isotipic Uranium, TAL, TKN, Cat. Balance, Anion, Fecal/E. Coli	Sedillo Grant
16.0	Seco Canyon #1	CSC01	35°10'07.40"	107°34'12.90"	Physical Parameters	Seco Canyon
17.0	Dripping Spring	SSP01	34°55'26.80"	107°30'19.46"	Physical Parameters	Reservation Proper
18.0	Encinal #1	ENC01	35°11'14.21"	107°28'56.90"	Physical Parameters	Paguate Purchase
19.0	Rio Paguate #2	RPG02	35°10'30.46"	107°26'52.83"	Physical Parameters	Paguate Purchase
20.0	Rio Paguate #4	RPG04	35°04'04.25"	107°19'37.11"	Physical Parameters	Paguate Purchase
20.0	Rio San Jose #5	RSJ05	34°53'38.52"	107°04'11.34"	Physical Parameters	Reservation Proper
22.0	Turquoise Spring	SSP02	34°59'07.47"	107°28'30.83"	Physical Parameters	Reservation Proper
23.0	Water Canyon #2	WCC02	35°13'19.28"	107°31'14.13"	Physical Parameters	Mt. Taylor Ranch
24.0	Water Canyon #4	WCC04	35°13'25.92"	107°31'20.25"	Physical Parameters	Reservation Proper
25.0	Water Canyon #5	WCC05	35°03'45.56"	107°31'22.80"	Physical Parameters	Reservation Proper
26.0	Rio Puerco #2	RPC02	35°20'50.87"	107°02'32.91"	Physical Parameters	Montano Grant
27.0	Rio Puerco #4	RPC04	34°34'58.92"	106°59'27.93"	Physical Parameters	Sedillo Grant
28.0	Kemp Santiago Spring	KSP01	34°57'04.20"	107°27'06.03"	Physical Parameters	Reservation Proper
29.0	Jack Wards #1	JWM01	34°45'08.35"	107°34'23.27"	Physical Parameters	Jack Wards Mesa
30.0	Jack Wards #2	JWM02	34°41'54.21"	107°33'59.26"	Physical Parameters	Jack Wards Mesa
31.0	Rio Salado #1	RSA01	35°19'23.29"	107°04'13.10"	Physical Parameters	Armjilo Ranch

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Methodology

Analytical Sample Collection

The methodology used by the POL staff in collection and physical parameter monitoring include the following:

1. Peristaltic Pump with poly and silicone tubing and 0.45 micron inline filters
2. YSI 556 Multiprobe system with 10 meter cable assembly
3. Hanna C102 Multiparameter Turbidity & Ion Specific Meter
4. Coolers for sample collection and Ice and drink storage
5. Pruning sheers and various hand tools
6. 5 lb sledge hammer
7. 4 wheel drive vehicle
8. Digital Camera

An analytical laboratory was contracted for the analytical portions, which include the following:

- TAL Metals (filtered) (Al, SB, As, Ba, Be, Cd, Ca, Cr,Co,Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Th, V, Zn) U
- Isotopic Uranium (U^{238}, U^{235} and U^{234})
- Total Kjehdahl Nitrogen
- Cation/Anion Balance (Ca, Mg, Na, K, Alk, F, Cl, Br, PO4, NO3, NO2, SO4, EC, TDS)
- Nitrate + Nitrite
- Fecal/E. Coli

The laboratory was tasked with providing all sample containers, preservatives, coolers chains-of-custody forms and receipt of samples by the laboratory was done on Pueblo land. The sampling procedures identified in the Quality Assurance Project Plan (QAPP) approved May 2004 were followed with the exception of submerging the sample container in the water body. As can be observed from the previous site photographs it is not possible to submerge a sample container in the water bodies present on the Pueblo of Laguna Indian lands. Dipping of samples using a sterile disposable container was not appropriate. This action disturbed the sediment in the bed of the stream; therefore, a peristaltic pump was used in the collection of all surface water samples. The use the peristaltic pump also allowed for the use of inline 0.45 micron filters for field filtering which is consistent with procedures outlined in the QAPP. All samples collected for this year are for inorganic analysis therefore the use of the poly tubing will not affect the data, however as time progress and different analysis are required, Teflon tubing will be used which will not affect semi volatile or volatile organic analysis.

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Physical Parameters

Surface water will be monitored for the following parameters:

- Dissolved Oxygen in mg/L
- Dissolved Oxygen in %
- Temperature ° C
- Conductivity in mS/cm
- pH
- pH in mV
- Resistivity in KOhm/cm
- Specific Conductance in mS/cm
- Barometric Pressure in psi
- Turbidity in NTU

All locations were attempted to be monitored on a bi-basis, which proved to not be feasible. All locations are noted for the following factors:

- Ingestion
- Accessibility
- Notable Flow
- immersion in water for cultural or other purposes
- or in response to problems with sewage lagoons

This locations specific data takes in to consideration areas where sewage lagoons are located close to surface water bodies and where the potential for impact is greatest. Data from suspect locations will not be included in the "background" database.

Physical parameter data collection as identified in the QAPP, is to be collected on a bi-basis, however this has proven to be problematic. Many locations are not accessible at all times and those with cultural/religious uses are not accessible during these types of functions. Weather is a major factor in this determining access to a location. Hot summer days and high evapotransporation rates diminish flow in shallow surface water bodies to damp soil in many of the locations; however, these locations are important and are retained as locations. These conditions are noted and recorded in the logbook and noted in the Quarterly Progress Reports.

When ever possible physical parameters and analytical sample collection are combined to save time and improve field efficiency.

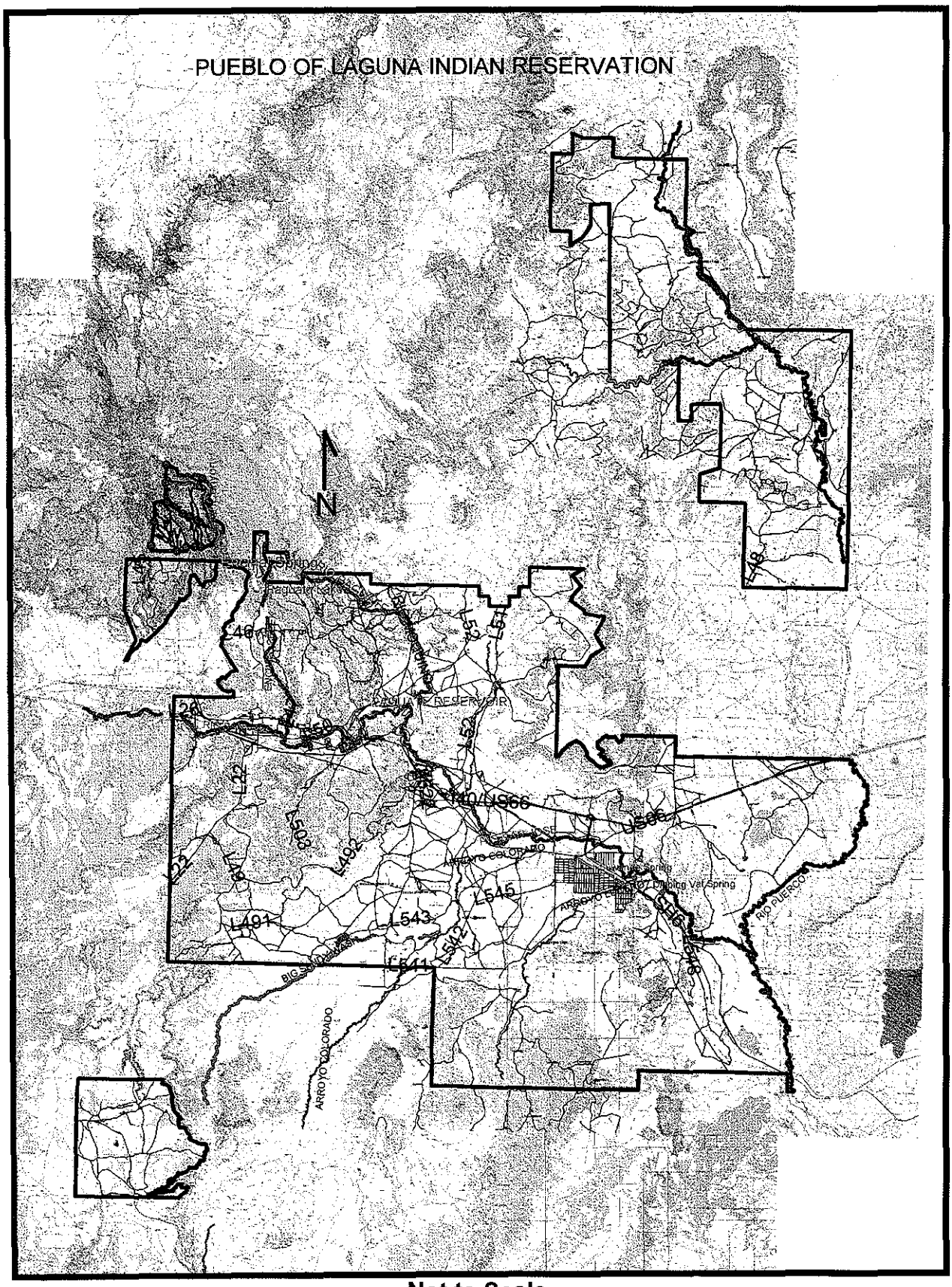
Year End Program Report FY 06
SURFACE WATER MONITORING PROGRAM

Pueblo of Laguna
Environmental and Natural Resources Department

P.O. Box 194
Laguna, New Mexico

December 31, 2006

27000356



Not to Scale

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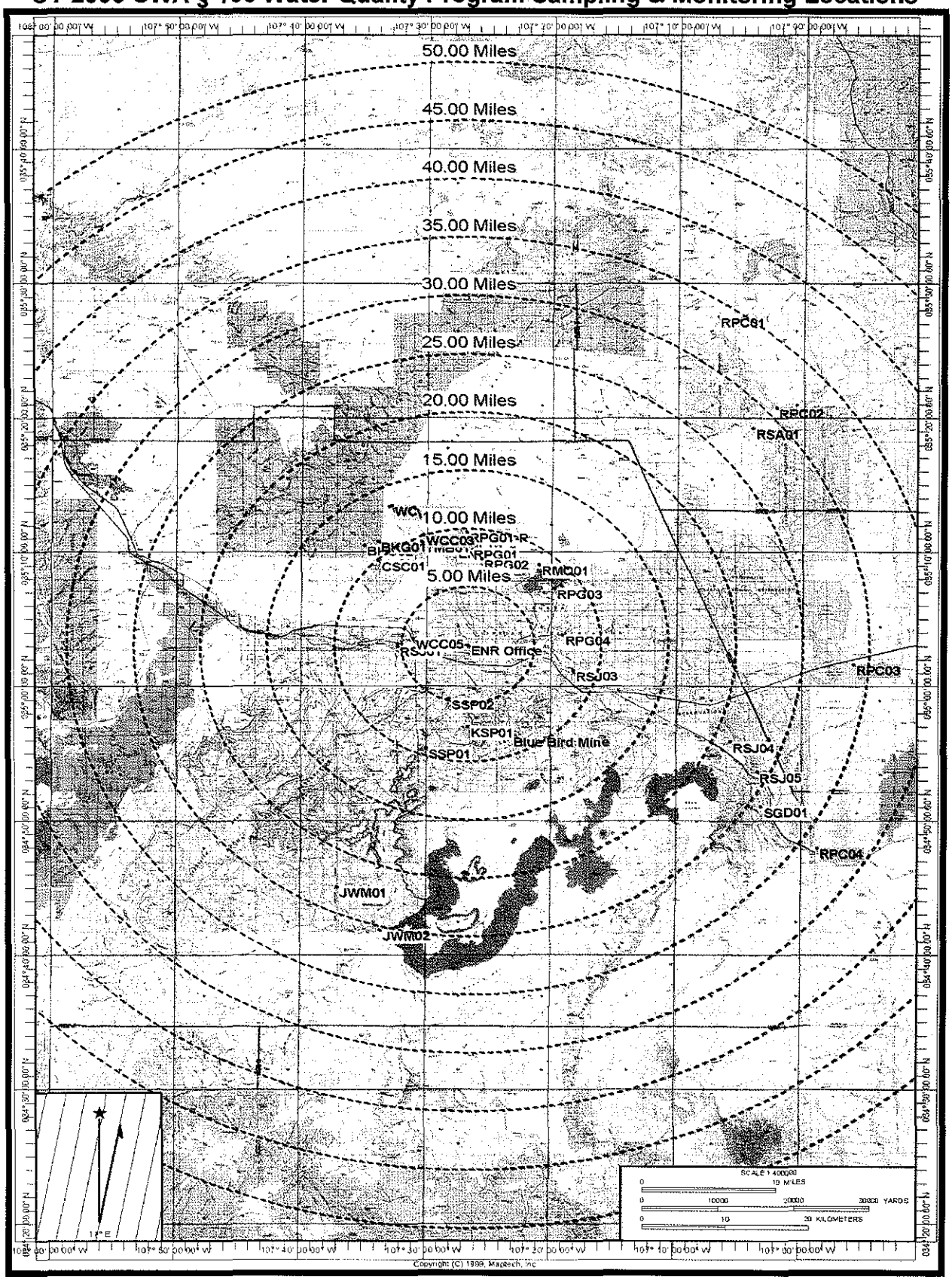
CY 2005 CWA § 106 Water Quality Program Sampling & Monitoring Locations



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Macroinvertebrates and Fish Habitats

The Rio San Jose and the Rio Puerco watersheds, which are both sub-watersheds of the Rio Grande Basin system, receive water from sources passing through or originating on Pueblo of Laguna Indian lands. The stream systems which comprise these watersheds vary with regard to the size of the basin, elevation, seasonal flow rates, ownership and resource management schemes, and of course, aquatic bio-diversity.

There are perennial, spring-fed and snow run-off, cold-water streams which support native and introduced trout species (Genus: *Salmo)*, of New Mexico and the elements of primary production, which these trout feed on. These stream systems vary from one (foot) in diameter, to approximately 12 feet in diameter, with varying levels of stream depth and flow rates. There is also variation in the pools, riffles, eddies, as well as, available fish cover and habitat. Additionally, there have been occurrences of catfish (Genus: *Ictalurus*) and Bluegill (Genus: *Lepomis*) in the Rio Paguate and Rio San Jose stream systems.

There are also areas of the stream systems, which have become "choked" with vegetation and silt. These choked areas of the stream system are primarily upstream of the Pueblo of Laguna's external boundary fence. Within the Pueblo of Laguna's boundaries, in the Water Canyon stream system, there are a series of high elevation, small, in-line ponds, which vary in size, depth, and habitat. There are some seasonal occurrences of algal blooms in this pond series, which effects aquatic life. Inhabitants of these high-mountain ponds include, but are not limited to, mudpuppies (Genus: *Necturus*), Gastropods (snails), crayfish (Order: Decapoda), and Leopard Frogs (Genus: *Rana*), and these ponds are regularly visited by bear, deer, mountain lion, turkey, ducks and elk.

The Pueblo of Laguna's Environmental and Natural Resource Teams are presently designing a complete aquatic biodiversity inventory to be conducted as funding becomes available.

Conclusions

The Pueblo of Laguna Surface Water Quality Monitoring program has experienced set back but has meet or exceeded all goals for the § 106 Clean Water Act Grant for FY 2005-2006. The water quality specialist and colleges have collected three rounds of analytical samples and attempted to collect bi-monthly physical parameter data. In addition, all quarterly reports have been submitted for this grant year, with the exception of this Year End Report. Analytical data for this year is incomplete and not attached to this report in summary format. The result of the analytical sampling and physical parameter monitoring is indicating great diversity within the waters of the Pueblo of Laguna. Variations in surface water bodies are beginning to be reviled. These variations have been suspected but not confirmed.

As discussed in the introduction section the hydrogeology of the Pueblo of Laguna Reservation land is unique and complex. Pristine conditions are no longer possible due to the extensive mining that occurred in the Grants Mineral Belt. Contamination from mining activities, population centers, National Laboratories, highways, detonation of nuclear weapons within the state of New Mexico, all have wide reaching effects and directly impact the air quality which in turn affects meteoric waters which are part of the hydrologic cycle. The first atomic bombs detonated were within the State of New Mexico, the first at Los Alamos National Laboratory and the second at the Trinity Site on the White Sands Missile Range. Much of the uranium needed for these weapons was mined from Pueblo lands and the effects of which are still being assessed.

The use of surface water by the Pueblo of Laguna people has not changed much since New Mexico became a State in 1912. These uses include irrigation of farmland, livestock watering, drinking water supplies, and cultural and traditional uses. Introduction of drinking water and waste water systems by the Indian Health Service have placed drastic demands on the limited supply of high quality waters on Pueblo lands from their introduction in the 1960's. Impacts from septic and sewage lagoons is not fully know but is expected to have been negative. Demands for water in the semi-arid climate of the southwest are growing both on and off the reservation. Large metropolitan areas demands for clean drinking water demands have exceeded the capability of the source supply and these areas are now looking towards Indian lands to fulfill their needs, with no regard to the needs of the Tribes own needs. It is extremely important for Tribes, specifically the Pueblo of Laguna to protect and determine the quality of its waters both surface and subsurface. It is also important to understand the impact of contaminants on the hydrologic cycle, and how these contaminants will influence human health and the environment.

The Pueblo of Laguna is in the beginning stages of this process and will continue to assess the surface waters within its boundaries to protect the health of its people, culture and society for future needs for all life.

This concludes all activities reportable for FY 2006.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: Roland E. Johnson

Title: Governor

Date: 12/14/2006

Appendix A

1st Quarter Report

Appendix B

2nd Quarter Report

PUEBLO OF LAGUNA
P.O. BOX 194
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Office of:
The Governor
The Secretary
The Treasurer

May 22, 2006

Mrs. Mariama Dover
Project Officer
Water Quality Protection Division
U.S. Environmental Protection Agency Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202 – 2733

RE: Quarterly Progress Report for Pueblo of Laguna Environmental & Natural Resources Department – Agreement No. I-97695801-0

Dear Mrs. Dover:

Please find enclosed a Quarterly Progress Report for the Second Quarter of FY 2006 for the Pueblo of Laguna Environmental & Natural Resources Department, Surface Water Monitoring Program that covers the period from January1st, 2006 to March 31st, 2006.

If you should have any questions about the report, please feel free to call either Barbara Cywinska-Bernacik, Environmental Director, at 505-552-7534, or Curtis L. Francisco, Water Quality Specialist, at 505-552-7546 ext.11.

Thank you for your time and attention to this matter.

Sincerely,

PUEBLO OF LAGUNA

Curtis L. Francisco
Water Quality Specialist

Enclosure

Second Quarter Progress Report

Pueblo of Laguna
Environmental and Natural Resources Department

CWA § 106 Water Quality Program

January 2006 – March 2006

Assistance Agreement No. I-97695801-0

27000365

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- Calibration of the YSI 556 Multi-parameter probe and the Hanna Meter has started in preparation for the first round of sampling for the coming year. Calibration Solutions required for calibration of equipment were ordered and a problem was identified with the YSI 556 Multi-parameter probe, it seems that the pH probe of the YSI series has a working life of 2-3 years only and has to be replaced. All other equipment is in good working order, has been calibrated, and is ready for use.

- Comments to the CWA 106 grant application were received and are being addressed for final submission to the U.S. EPA Region VI office for funding.

- Revision of the Existing Quality Assurance Project Plan (QAPP) is on going, a contractor was identified, however due to health related problems was unable to accept the project and the search for a new contractor is ongoing.

- Training is an on going process and will be included in work activities as needed for refresher and improving job performance, however, do to budget short falls any training obtained will have to be done in-house or obtained through the Bureau of Indian Affairs (BIA) or Indian Heath Service (IHS) or other provider on a no-cost basis.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Problems with the existing QAPP are an on-going issue. Currently the existing QAPP does not allow for inaccessible terrain, weather delays, cultural/traditional use, designated use factors, or acts of God. There are also discrepancies in sampling

protocols on physical parameter data collection vs. laboratory analytical data. Proposed changes have been discussed and submitted in the revised version. Comments from U.S. EPA Region VI are expected and will be addressed when they are received. It is anticipated that a contractor will be hired by the Pueblo of Laguna to assist the current staff due to the up-coming sample collection activities. It is not possible to collect samples and physical parameter data in the field and revise the current QAPP at the same time.

- Collection of analytical and physical parameter data was not feasible during the first quarter of the new fiscal year and is addressed in the revisions to the QAPP.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- A meeting was held with the USGS and some newer sources of data were identified regarding the water resources for the Pueblo of Laguna. The requirements for the involvement of the USGS in assisting the Pueblo of Laguna in the development of water quality standards were discussed. In addition, the process required for time and staff from both the USGS and Pueblo of Laguna, to work on water quality issues have been identified. The USGS is not a direct funding agency and can only match time with the Pueblo of Laguna for work in this area.

- The Environmental Specialist from the GAP program has been assisting in the GPS/GIS location of sampling points both new and old. Not all new points have been located due to time constraints and program demands of the GAP program. Assistance to the CWA § 106 program is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and off reservation sources of water that affect the Pueblo of Laguna. Training on the Multi-Parameter Probe has been started and will continue with each of the rounds of sampling and as the QAPP is revised. Budget deficiencies have forced the use of more physical parameter data collection instead of analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line has been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe and Hanna Probe as well as tubing needed for analytical sample collection and 0.45-micron disposable filters and personal protective equipment (ppe).

- As part of the Tribal Re-organization, programs are still being re-arranged and established in their new locations. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect and process GPS/GIS data on the sites and process the data. Assistance from Natural Resources Program has been sought from available staff as well in areas where program interest and objectives overlap or the responsibility has been split. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- Assistance from the GAP Environmental Specialist to GIS/GPS the new points is in the process of being done, and is expected to be an on-going process. Both programs are very busy and as time for none project specific activities comes available the new site will be located and added to the sampling map.

- All analytical data received from the laboratory has been reviewed and entered into the Master Data Base. All associated Physical Parameter data have been archived and site location maps have been up-dated to reflect current conditions.

This concludes all activities reportable for the second Quarter of FY 2006.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: Roland E. Johnson

Title: Governor

Date: 5/19/06

First Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

October 2006 – December 2006

Assistance Agreement No. I-96620101-0

27000370

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- All data from the three rounds of sampling collected during the previous year, along with physical parameter data collected utilizing the YSI 556 Multi-parameter probe and the Hanna Meter, has been compiled and archived. All analytical results were entered into the Master Data Base.
- The CWA § 106 Water Quality Program Year-End Report was completed and signed by Pueblo of Laguna Governor Roland E. Johnson and submitted to Region VI for approval.
- A new revised QAPP was submitted to Region VI for approval.
- Training is an on going process and will be included in work activities as needed for refresher and improving job performance, however, do to budget short falls any training obtained will have to be done in-house or obtained through the Bureau of Indian Affairs (BIA) or Indian Heath Service (IHS) or other provider on a no-cost basis.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Problems with the existing QAPP are an on-going issue. Currently the existing QAPP does not allow for inaccessible terrain, weather delays, cultural/traditional use, designated use factors, or acts of God. There are also discrepancies in sampling protocols on physical parameter data collection vs. laboratory analytical data. Proposed changes have been discussed and submitted in the revised version.

Comments from U.S. EPA Region VI are expected and will be addressed when they are received.

- Collection of analytical and physical parameter data was not feasible during the first quarter of the new fiscal year and is addressed in the revisions to the QAPP.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- No new data has been found from any federal agencies. As a point of fact, the water uses and sources vary greatly between tribes. It has been found that, in most cases, this information is not relevant or viable to the needs here at the Pueblo of Laguna.

- The Partners for Success (PFS) program under the Pueblo of Laguna Department of Educations has provided another inter for the CWA § 106 program and he has proven to be an invaluable asset. Collection of Analytical Samples and Physical Data Collection would not have been possible without the added assistance of the PFS intern. This person was especially valuable during the flooding events here at the Pueblo of Laguna since funding is only provide for one staff person but the QAPP requires at least 2 people for all field activities.

- Assistance to the CWA § 106 program is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna

and off reservation sources of water that affect the Pueblo of Laguna. Training on the Multi-Parameter Probe has been started and will continue with each of the rounds of sampling and as the QAPP is revised. Budget deficiencies have forced the use of more physical parameter data collection instead of analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line have not increased but been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe and Hanna Probe as well as tubing needed for analytical sample collection and ppe.

- As part of the Tribal Re-organization, programs are still being re-arranged and established in their new locations. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect and process GPS/GIS data on the sites and process the data. Assistance from Natural Resources Program has been sought from available staff as well in areas where program interest and objectives overlap or the responsibility has been split. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- All analytical data received from the laboratory has been reviewed and entered into the Master Data Base. All associated Physical Parameter data have been archived and site location maps have been up-dated to reflect current conditions.

This concludes all activities reportable for the first Quarter of FY 2007.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: John E. Antonio

Title: Governor

Date: 1-26-07

Appendix C

3rd Quarter Report

PUEBLO OF LAGUNA
P.O. BOX 194
LAGUNA, NEW MEXICO 87026

Office of:
The Governor
The Secretary
The Treasurer

(505) 552-6598
(505) 552-6654
(505) 552-6655

July 11, 2006

Mrs. Mariama Dover
Project Officer
Water Quality Protection Division
U.S. Environmental Protection Agency Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202 – 2733

RE: **Quarterly Progress Report for Pueblo of Laguna Environmental & Natural Resources Department – Agreement No. I-97695801-0**

Dear Mrs. Dover:

Please find enclosed a Quarterly Progress Report for the Third Quarter of FY 2006 for the Pueblo of Laguna Environmental & Natural Resources Department, Surface Water Monitoring Program that covers the period from April 1st, 2006 to June 30th, 2006.

If you should have any questions about the report, please feel free to call either Barbara Cywinska-Bernacik, Environmental Director, at 505-552-7534, or Curtis L. Francisco, Water Quality Specialist, at 505-552-7546 ext.11.

Thank you for your time and attention to this matter.

Sincerely,

PUEBLO OF LAGUNA

Curtis L. Francisco

Curtis L. Francisco
Water Quality Specialist

Enclosure

Third Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

April 2006- June 2006

Assistance Agreement No. I-97695801-0

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- The YSI 556 Multi-parameter probe repaired, calibrated and the Hanna Meter calibrated. Both pieces of equipment were used for the first round of sampling and data collection and prepped for the upcoming rounds.

- The CWA 106 grant application has been revised and submitted for to the U.S. EPA Region VI office for funding.

- Revision of the Existing Quality Assurance Project Plan (QAPP) is on going. Identification of a new contractor is complete and an Independent Service Agreement is in the process of being implemented.

- Training is an on going process and will be included in work activities as needed for refresher and improving job performance, however, do to budget short falls any training obtained will have to be done in-house or obtained through the Bureau of Indian Affairs (BIA) or Indian Heath Service (IHS) or other provider on a no-cost basis.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

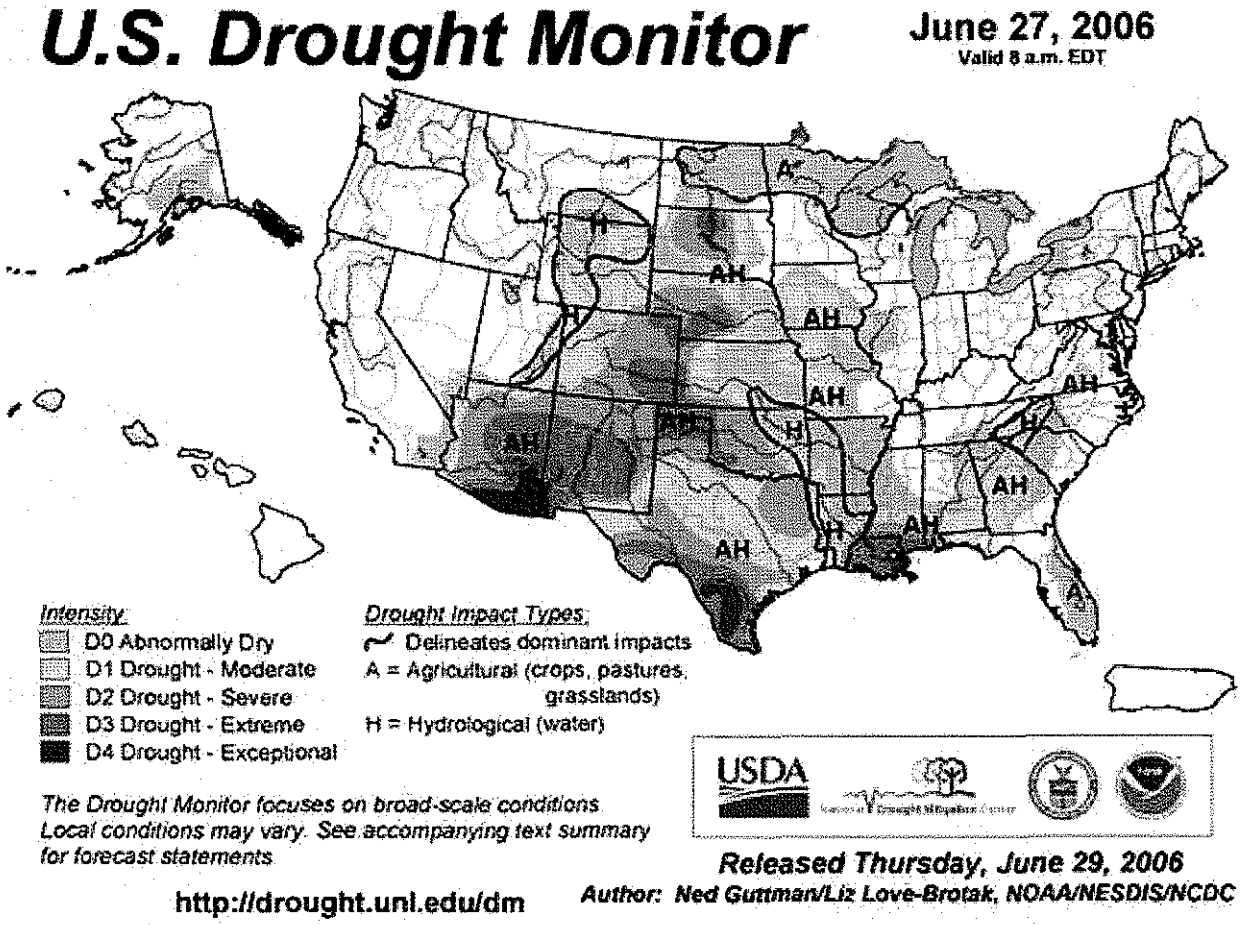
C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Problems with the existing QAPP are an on-going issue. Currently the existing QAPP does not allow for inaccessible terrain, weather delays, cultural/traditional use, Tribally designated use factors, or acts of God. There are also discrepancies in sampling protocols on physical parameter data collection vs. laboratory analytical data. Proposed changes have been discussed and submitted in the revised version. Comments from U.S. EPA Region VI have been received and will be addressed by the

current contractor. It is likely that the Independent Services Agreement will be approved by the Pueblo of Laguna to assist the current staff due to sample/data collection activities. It is important to emphasis that the current grant does not provide funding for this activity so alternative sources of funding have to be identified and were acquired from the BIA. It is not possible to collect samples or physical parameter data in the field and revise the current QAPP at the same time.

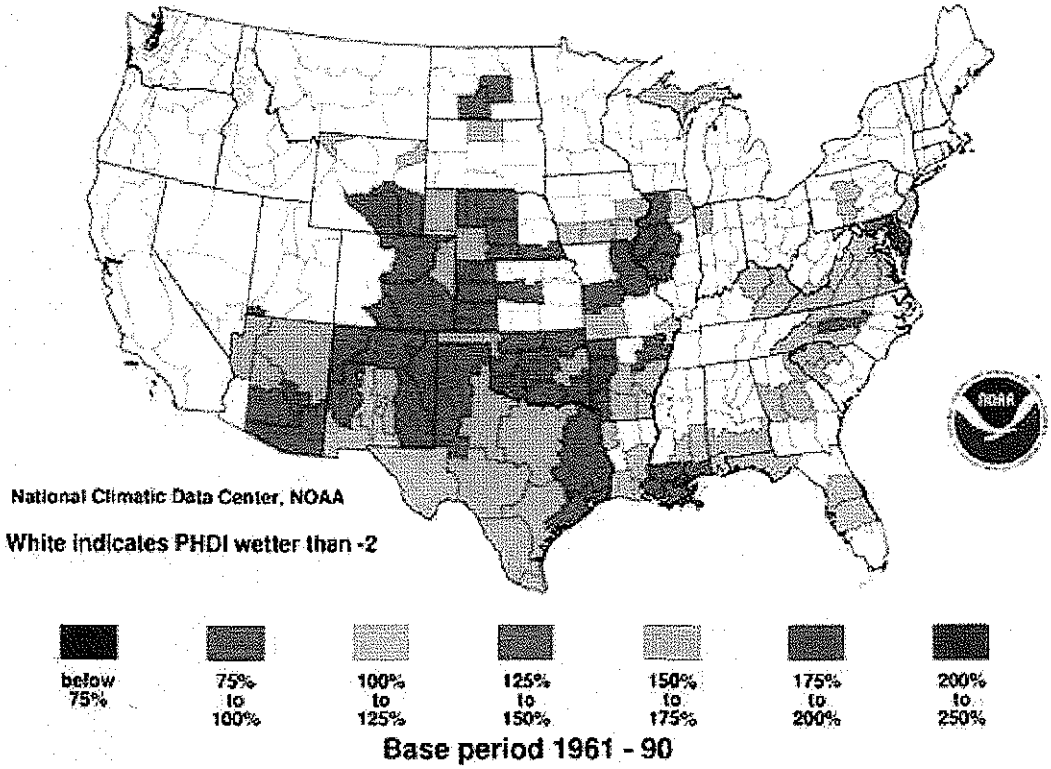
- The field conditions for this year are very different from those of the past year. Last year was the wettest winter on record while this is the near the driest winter on record. The lack of precipitation and the level 2 drought, which encompasses the Pueblo of Laguna lands, is affecting the surface water availability across the reservation. The following graphic form the National Oceanic and Atmospheric Administration (NOAA) and National Climatic Data Center (NCDC) show the lands of the Pueblo of Laguna to be in a D3 zone or Extreme Drought and is delineated by the AH red area on the map below. The AH designation shows Agricultural and Hydrologic water are both impacted.



The next graphic from the NOAA web site show the amount of precipitation required to end the drought in a 6-month period to be between 125%-150% above normal.

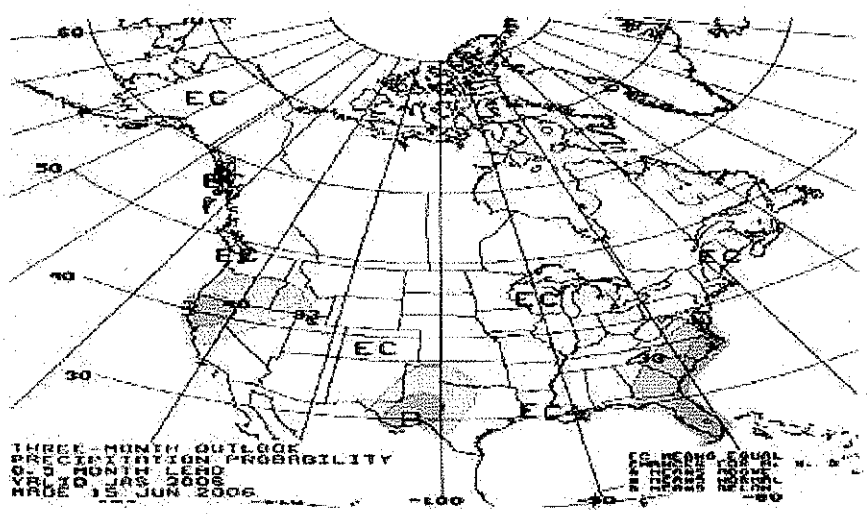
Percent of Normal Precipitation Required to End Current Drought Conditions in Six Months

May 2006



Base period 1961 - 90

It is unlikely that this amount of precipitation will be received in the next three-month as shown in the following NOAA prediction graphic.



- There was also another set back in the collection of analytical and physical parameter data. An Antelope rammed our GSA vehicle while out in the field and did a fair amount of body damage to the vehicle. The delay came in the time required to repair the vehicle and all the paperwork required by GSA. The fact that this did not happen on a State road or Interstate Highway further complicated the matter. There are no physical addresses on the reservation and Tribal Road are denoted only numbers used by the Pueblo of Laguna programs and Bureau of Indian Affairs (BIA). They are not accessible to the mapping programs available via the internet or by software sold over the counter. The nature of the incident in itself has been subject to belief, in that a wild animal would head butt a moving vehicle.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- Contact with neighboring Pueblo's and Tribes is an on going effort and accomplished through meeting such as the Inter-Tribal Resources Advisory Council (IRAC).

- Identification of potential partners and programs is an on going process. Involvement with the Pueblo of Laguna Water & Sewer Workgroup has proven an effective route to reach State, Private and other Federal programs for technical assistance and potential resources.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and off reservation sources of water that affect the Pueblo of Laguna. Training on the Multi-Parameter Probe has been started and will continue with each of the rounds of

sampling and as the QAPP is revised. Budget deficiencies have forced the use of more physical parameter data collection instead of analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line has been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe and Hanna Probe as well as tubing needed for analytical sample collection and 0.45-micron disposable filters and personal protective equipment (ppe).

- As part of the Tribal Re-organization, programs are still being re-arranged and established in their new locations. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect and process GPS/GIS data on the sites and process the data. Assistance from Natural Resources Program has been sought from available staff as well in areas where program interest and objectives overlap or the responsibility has been split. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- Assistance from the GAP Environmental Specialist to GIS/GPS the new points is in the process of being done, and is expected to be an on-going process. Both programs are very busy and as time for none project specific activities comes available the new site will be located and added to the sampling map.

- All analytical data received from the laboratory has been reviewed and entered into the Master Data Base. All associated Physical Parameter data have been archived and site location maps have been up-dated to reflect current conditions.

This concludes all activities reportable for the Third Quarter of FY 2006.

Submitted by:	
Printed Name:	Curtis L. Francisco
Title:	Water Quality Specialist
Project Official:	
Printed Name:	Roland E. Johnson
Title:	Governor
Date:	7/17/06

First Quarter Progress Report

Pueblo of Laguna

Environmental and Natural Resources Department

CWA § 106 Water Quality Program

October 2005 – December 2005

Assistance Agreement No. I-97695801-0

27000382

Objective 1: Build/Implement and Maintain Water Quality Program Capacity

Deliverables:

A. Hire/Training

B. Progress Reports

C. Related Activities

Related Activities completed during this quarter:

- All data from the three rounds of sampling collected in the 4th quarter of the previous year were compiled and physical parameter data that was collected utilizing the YSI 556 Multi-parameter probe and the Hanna Meter, was archived. All analytical results were entered into the Master Data Base.

- The CWA § 106 Water Quality Program Year-End Report was completed and signed by Pueblo of Laguna Governor Roland E. Johnson and submitted to Region VI for approval or rejection.

- Revision of the Existing QAPP was submitted to Region VI for approval or rejection.

- Training is an on going process and will be included in work activities as needed for refresher and improving job performance, however, do to budget short falls any training obtained will have to be done in-house or obtained through the Bureau of Indian Affairs (BIA) or Indian Heath Service (IHS) or other provider on a no-cost basis.

Objective 2: Develop Program Design for Water Quality Monitoring

Deliverables:

A. Review Required Documents

B. Implementation of Program QAPP

C. Execute Sampling/Monitoring Plan on existing locations within Pueblo of Laguna.

D. Expand Sampling/Monitoring Plan to encompass all of Pueblo of Laguna Lands.

- Problems with the existing QAPP are an on-going issue. Currently the existing QAPP does not allow for inaccessible terrain, weather delays, cultural/traditional use, designated use factors, or acts of God. There are also discrepancies in sampling protocols on physical parameter data collection vs. laboratory analytical data. Proposed changes have been discussed and submitted in the revised version.

Comments from U.S. EPA Region VI are expected and will be addressed when they are received.

- Collection of analytical and physical parameter data was not feasible during the first quarter of the new fiscal year and is addressed in the revisions to the QAPP.

Objective 3: Aggregate Existing Water Quality Data

Deliverables:

A. Report on Data Recovered from Federal Agencies and neighboring Tribes

B. Identify Potential Partners for Program Support

- No new data has been found from any federal agencies. As a point of fact, the water uses and sources vary greatly between tribes. It has been found that, in most cases, this information is not relevant or viable to the needs here at the Pueblo of Laguna.

- The Environmental Specialist from the GAP program has been assisting in the GPS/GIS location of sampling points both new and old. Not all new points have been located due to time constraints and program demands of the GAP program. Assistance to the CWA § 106 program is on an unallocated time bases and occurs as time comes available from non-program specific project/program duties.

- Assistance to other ENR programs/staff is provided on technical issues and/or related issues as it relates to program directives, goals, tasks, objectives, and Pueblo of Laguna's best interest.

Objective 4: Create/Maintain Basic Water Quality Monitoring Program

Deliverables:

A. Train existing and new Staff on Multi-Parameter Probe

B. Collect Surface Water Field samples for Database Parameters.

C. Verification of existing locations of surface water collection sites for accuracy.

- Training is an on-going process for the staff to build capabilities and responsibilities within the program. It is hoped that new staff will be added and the scope of the program will grow to encompass all of the lands controlled by the Pueblo of Laguna and off reservation sources of water that affect the Pueblo of Laguna. Training on the Multi-Parameter Probe has been started and will continue with each of the rounds of sampling and as the QAPP is revised. Budget deficiencies have forced the use of more physical parameter data collection instead of analytical sample collection. These deficiencies will affect the collection of physical data since the supplies budget line has

been cut, which includes the calibration standards, and pH solutions required for the Multi-Parameter Probe and Hanna Probe as well as tubing needed for analytical sample collection and 0.45 micron disposable filters and ppe.

- As part of the Tribal Re-organization, programs are still being re-arranged and established in their new locations. Because of the re-organization, programs have been added and removed from the ENR department. The General Assistance Program (GAP) now has the staff capable to collect and process GPS/GIS data on the sites and process the data. Assistance from Natural Resources Program has been sought from available staff as well in areas where program interest and objectives overlap or the responsibility has been split. The Pueblo of Laguna Tribal Government has placed a high priority on this Re-organization and from time to time consumes vast amounts of time of program staff. No definite dates for completion of the re-organization have been set; therefore, requests from the Pueblo Government are expected on an as needed basis.

- Assistance from the GAP Environmental Specialist to GIS/GPS the new points is in the process of being done, and is expected to be an on-going process. Both programs are very busy and as time for none project specific activities comes available the new site will be located and added to the sampling map.

- All analytical data received from the laboratory has been reviewed and entered into the Master Data Base. All associated Physical Parameter data have been archived and site location maps have been up-dated to reflect current conditions.

This concludes all activities reportable for the first Quarter of FY 2006.

Submitted by: _____

Printed Name: Curtis L. Francisco

Title: Water Quality Specialist

Project Official: _____

Printed Name: Roland E. Johnson

Title: Governor

Date: Jan 19, 2006

New Mexico Ecological Services Field Office

Listed and Sensitive Species in Cibola County

Total number of species: 18

Print

Common Name	Scientific Name	Group	Status
Yellow-billed cuckoo	*Coccyzus americanus*	Bird	Candidate
Zuni bluehead sucker	*Catostomus discobolus yarrowi*	Fish	Candidate
Southwestern willow flycatcher	*Empidonax traillii extimus*	Bird	Endangered
Black-footed ferret [2]	*Mustela nigripes*	Mammal	Endangered
Mexican spotted owl Designated Critical Habitat	*Strix occidentalis lucida*	Bird	Threatened
Pecos sunflower Designated Critical Habitat	*Helianthus paradoxus*	Plant	Threatened
Zuni fleabane	*Erigeron rhizomatus*	Plant	Threatened

Species of Concern

Species of Concern are included for planning purposes only.

Common Name	Scientific Name	Group	Status
New Mexico silverspot butterfly	*Speyeria nokomis nitocris*	Arthropod - Invertebrate	Species of Concern
American peregrine falcon	*Falco peregrinus anatum*	Bird	Species of Concern
Arctic peregrine falcon	*Falco peregrinus tundrius*	Bird	Species of Concern
Mountain plover	*Charadrius montanus*	Bird	Species of Concern
Northern goshawk	*Accipiter gentilis*	Bird	Species of Concern
Western burrowing owl	*Athene cunicularia hypugaea*	Bird	Species of Concern
Rio Grande sucker	*Catostomus plebeius*	Fish	Species of Concern
Cebolleta southern pocket gopher	*Thomomys umbrinus paguatae*	Mammal	Species of Concern
Acoma fleabane	*Erigeron acomanus*	Plant	Species of Concern
Cinder phacelia	*Phacelia serrata*	Plant	Species of Concern
Gypsum phacelia	*Phacelia sp. nov.*	Plant	Species of Concern

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range.	**Threatened**	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.
Candidate	Candidate Species (taxa for which the Service has sufficient information to propose that they be added to list of endangered and threatened species, but the listing action has been precluded by other higher priority listing activities).	**Proposed**	Any species of fish, wildlife or plant that is proposed in the Federal Register to be listed under section 4 of the Act. This could be either proposed for endangered or threatened status.
Species of	Taxa for which further biological research and field study are needed to resolve their conservation status OR are considered		

Concern	sensitive, rare, or declining on lists maintained by Natural Heritage Programs, State wildlife agencies, other Federal agencies, or professional/academic scientific societies. Species of Concern are included for planning purposes only.

Foot Notes:

D Designated Critical Habitat.

P Proposed Critical Habitat.

1 Introduced population.

3 Extirpated in this county.

2 Survey should be conducted if project involves impacts to prairie dog towns or complexes of 200-acres or more for the Gunnison's prairie dog (*Cynomys gunnisoni*) and/or 80-acres or more for any subspecies of Black-tailed prairie dog (*Cynomys ludovicianus*). A complex consists of two or more neighboring prairie dog towns within 4.3 miles (7 kilometers) of each other.

Pueblo of Laguna
Environmental and Natural Resources Department
P.O. Box 194
Laguna, New Mexico 87026
Telephone: 505/552-7546
Fax: 505/552-6857

MEMORANDUM

To: **Michelle Brown**

From: **Curtis L. Francisco**

Date: **03-15-2010**

Subject: **Fishing in the Rio Paguate and Rio San Jose**

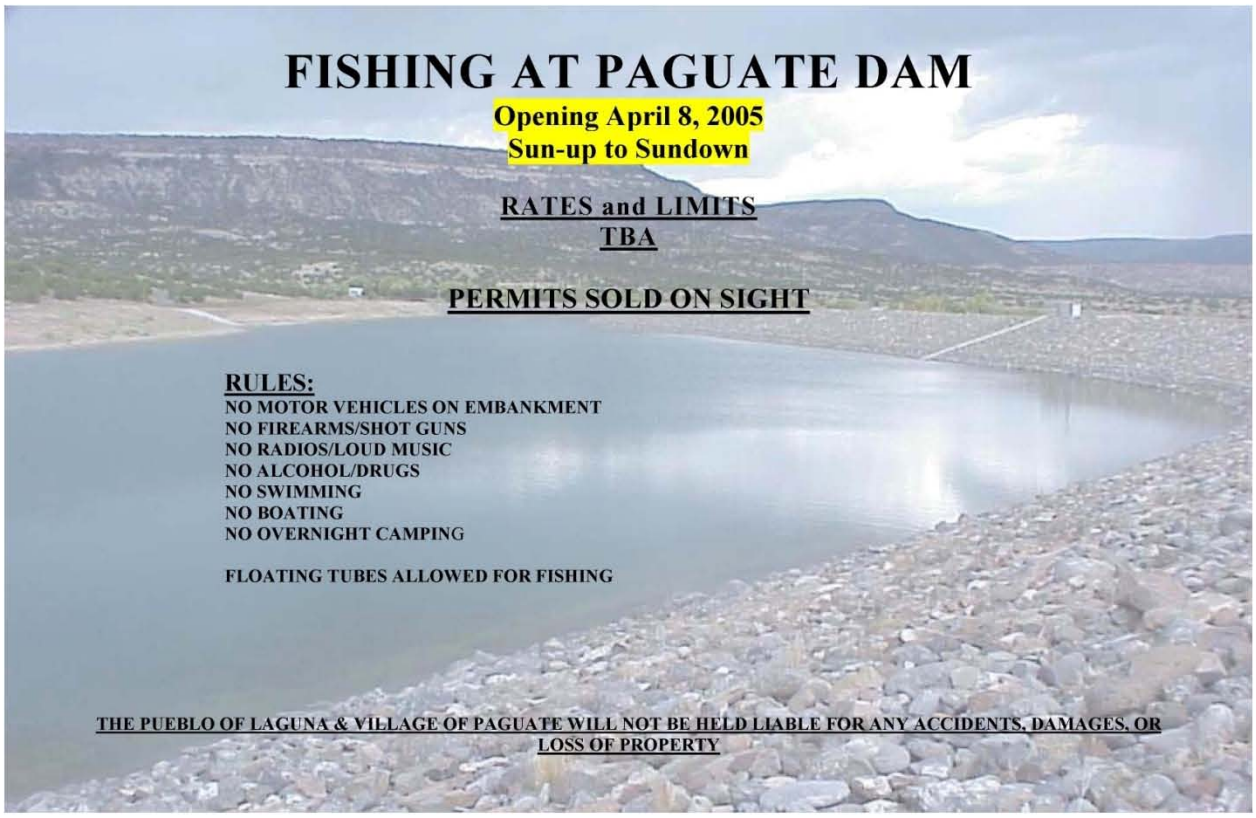
This memo is to document that fishing does occur on the Rio Paguate and Rio San Jose. The Rio Paguate above the mine is a high quality cold water fishery and has long been thought to hold a hybrid species of fish, the native trout and imported rainbow, but has not been documented by the fish and wild life service. Fish do occur in the upper reaches and are of some sort of trout species. They were being caught in the Paguate Lake prior to stocking the lake with Rainbow and Blue Channel Catfish by village members. The segments of the Rio Paguate below the mine and in the area of the Paguate Reservoir AKA Mesita Dam are also used by locals to catch catfish, bluegill and what I believe to be crappie because of the symbiotic relationship with wading birds such as herons where the fishes eggs stick to the legs of the birds and are dropped off in new bodies of water and the fish populate them. The Rio San Jose is also fished but for the same species of fish that are found in the lower reaches of the Rio Paguate. The water is warmer and shallower and is 100 percent diverted for irrigation during the growing season. The only day water is not diverted is on Sunday and is allowed to return to its natural channel.

It is important to note that fishing is only officially allowed in the Paguate Lake and operated by the Village of Paguate the other water bodies are under the jurisdiction of the Natural Resources Program but they do not issue permits for any of the other water bodies on the reservation.

The pools that collect water below the Mesita Dam and in the Rio San Jose below the convergence with the Rio Paguate are continually wet and filled with groundwater that is seeping through the Mesita Dam when up steam diversion for irrigation is taking place.

Fishing in the Rio Paguate below the mine is discouraged as is in the Rio San Jose however, residents still fish and consume the fish caught there, evidence has been observed numerous times on the Rio Paguate at and around the Mesita Dam and at the Village of Mesita at the Rio San Jose Irrigation Diversion which is below the convergence with the Rio Paguate.

Traditional uses and taking of water fowl have been also been observed on a routine and continuing basis.



Standards for Interstate and Intrastate Waters, 20.6.4 NMAC, 2005
Effective December 29, 2006

The following document includes all provisions that are in effect for Clean Water Act purposes with the following exceptions:

1. EPA has not taken action on new/revised provisions in **Sections 20.6.4.97, 98 and 99.**

2. EPA has not taken action on new and/or revised use designations for classified stream segments listed in **Sections 20.6.4.126, 128, 221, 310, 701 and 702.**

3. EPA has approved **Sections 20.6.4.108, 113, 115, 116, 118, 123, 206, 208, 209, 215, 217, 305, 309, 407 and 804** with the assumption that use designations for all non-perennial reaches and tributaries to classified stream segments that may be covered by these sections are capable of supporting the uses described in CWA Section 101(a)(2).

The corresponding provisions which *are* in effect for Clean Water Act purposes can be found in Standards for Interstate and Intrastate Surface Waters, 20.6.4 (Effective October 23, 2003)

TITLE 20 ENVIRONMENTAL PROTECTION
CHAPTER 6 WATER QUALITY
PART 4 STANDARDS FOR INTERSTATE AND INTRASTATE SURFACE WATERS

20.6.4.1 ISSUING AGENCY: Water Quality Control commission.
[20.6.4.1 NMAC - Rp 20 NMAC 6.1.1001, 10-12-00]

20.6.4.2 SCOPE: Except as otherwise provided by statute or regulation of the water quality control commission, this part governs all surface waters of the state of New Mexico, which are subject to the New Mexico Water Quality Act, Sections 74-6-1 through 74-6-17 NMSA 1978.
[20.6.4.2 NMAC - Rp 20 NMAC 6.1.1002, 10-12-00; A, 05-23-05]

20.6.4.3 STATUTORY AUTHORITY: This part is adopted by the water quality control commission pursuant to Subsection C of Section 74-6-4 NMSA 1978.
[20.6.4.3 NMAC - Rp 20 NMAC 6.1.1003, 10-12-00]

20.6.4.4 DURATION: Permanent.
[20.6.4.4 NMAC - Rp 20 NMAC 6.1.1004, 10-12-00]

20.6.4.5 EFFECTIVE DATE: October 12, 2000, unless a later date is indicated in the history note at the end of a section.
[20.6.4.5 NMAC - Rp 20 NMAC 6.1.1005, 10-12-00]

20.6.4.6 OBJECTIVE:

A. The purpose of this part is to establish water quality standards that consist of the designated use or uses of surface waters of the state, the water quality criteria necessary to protect the use or uses and an antidegradation policy.

B. The state of New Mexico is required under the New Mexico Water Quality Act (Subsection C of Section 74-6-4 NMSA 1978) and the federal Clean Water Act, as amended (33 U.S.C. Section 1251 *et seq*.) to adopt water quality standards that protect the public health or welfare, enhance the quality of water and are consistent with and serve the purposes of the New Mexico Water Quality Act and the federal Clean Water Act. It is the objective of the federal Clean Water Act to restore and maintain the chemical, physical and biological integrity of the nation's waters, including those in New Mexico. This part is consistent with Section 101(a)(2) of the federal Clean Water Act, which declares that it is the national goal that wherever attainable, an interim goal of water quality that provides for the protection and propagation of fish, shellfish and wildlife and provides for recreation in and on the water be achieved by July 1, 1983. Agricultural, municipal, domestic and industrial water supply are other essential uses of New Mexico's surface water; however, water contaminants resulting from these activities will not be permitted to lower the quality of surface waters of the state below that required for protection and propagation of fish, shellfish and wildlife and recreation in and on the water, where practicable.

C. Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.
[20.6.4.6 NMAC - Rp 20 NMAC 6.1.1006, 10-12-00; A, 05-23-05]

20.6.4.7 DEFINITIONS: Terms defined in the New Mexico Water Quality Act, but not defined in this part will have the meaning given in the Water Quality Act.

A. **"Acute toxicity"** means toxicity involving a stimulus severe enough to induce a response in 96 hours of exposure or less. Acute toxicity is not always measured in terms of lethality, but may include other toxic effects that occur within a short time period.

B. "**Adjusted gross alpha**" means the total radioactivity due to alpha particle emission as inferred from measurements on a dry sample, including radium-226, but excluding radon-222 and uranium. Also excluded are source, special nuclear and by-product material as defined by the Atomic Energy Act of 1954.

C. "**Aquatic life**" means any plant or animal life that uses surface water as primary habitat for at least a portion of its life cycle, but does not include avian or mammalian species.

D. "**Attainable"** means achievable by the imposition of effluent limits required under sections 301(b) and 306 of the Clean Water Act and implementation of cost-effective and reasonable best management practices for nonpoint source control.

E. "Best management practices" or "BMPs":

(1) for national pollutant discharge elimination system (NPDES) permitting purposes means schedules of activities, prohibitions of practices, maintenance procedures and other management practices to prevent or reduce the pollution of "waters of the United States;" BMPs also include treatment requirements, operating procedures and practices to control plant site runoff, spillage or leaks, sludge or waste disposal or drainage from raw material storage; or

(2) for nonpoint source pollution control purposes means methods, measures or practices selected by an agency to meet its nonpoint source control needs; BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures; BMPS can be applied before, during and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters; BMPs for nonpoint source pollution control purposes shall not be mandatory except as required by state or federal law.

F. "Bioaccumulation" refers to the uptake and retention of a substance by an organism from its surrounding medium and food.

G. "Bioaccumulation factor" is the ratio of a substance's concentration in tissue versus its concentration in ambient water, in situations where the organism and the food chain are exposed.

H. "Biomonitoring" means the use of living organisms to test the suitability of effluents for discharge into receiving waters or to test the quality of surface waters of the state.

I. "**CAS number**" means an assigned number by chemical abstract service (CAS) to identify a substance. CAS numbers index information published in chemical abstracts by the American chemical society.

J. "cfs" means cubic feet per second.

K. "cfu" means colony forming units.

L. "Chronic toxicity" means toxicity involving a stimulus that lingers or continues for a relatively long period relative to the life span of an organism. Chronic effects include, but are not limited to, lethality, growth impairment, behavioral modifications, disease and reduced reproduction.

M. "Classified water of the state" means a surface water of the state, or reach of a surface water of the state, for which the commission has adopted a segment description and has designated a use or uses and applicable water quality criteria in 20.6.4.101 through 20.6.4.899 NMAC.

N. "Coldwater" in reference to an aquatic life use means a surface water of the state where the water temperature and other characteristics are suitable for the support or propagation or both of coldwater aquatic life.

O. "Commission" means the New Mexico water quality control commission.

P. "Criteria" are elements of state water quality standards, expressed as constituent concentrations, levels or narrative statements, representing a quality of water that supports a use. When criteria are met, water quality will protect the designated use.

Q. "**DDT and derivatives**" means 4,4'-DDT (CAS number 50293), 4,4'-DDE (CAS number 72559) and 4,4'-DDD (CAS number 72548).

R. "Department" means the New Mexico environment department.

S. "Designated use" means a use specified in Sections 20.6.4.101 through 20.6.4.899 NMAC for a surface water of the state whether or not it is being attained.

T. "Dissolved" means a constituent of a water sample that will pass through a 0.45-micrometer pore-size membrane filter under a pressure differential not exceeding one atmosphere. The "dissolved" fraction is also termed "filterable residue."

U. "Domestic water supply" means a surface water of the state that could be used for drinking or culinary purposes after disinfection.

V. "**Escherichia coli" or "E. coli"** means a bacterial species that inhabits the intestinal tract of humans and other warm-blooded animals, the presence of which indicates the potential presence of pathogenic microorganisms capable of producing disease.

W. "Ephemeral" when used to describe a surface water of the state means a water body that flows only in direct response to precipitation or snowmelt in the immediate locality; its bed is always above the water table of the adjacent region.

X. "Existing use" means a use actually attained in a surface water of the state on or after November 28, 1975, whether or not it is a designated use.

Y. "Fecal coliform bacteria" means the portion of the coliform group of bacteria present in the gut or the feces of warmblooded animals. It generally includes organisms capable of producing gas from lactose broth in a suitable culture medium within 24 hours at 44.5 ± 0.2°C.

Z. "Fish culture" means production of coldwater or warmwater fishes in a hatchery or rearing station.

AA. "**Fish early life stages**" means the egg and larval stages of development of fish ending when the fish has its full complement of fin rays and loses larval characteristics.

BB. **"High quality coldwater"** in reference to an aquatic life use means a perennial surface water of the state in a minimally disturbed condition with considerable aesthetic value and superior coldwater aquatic life habitat. A surface water of the state to be so categorized must have water quality, stream bed characteristics and other attributes of habitat sufficient to protect and maintain a propagating coldwater aquatic life population.

CC. **"Intermittent"** when used to describe a surface water of the state means a water body that contains water only at certain times of the year, such as when it receives flow from springs, melting snow or precipitation.

DD. **"Interstate waters"** means all surface waters of the state that cross or form a part of the border between states.

EE. **"Intrastate waters"** means all surface waters of the state that are not interstate waters.

FF. **"Irrigation"** means application of water to land areas to supply the water needs of beneficial plants.

GG. **"LC-50"** means the concentration of a substance that is lethal to 50 percent of the test organisms within a defined time period. The length of the time period, which may vary from 24 hours to one week or more, depends on the test method selected to yield the information desired.

HH. "**Limited aquatic life**" as a designated use, means the surface water is capable of supporting only a limited community of aquatic life. This subcategory includes surface waters that support aquatic species selectively adapted to take advantage of naturally occurring rapid environmental changes, ephemeral or intermittent water, high turbidity, fluctuating temperature, low dissolved oxygen content or unique chemical characteristics.

II. **"Livestock watering"** means the use of a surface water of the state as a supply of water for consumption by livestock.

JJ. **"Marginal coldwater"** in reference to an aquatic life use means that natural intermittent or low flows, or other natural habitat conditions severely limit maintenance of a coldwater aquatic life population or historical data indicate that the maximum temperature in the surface water of the state may exceed 25°C (77°F).

KK. **"Marginal warmwater"** in reference to an aquatic life use means natural intermittent or low flow or other natural habitat conditions severely limit the ability of the surface water of the state to sustain a natural aquatic life population on a continuous annual basis; or historical data indicate that natural water temperature routinely exceeds 32.2°C (90°F).

LL. **"Micrograms per liter (µg/L)"** means micrograms of solute per liter of solution; equivalent to parts per billion when the specific gravity of the solution = 1.000.

MM. **"Milligrams per liter (mg/L)"** means milligrams of solute per liter of solution; equivalent to parts per million when the specific gravity of the solution = 1.000.

NN. **"Minimum quantification level"** means the minimum quantification level for a constituent determined by official published documents of the United States environmental protection agency.

OO. **"Natural causes"** means those causal agents that would affect water quality and the effect is not caused by human activity but is due to naturally occurring conditions.

PP. **"Nonpoint source"** means any source of pollutants not regulated as a point source that degrades the quality or adversely affects the biological, chemical or physical integrity of surface waters of the state.

QQ. **"NTU"** means nephelometric turbidity units based on a standard method using formazin polymer or its equivalent as the standard reference suspension. Nephelometric turbidity measurements expressed in units of NTU are numerically identical to the same measurements expressed in units of FTU (formazin turbidity units).

RR. "**Organoleptic**" means the capability to produce a detectable sensory stimulus such as odor or taste.

SS. "**Playa**" means a shallow closed basin lake typically found in the high plains and deserts.

TT. **"Perennial"** when used to describe a surface water of the state means the water body contains water continuously throughout the year in all years; its upper surface, generally, is lower than the water table of the region adjoining the stream.

UU. **"Picocurie (pCi)"** means a measure of radioactivity equal to the quantity of a radioactive substance in which the rate of disintegrations is 2.22 per minute.

VV. **"Point source"** means any discernible, confined and discrete conveyance from which pollutants are or may be discharged into a surface water of the state, but does not include return flows from irrigated agriculture.

WW. "**Practicable**" means that which may be done, practiced or accomplished; that which is performable, feasible, possible.

XX. "Primary contact" means any recreational or other water use in which there is prolonged and intimate human contact with the water, such as swimming and water skiing, involving considerable risk of ingesting water in quantities sufficient to pose a significant health hazard. Primary contact also means any use of surface waters of the state for cultural, religious or ceremonial purposes in which there is intimate human contact with the water, including but not limited to ingestion or immersion, that could pose a significant health hazard.

YY. "Secondary contact" means any recreational or other water use in which human contact with the water may occur and in which the probability of ingesting appreciable quantities of water is minimal, such as fishing, wading, commercial and recreational boating and any limited seasonal contact.

ZZ. "Segment" means a classified surface water of the state described in 20.6.4.101 through 20.6.4.899 NMAC. The water within a segment should have the same uses, similar hydrologic characteristics or flow regimes, and natural physical, chemical and biological characteristics and exhibit similar reactions to external stresses, such as the discharge of pollutants.

AAA. "**Specific conductance**" means conductivity adjusted to 25°C.

BBB. "State" means the state of New Mexico.

CCC. "Surface water(s) of the state" means all surface waters situated wholly or partly within or bordering upon the state, including lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, reservoirs or natural ponds. Surface waters of the state also means all tributaries of such waters, including adjacent wetlands, any manmade bodies of water that were originally created in surface waters of the state or resulted in the impoundment of surface waters of the state, and any "waters of the United States" as defined under the Clean Water Act that are not included in the preceding description. Surface waters of the state does not include private waters that do not combine with other surface or subsurface water or any water under tribal regulatory jurisdiction pursuant to Section 518 of the Clean Water Act. Waste treatment systems, including treatment ponds or lagoons designed and actively used to meet requirements of the Clean Water Act (other than cooling ponds as defined in 40 CFR Part 423.11(m) that also meet the criteria of this definition), are not surface waters of the state, unless they were originally created in surface waters of the state or resulted in the impoundment of surface waters of the state.

DDD. "TDS" means total dissolved solids, also termed "total filterable residue."

EEE. "Technology-based limitations" means the application of technology-based effluent limitations as required under Section 301(b) of the federal Clean Water Act.

FFF. "Total" means a constituent of a water sample that is analytically determined without filtration.

GGG. "**Total PCBs**" means the sum of all homolog, all isomer, all congener or all aroclor analyses.

HHH. "Toxic pollutant" means those pollutants, or combination of pollutants, including disease-causing agents, that after discharge and upon exposure, ingestion, inhalation or assimilation into any organism, either directly from the environment or indirectly by ingestion through food chains, will cause death, shortened life spans, disease, adverse behavioral changes, reproductive or physiological impairment or physical deformations in such organisms or their offspring.

III. "**Tributary**" means a perennial, intermittent or ephemeral waterbody that flows into a larger waterbody, and includes a tributary of a tributary.

JJJ. "Turbidity" is an expression of the optical property in water that causes incident light to be scattered or absorbed rather than transmitted in straight lines.

KKK. "Warmwater" with reference to an aquatic life use means that water temperature and other characteristics are suitable for the support or propagation or both of warmwater aquatic life.

LLL. "Water contaminant" means any substance that could alter if discharged or spilled the physical, chemical, biological or radiological qualities of water. "Water contaminant" does not mean source, special nuclear or by-product material as defined by the Atomic Energy Act of 1954, but may include all other radioactive materials, including but not limited to radium and accelerator-produced isotopes.

MMM. "Water pollutant" means a water contaminant in such quantity and of such duration as may with reasonable probability injure human health, animal or plant life or property, or to unreasonably interfere with the public welfare or the use of property.

NNN. "Water quality-based controls" means effluent limitations, as provided under Section 301(b)(1)(C) of the federal Clean Water Act, that are developed and imposed on point-source dischargers in order to protect and maintain applicable water quality standards. These controls are more stringent than the technology-based effluent limitations required under other paragraphs of Section 301(b).

OOO. "Wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions in New Mexico. Wetlands that are constructed outside of a

surface water of the state for the purpose of providing wastewater treatment and that do not impound a surface water of the state are not included in this definition.

PPP. "Wildlife habitat" means a surface water of the state used by plants and animals not considered as pathogens, vectors for pathogens or intermediate hosts for pathogens for humans or domesticated livestock and plants.

[20.6.4.7 NMAC - Rp 20 NMAC 6.1.1007, 10-12-00; A, 7-19-01; A, 05-23-05; A, 07-17-05]

20.6.4.8 ANTIDEGRADATION POLICY AND IMPLEMENTATION PLAN:

A. Antidegradation Policy: This antidegradation policy applies to all surface waters of the state.

(1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state.

(2) Where the quality of a surface water of the state exceeds levels necessary to support the propagation of fish, shellfish, and wildlife, and recreation in and on the water, that quality shall be maintained and protected unless the commission finds, after full satisfaction of the intergovernmental coordination and public participation provisions of the state's continuing planning process, that allowing lower water quality is necessary to accommodate important economic and social development in the area in which the water is located. In allowing such degradation or lower water quality, the state shall assure water quality adequate to protect existing uses fully. Further, the state shall assure that there shall be achieved the highest statutory and regulatory requirements for all new and existing point sources and all cost-effective and reasonable BMPs for nonpoint source control. Additionally, the state shall encourage the use of watershed planning as a further means to protect surface waters of the state.

(3) No degradation shall be allowed in high quality waters designated by the commission as outstanding national resource waters (ONRWs).

(4) In those cases where potential water quality impairment associated with a thermal discharge is involved, this antidegradation policy and implementing method shall be consistent with Section 316 of the federal Clean Water Act.

(5) In implementing this section, the commission through the appropriate regional offices of the United States environmental protection agency will keep the administrator advised and provided with such information concerning the surface waters of the state as he or she will need to discharge his or her responsibilities under the federal Clean Water Act.

B. Implementation Plan: The department, acting under authority delegated by the commission, implements the water quality standards, including the antidegradation policy, by describing specific methods and procedures in the continuing planning process and by establishing and maintaining controls on the discharge of pollutants to surface waters of the state. The steps summarized in the following paragraphs, which may not all be applicable in every water pollution control action, list the implementation activities of the department. These implementation activities are supplemented by detailed antidegradation review procedures developed under the state's continuing planning process. The department:

(1) obtains information pertinent to the impact of the effluent on the receiving water and advises the prospective discharger of requirements for obtaining a permit to discharge;

(2) reviews the adequacy of existing data and conducts a water quality survey of the receiving water in accordance with an annually reviewed, ranked priority list of surface waters of the state requiring total maximum daily loads pursuant to Section 303(d) of the federal Clean Water Act;

(3) assesses the probable impact of the effluent on the receiving water relative to its attainable or designated uses and numeric and narrative criteria;

(4) requires the highest and best degree of wastewater treatment practicable and commensurate with protecting and maintaining the designated uses and existing water quality of surface waters of the state;

(5) develops water quality based effluent limitations and comments on technology based effluent limitations, as appropriate, for inclusion in any federal permit issued to a discharger pursuant to Section 402 of the federal Clean Water Act;

(6) requires that these effluent limitations be included in any such permit as a condition for state certification pursuant to Section 401 of the federal Clean Water Act;

(7) coordinates its water pollution control activities with other constituent agencies of the commission, and with local, state and federal agencies, as appropriate;

(8) develops and pursues inspection and enforcement programs to ensure that dischargers comply with state regulations and standards, and complements EPA's enforcement of federal permits;

(9) ensures that the provisions for public participation required by the New Mexico Water Quality Act and the federal Clean Water Act are followed;

(10) provides continuing technical training for wastewater treatment facility operators through the utility operators training and certification programs;

(11) provides funds to assist the construction of publicly owned wastewater treatment facilities through the wastewater construction program authorized by Section 601 of the federal Clean Water Act, and through funds appropriated by the New Mexico legislature;

(12) conducts water quality surveillance of the surface waters of the state to assess the effectiveness of water pollution controls, determines whether water quality standards are being attained, and proposes amendments to improve water quality standards;

(13) encourages, in conjunction with other state agencies, implementation of the best management practices set forth in the New Mexico statewide water quality management plan and the nonpoint source management program, such implementation shall not be mandatory except as provided by federal or state law;

(14) evaluates the effectiveness of BMPs selected to prevent, reduce or abate sources of water pollutants;

(15) develops procedures for assessing use attainment as required by 20.6.4.15 NMAC and establishing site-specific standards; and

(**16)** develops list of surface waters of the state not attaining designated uses, pursuant to Sections 305(b) and 303(d) of the federal Clean Water Act.

[20.6.4.8 NMAC - Rp 20 NMAC 6.1.1101, 10-12-00; A, 05-23-05]

20.6.4.9 OUTSTANDING NATIONAL RESOURCE WATERS:

A. Procedures for nominating an ONRW: Any person may nominate a surface water of the state for designation as an ONRW by filing a petition with the commission pursuant to the *guidelines for water quality control commission regulation hearings*. A petition to classify a surface water of the state as an ONRW shall include:

(1) a map of the surface water of the state, including the location and proposed upstream and downstream boundaries;

(2) a written statement and evidence based on scientific principles in support of the nomination, including specific reference to one or more the applicable ONRW criteria listed in Subsection B of this section;

(3) water quality data including chemical, physical or biological parameters, if available, to establish a baseline condition for the proposed ONRW;

(4) a discussion of activities that might contribute to the reduction of water quality in the proposed ONRW;

(5) any additional evidence to substantiate such a designation, including a discussion of the economic impact of the designation on the local and regional economy within the state of New Mexico and the benefit to the state; and

(6) affidavit of publication of notice of the petition in a newspaper of general circulation in the affected counties and in a newspaper of general statewide circulation.

B. Criteria for ONRWs: A surface water of the state, or a portion of a surface water of the state, may be designated as an ONRW where the commission determines that the designation is beneficial to the state of New Mexico, and:

(1) the water is a significant attribute of a state gold medal trout fishery, national or state park, national or state monument, national or state wildlife refuge or designated wilderness area, or is part of a designated wild river under the federal Wild and Scenic Rivers Act; or

(2) the water has exceptional recreational or ecological significance; or

(3) the existing water quality is equal to or better than the numeric criteria for protection of aquatic life uses, recreational uses and human health uses, and the water has not been significantly modified by human activities in a manner that substantially detracts from its value as a natural resource.

C. Pursuant to a petition filed under Subsection A of this section, the commission may classify a surface water of the state or a portion of a surface water of the state as an ONRW if the criteria set out in Subsection B of this section are met.

D. Waters classified as ONRWs: The following waters are classified as ONRWs:

(1) Rio Santa Barbara, including the west, middle and east forks from their headwaters downstream to the boundary of the Pecos Wilderness; and

(2) the waters within the United States forest service Valle Vidal special management unit including:

(a) Rio Costilla, including Comanche, La Cueva, Fernandez, Chuckwagon, Little Costilla, Holman, Gold, Grassy, LaBelle and Vidal creeks, from their headwaters downstream to the boundary of the United States forest service Valle Vidal special management unit;

(b) Middle Ponil creek, including the waters of Greenwood Canyon, from their headwaters downstream to the boundary of the Elliott S. Barker wildlife management area;

(c) Shuree lakes;

(d) North Ponil creek, including McCrystal and Seally Canyon creeks, from their headwaters downstream to the boundary of the United States forest service Valle Vidal special management unit; and

(e) Leandro creek from its headwaters downstream to the boundary of the United States forest service Valle Vidal special management unit.

[20.6.4.9 NMAC - Rn, Subsections B, C and D of 20.6.4.8 NMAC, 05-23-05; A, 05-23-05; A, 07-17-05; A, 02-16-06]

20.6.4.10 REVIEW OF STANDARDS; NEED FOR ADDITIONAL STUDIES:

A. Section 303(c)(1) of the federal Clean Water Act requires that the state hold public hearings at least once every three years for the purpose of reviewing water quality standards and proposing, as appropriate, necessary revisions to water quality standards.

B. It is recognized that, in some cases, numeric criteria have been adopted that reflect use designations rather than existing conditions of surface waters of the state. Narrative criteria are required for many constituents because accurate data on background levels are lacking. More intensive water quality monitoring may identify surface waters of the state where existing quality is considerably better than the established criteria. When justified by sufficient data and information, the water quality criteria will be modified to protect the attainable uses.

C. It is also recognized that contributions of water contaminants by diffuse nonpoint sources of water pollution may make attainment of certain criteria difficult. Revision of these criteria may be necessary as new information is obtained on nonpoint sources and other problems unique to semi-arid regions.

[20.6.4.10 NMAC - Rp 20 NMAC 6.1.1102, 10-12-00; Rn, 20.6.4.9 NMAC, 05-23-05; A, 05-23-05]

20.6.4.11 APPLICABILITY OF WATER QUALITY STANDARDS:

A. **Waters Created by Discharge**: When a discharge to an otherwise ephemeral or intermittent, non-classified surface water of the state causes a water to enter a surface water of the state with criteria that are more restrictive than the criteria listed in 20.6.4.97 or 20.6.4.98 NMAC, the more restrictive criteria shall apply at the point such a water enters the surface water of the state with the more restrictive criteria. If discharge to such otherwise ephemeral or intermittent, non-classified waters of the state ceases or is diverted elsewhere the criteria listed in 20.6.4.97 or 20.6.4.98 NMAC shall apply.

B. **Critical Low Flow**: The numeric standards set under Subsection F of 20.6.4.13 NMAC, 20.6.4.101 through 20.6.4.899 NMAC and 20.6.4.900 NMAC may not be attainable when streamflow is less than the critical low flow, but narrative criteria in 20.6.4.13 NMAC will continue to apply. The critical low flow of a stream at a particular site shall be:

(1) for human health criteria, the harmonic mean flow; "harmonic mean flow" is the number of daily flow measurements divided by the sum of the reciprocals of the flows; that is, it is the reciprocal of the mean of reciprocals; for ephemeral waters the calculation shall be based upon the nonzero flow intervals and modified by including a factor to adjust for the proportion of intervals with zero flow;

$$\text{Harmonic Mean} = \frac{n}{\sum 1/Q}$$

where n = number of flow values
and Q = flow value

$$\text{Modified Harmonic Mean} = \left[\frac{\sum_{i=1}^{Nt-N_0} \frac{1}{Qi}}{Nt - N_0} \right]^{-1} x \left[\frac{Nt - N_0}{Nt} \right]$$

where, Qi = nonzero flow
Nt = total number of flow values
and N_0 = number of zero flow values

(2) for all other narrative and numeric criteria, the minimum average four consecutive day flow that occurs with a frequency of once in three years (4Q3); critical low-flow numeric values may be determined on an annual, a seasonal or a monthly basis, as appropriate, after due consideration of site-specific conditions.

C. Guaranteed Minimum Flow: The commission may allow the use of a contractually guaranteed minimum streamflow in lieu of a critical low flow determined under Subsection B of this section on a case-by-case basis and upon consultation with the interstate stream commission. Should drought, litigation or any other reason interrupt or interfere with minimum flows under a guaranteed minimum flow contract for a period of at least thirty consecutive days, such permission, at the sole discretion of the commission, may then be revoked. Any minimum flow specified under such revoked permission shall be superseded by a critical low flow determined under Subsection B of this section. A public notice of the request for a guaranteed minimum flow shall be published in a newspaper of general circulation by the department at least 30 days prior to scheduled action by the commission. These water quality standards do not grant to the commission or any other entity the power to create, take away or modify property rights in water.

D. Mixing Zones: A limited mixing zone, contiguous to a point source wastewater discharge, may be allowed in any stream receiving such a discharge. Mixing zones serve as regions of initial dilution that allow the application of a dilution factor in calculations of effluent limitations. Effluent limitations shall be developed that will protect the most sensitive existing, designated or attainable use of the receiving water.

E. Mixing Zone Limitations: Wastewater mixing zones, in which the numeric criteria set under Subsection F of 20.6.4.13 NMAC, 20.6.4.101 through 20.6.4.899 NMAC or 20.6.4.900 NMAC may be exceeded, shall be subject to the following limitations:

(1) Mixing zones are not allowed for discharges to publicly owned lakes, reservoirs, or playas; these effluents shall meet all applicable criteria set under Subsection F of 20.6.4.13 NMAC, 20.6.4.101 through 20.6.4.899 NMAC and 20.6.4.900 NMAC at the point of discharge.

(2) The acute numeric criteria, as set out in Paragraph (1) of Subsection I, Subsection J, and Subsection K of 20.6.4.900 NMAC, shall be attained at the point of discharge for any discharge to a surface water of the state with a designated aquatic life use.

(3) The general criteria set out in Subsections A, B, C, D, E, G, H and J of 20.6.4.13 NMAC, and the provision set out in Subsection D of 20.6.4.14 NMAC are applicable within mixing zones.

(4) The areal extent and concentration isopleths of a particular mixing zone will depend on site-specific conditions including, but not limited to, wastewater flow, receiving water critical low flow, outfall design, channel characteristics and climatic conditions and, if needed, shall be determined on a case-by-case basis. When the physical boundaries or other characteristics of a particular mixing zone must be known, the methods presented in Section 4.4.5, “Ambient-induced mixing,” in “Technical support document for water quality-based toxics control” (March 1991, EPA/505/2-90-001) shall be used.

(5) All applicable water quality criteria set under Subsection F of 20.6.4.13 NMAC, 20.6.4.101 through 20.6.4.899 NMAC and 20.6.4.900 NMAC, shall be attained at the boundaries of mixing zones. A continuous zone of passage through or around the mixing zone shall be maintained in which the water quality meets all applicable criteria and allows the migration of aquatic life presently common in surface waters of the state with no effect on their populations.

F. Multiple Uses: When a classified water of the state has more than a single designated use, the applicable numeric criteria shall be the most stringent of those established for such classified water.

G. Human health criteria in Subsection J of Section 20.6.4.900 NMAC shall apply to those waters with a designated, existing or attainable aquatic life use. When limited aquatic life is a designated use, the human health criteria shall apply only if adopted on a segment-specific basis. The human health criteria for persistent toxic

pollutants, as identified in Subsection J of Section 20.6.4.900 NMAC, shall also apply to all tributaries of waters with a designated, existing or attainable aquatic life use.

H. **Aquatic Life:** Aquatic life criteria shall apply to all surface waters of the state containing an aquatic life community. Except when a limited aquatic life use and specific criteria have been designated on a segment-specific basis, or when otherwise provided in this part, chronic aquatic life criteria listed in Subsection J of 20.6.4.900 NMAC are applicable to all perennial surface waters of the state, and acute aquatic life criteria listed in Subsection J of 20.6.4.900 NMAC are applicable to all surface waters of the state.

I. **Exceptions:** Numeric criteria for temperature, dissolved solids, dissolved oxygen, sediment or turbidity adopted under the Water Quality Act do not apply when changes in temperature, dissolved solids, dissolved oxygen, sediment or turbidity in a surface water of the state are attributable to:

(1) natural causes (discharges from municipal separate storm sewers are not covered by this exception.); or

(2) the reasonable operation of irrigation and flood control facilities that are not subject to federal or state water pollution control permitting; major reconstruction of storage dams or division dams except for emergency actions necessary to protect health and safety of the public are not covered by this exception.

[20.6.4.11 NMAC - Rp 20 NMAC 6.1.1103, 10-12-00; A, 10-11-02; Rn, 20.6.4.10 NMAC, 05-23-05; A, 05-23-05]

20.6.4.12 **COMPLIANCE WITH WATER QUALITY STANDARDS:** The following provisions apply to determining compliance for enforcement purposes; they do not apply for purposes of determining attainment of uses. The department has developed assessment protocols for the purpose of determining attainment of uses that are available for review from the department's surface water quality bureau.

A. Compliance with acute water quality criteria shall be determined from the analytical results of a single grab sample. Acute criteria shall not be exceeded.

B. Compliance with chronic water quality criteria shall be determined from the arithmetic mean of the analytical results of samples collected using applicable protocols. Chronic criteria shall not be exceeded more than once every three years.

C. Compliance with water quality standards for total ammonia shall be determined by performing the biomonitoring procedures set out in Subsections D and E of 20.6.4.14 NMAC, or by attainment of applicable ammonia criteria set out in Subsections K, L and M of 20.6.4.900 NMAC.

D. Compliance with water quality criteria for the protection of human health shall be determined from the analytical results of representative grab samples, as defined in the water quality management plan. Human health criteria shall not be exceeded.

E. The commission may establish a numeric water quality standard at a concentration that is below the minimum quantification level. In such cases, the water quality standard is enforceable at the minimum quantification level.

F. In determining compliance with criteria for chromium an analysis that measures both the trivalent and hexavalent ions shall be used.

G. For compliance with hardness-dependent numeric criteria, hardness (as mg $CaCO_3$/L) shall be determined from a sample taken at the same time that the sample for the water contaminant is taken.

H. The hardness-dependent formulae for metals shall be valid only for hardness values of 0-400 mg/L. For values above 400 mg/L, the value for 400 mg/L shall apply.

I. The total ammonia tables shall be valid only for temperatures of 0 to 30°C and for pH values of 6.5 to 9.0. For temperatures below 0°C, the total ammonia criteria for 0°C shall apply; for temperatures above 30°C, the total ammonia criteria for 30°C shall apply. For pH values below 6.5, the total ammonia criteria for 6.5 shall apply; for pH values above 9.0, the total ammonia criteria for 9.0 shall apply.

J. **Compliance Schedules**: It shall be the policy of the commission to allow on a case-by-case basis the inclusion of a schedule of compliance in a NPDES permit issued to an existing facility. Such schedule of compliance will be for the purpose of providing a permittee with adequate time to make treatment facility modifications necessary to comply with water quality based permit limitations determined to be necessary to implement new or revised water quality standards. Compliance schedules may be included in NPDES permits at the time of permit renewal or modification and shall be written to require compliance at the earliest practicable time. Compliance schedules shall also specify milestone dates so as to measure progress towards final project completion (e.g., design completion, construction start, construction completion, date of compliance).

[20.6.4.12 NMAC - Rp 20 NMAC 6.1.1104, 10-12-00; A, 10-11-02; Rn, 20.6.4.11 NMAC, 05-23-05; A, 05-23-05]

20.6.4.13 GENERAL CRITERIA: General criteria are established to sustain and protect existing or attainable uses of surface waters of the state. These general criteria apply to all surface waters of the state at all times, unless a specified criterion is provided elsewhere in this part. Surface waters of the state shall be free of any water contaminant in such quantity and of such duration as may with reasonable probability injure human health, animal or plant life or property, or unreasonably interfere with the public welfare or the use of property.

A. Bottom Deposits and Suspended or Settleable Solids:

(1) Surface waters of the state shall be free of water contaminants including fine sediment particles (less than two millimeters in diameter), precipitates or organic or inorganic solids from other than natural causes that have settled to form layers on or fill the interstices of the natural or dominant substrate in quantities that damage or impair the normal growth, function or reproduction of aquatic life or significantly alter the physical or chemical properties of the bottom.

(2) Suspended or settleable solids from other than natural causes shall not be present in surface waters of the state in quantities that damage or impair the normal growth, function or reproduction of aquatic life or adversely affect other designated uses.

B. Floating Solids, Oil and Grease: Surface waters of the state shall be free of oils, scum, grease and other floating materials resulting from other than natural causes that would cause the formation of a visible sheen or visible deposits on the bottom or shoreline, or would damage or impair the normal growth, function or reproduction of human, animal, plant or aquatic life.

C. Color: Color-producing materials resulting from other than natural causes shall not create an aesthetically undesirable condition nor shall color impair the use of the water by desirable aquatic life presently common in surface waters of the state.

D. Organoleptic Quality:

(1) Flavor of Fish: Water contaminants from other than natural causes shall be limited to concentrations that will not impart unpalatable flavor to fish.

(2) Odor and Taste of Water: Water contaminants from other than natural causes shall be limited to concentrations that will not result in offensive odor or taste arising in a surface water of the state or otherwise interfere with the reasonable use of the water.

E. Plant Nutrients: Plant nutrients from other than natural causes shall not be present in concentrations that will produce undesirable aquatic life or result in a dominance of nuisance species in surface waters of the state.

F. Toxic Pollutants:

(1) Except as provided in 20.6.4.16 NMAC, surface waters of the state shall be free of toxic pollutants from other than natural causes in amounts, concentrations or combinations that affect the propagation of fish or that are toxic to humans, livestock or other animals, fish or other aquatic organisms, wildlife using aquatic environments for habitation or aquatic organisms for food, or that will or can reasonably be expected to bioaccumulate in tissues of fish, shellfish and other aquatic organisms to levels that will impair the health of aquatic organisms or wildlife or result in unacceptable tastes, odors or health risks to human consumers of aquatic organisms.

(2) Pursuant to this section, the human health criteria shall be as set out in 20.6.4.900 NMAC. For a toxic pollutant for human health not listed in 20.6.4.900 NMAC, the following provisions shall be applied in accordance with 20.6.4.11, 20.6.4.12 and 20.6.4.14 NMAC.

(a) The human health criterion shall be the recommended human health criterion for "consumption of organisms only" published by the U.S. environmental protection agency pursuant to Section 304(a) of the federal Clean Water Act. In determining such criterion for a cancer-causing toxic pollutant, a cancer risk of 10^{-5} (one cancer per 100,000 exposed persons) shall be used.

(b) When a numeric criterion for the protection of human health has not been published by the U.S. environmental protection agency, a quantifiable criterion may be derived from data available in the U.S. environmental protection agency's Integrated Risk Information System (IRIS) using the appropriate formula specified in *methodology for deriving ambient water quality criteria for the protection of human health (2000)*, EPA-822-B-00-004.

(3) Pursuant to this section, the chronic aquatic life standard shall be as set out in 20.6.4.900 NMAC. For a toxic pollutant for aquatic life with no chronic standard listed in 20.6.4.900 NMAC, the following provisions shall be applied in sequential order in accordance with 20.6.4.11, 20.6.4.12 and 20.6.4.14 NMAC.

(a) The chronic aquatic life criterion shall be the "freshwater criterion continuous concentration" published by the U.S. environmental protection agency pursuant to Section 304(a) of the federal Clean Water Act;

(b) If the U.S. environmental protection agency has not published a chronic aquatic life criterion, a geometric mean LC-50 value shall be calculated for the particular species, genus or group that is representative of the form of life to be preserved, using the results of toxicological studies published in scientific journals.

(i) The chronic aquatic life criterion for a toxic pollutant that does not bioaccumulate shall be 10 percent of the calculated geometric mean LC-50 value; and

(ii) The chronic aquatic life criterion for a toxic pollutant that does bioaccumulate shall be: the calculated geometric mean LC-50 adjusted by a bioaccumulation factor for the particular species, genus or group representative of the form of life to be preserved, but when such bioaccumulation factor has not been published, the criterion shall be one percent of the calculated geometric mean LC-50 value.

(4) Pursuant to this section, the acute aquatic life criteria shall be as set out in 20.6.4.900 NMAC. For a toxic pollutant for aquatic life with no acute criterion listed in 20.6.4.900 NMAC, the acute aquatic life criterion shall be the "freshwater criterion maximum concentration" published by the U.S. environmental protection agency pursuant to Section 304(a) of the federal Clean Water Act.

(5) Within 90 days of the issuance of a final NPDES permit containing a numeric criterion selected or calculated pursuant to Paragraph 2, Paragraph 3 or Paragraph 4 of Subsection F of this section, the department shall petition the commission to adopt such criterion into these standards.

G. **Radioactivity**: The radioactivity of surface waters of the state shall be maintained at the lowest practical level and shall in no case exceed the criteria set forth in the New Mexico Radiation Protection Regulations, 20.3.1 and 20.3.4 NMAC.

H. **Pathogens**: Surface waters of the state shall be free of pathogens from other than natural sources in sufficient quantity to impair public health or the designated, existing or attainable uses of a surface water of the state.

I. **Temperature**: Maximum temperatures for each classified water of the state have been specified in 20.6.4.101 through 20.6.4.899 NMAC. However, the introduction of heat by other than natural causes shall not increase the temperature, as measured from above the point of introduction, by more than 2.7°C (5°F) in a stream, or more than 1.7°C (3°F) in a lake or reservoir. In no case will the introduction of heat be permitted when the maximum temperature specified for the reach would thereby be exceeded. These temperature criteria shall not apply to impoundments constructed offstream for the purpose of heat disposal. High water temperatures caused by unusually high ambient air temperatures are not violations of these standards.

J. **Turbidity**: Turbidity attributable to other than natural causes shall not reduce light transmission to the point that the normal growth, function or reproduction of aquatic life is impaired or that will cause substantial visible contrast with the natural appearance of the water. Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or increase more than 20 percent when the background turbidity is more than 50 NTU. Background turbidity shall be measured at a point immediately upstream of the turbidity-causing activity. However, limited-duration activities necessary to accommodate dredging, construction or other similar activities and that cause the criterion to be exceeded may be authorized provided all practicable turbidity control techniques have been applied and all appropriate permits and approvals have been obtained.

K. **Total Dissolved Solids (TDS):** TDS attributable to other than natural causes shall not damage or impair the normal growth, function or reproduction of animal, plant or aquatic life. TDS shall be measured by either the "calculation method" (sum of constituents) or the filterable residue method. Approved test procedures for these determinations are set forth in 20.6.4.14 NMAC.

L. **Dissolved Gases**: Surface waters of the state shall be free of nitrogen and other dissolved gases at levels above 110 percent saturation when this supersaturation is attributable to municipal, industrial or other discharges.

[20.6.4.13 NMAC - Rp 20 NMAC 6.1.1105, 10-12-00; A, 10-11-02; Rn, 20.6.4.12 NMAC, 05-23-05; A, 05-23-05]

20.6.4.14 SAMPLING AND ANALYSIS:

A. Sampling and analytical techniques shall conform with methods described in the following references unless otherwise specified by the commission pursuant to a petition to amend these standards:

(1) *"guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act,"* 40 CFR Part 136 or any test procedure approved or accepted by EPA using procedures provided in 40 CFR Parts 136.3(d), 136.4, and 136.5;

(2) *standard methods for the examination of water and wastewater*, latest edition, American public health association;

(3) *methods for chemical analysis of water and waste*, and other methods published by EPA office of research and development or office of water;

(4) *techniques of water resource investigations of the U.S. geological survey*;

(5) *annual book of ASTM standards*: volumes 11.01 and 11.02, water (I) and (II), latest edition, ASTM international;

(6) *federal register*, latest methods published for monitoring pursuant to Resource Conservation and Recovery Act regulations;

(7) *national handbook of recommended methods for water-data acquisition*, latest edition, prepared cooperatively by agencies of the United States government under the sponsorship of the U.S. geological survey; or

(8) *federal register*, latest methods published for monitoring pursuant to the Safe Drinking Water Act regulations.

B. **Bacteriological Surveys**: The monthly geometric mean shall be used in assessing attainment of criteria when a minimum of five samples is collected in a 30-day period.

C. **Sampling Procedures**:

(1) Streams: Stream monitoring stations below discharges shall be located a sufficient distance downstream to ensure adequate vertical and lateral mixing.

(2) Lakes: Sampling stations in lakes shall be located at least 250 feet from a discharge.

(3) Lakes: Except for the restriction specified in Paragraph (2) of this subsection, lake sampling stations shall be located at any site where the attainment of a water quality standard is to be assessed. Water quality measurements taken at intervals in the entire water column at a sampling station shall be averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to determine attainment of criteria, except that attainment of criteria for toxic pollutants shall be assessed during periods of complete vertical mixing, e.g., during spring or fall turnover, or by taking depth-integrated composite samples of the water column.

D. Acute toxicity of effluent to aquatic life shall be determined using the procedures specified in U.S. environmental protection agency "methods for measuring the acute toxicity of effluents to freshwater and marine organisms" (5th Ed., 2002, EPA 821-R-02-012), or latest edition thereof if adopted by EPA at 40 CFR Part 136, which is incorporated herein by reference. Acute toxicities of substances shall be determined using at least two species tested in whole effluent and a series of effluent dilutions. Acute toxicity due to discharges shall not occur within the wastewater mixing zone in any surface water of the state with an existing or designated aquatic life use.

E. Chronic toxicity of effluent or ambient surface waters of the state to aquatic life shall be determined using the procedures specified in U.S. environmental protection agency "Short-term methods for estimating the chronic toxicity of effluents and receiving waters to freshwater organisms" (4th Ed., 2002, EPA 821-R-02-013), or latest edition thereof if adopted by EPA at 40 CFR Part 136, which is incorporated herein by reference. Chronic toxicities of substances shall be determined using at least two species tested in ambient surface water or whole effluent and a series of effluent dilutions. Chronic toxicity due to discharges shall not occur at the critical low flow, or any flow greater than the critical low flow, in any surface water of the state with an existing or designated aquatic life use more than once every three years.

[20.6.4.14 NMAC - Rp 20 NMAC 6.1.1106, 10-12-00; Rn, 20.6.4.13 NMAC, 05-23-05, A, 05-23-05]

20.6.4.15 USE ATTAINABILITY ANALYSIS:

A. A use attainability analysis is a scientific study that shall be conducted only for the purpose of assessing the factors affecting the attainment of a use. Whenever a use attainability analysis is conducted, it shall be subject to the requirements and limitations set forth in 40 CFR Part 131, Water Quality Standards; specifically, Subsections 131.3(g), 131.10(g), 131.10(h) and 131.10(j) shall be applicable.

(1) Any person who proposes to classify, or reclassify to a designated use with less stringent criteria, a surface water of the state with designated uses that do not include the uses specified in Section 101(a)(2) of the federal Clean Water Act must conduct a use attainability analysis. Section 101(a)(2) uses are also specified in Subsection B of 20.6.4.6 NMAC.

(2) A designated use cannot be removed if it is an existing use.

(3) A use attainability analysis or an equivalent study approved by the department and the regional administrator must be conducted to remove any non-existing designated use from any classified waters of the state.

B. Physical, chemical and biological evaluations of surface waters of the state other than lakes and reservoirs for purposes of use attainability analyses or equivalent studies shall be conducted according to the procedures outlined in the "*technical support manual: waterbody surveys and assessments for conducting use attainability analyses*," United States environmental protection agency, office of water, regulations and standards,

Washington, D.C., November 1983, or latest edition thereof, which is incorporated herein by reference, or an alternative equivalent study methodology approved by the department.

C. Physical, chemical and biological evaluations of lakes and reservoirs for purposes of use attainability analyses or equivalent studies shall be conducted according to the procedures outlined in the "*technical support manual: waterbody surveys and assessments for conducting use attainability analyses, volume III: lake systems*," United States environmental protection agency, office of water, regulations and standards, Washington, D.C., November 1984, or latest edition thereof, which is incorporated herein by reference, or an alternative equivalent study methodology approved by the department.

D. A use attainability analysis or equivalent study should include:

(1) identification of existing uses of the surface water of the state to be reviewed that have existed since 1975;

(2) an evaluation of the best water quality attained in the surface water of the state to be reviewed that has existed since 1975;

(3) an analysis of appropriate factors demonstrating that attaining the designated use is not feasible because of the condition listed in 40 CFR Part 131.10(g);

(4) a physical evaluation of the surface water of the state to be reviewed to identify factors that impair attainment of designated uses and to determine which designated uses are feasible to attain in such surface water of the state;

(5) an evaluation of the water chemistry of the surface water of the state to be reviewed to identify chemical constituents that impair the designated uses that are feasible to attain in such water; and

(6) an evaluation of the aquatic and terrestrial biota utilizing the surface water of the state to determine resident species and which species could potentially exist in such water if physical and chemical factors impairing a designated use are corrected.

E. Any person may submit notice to the department stating that they intend to conduct a use attainability analysis or equivalent study. The proponent shall develop a work plan to conduct the use attainability analysis or equivalent study and shall submit the work plan to the department and the regional EPA staff for review and comment. The work plan should identify the scope of data currently available and proposed to be gathered, the factors affecting use attainment that will be analyzed and must contain provisions for public notice and consultation with appropriate state and federal agencies. A copy of the notice and the work plan must be submitted concurrently to the commission. Upon approval of the work plan by the department, the proponent shall conduct the use attainability analysis or equivalent study in accordance with the approved work plan. The cost of such analysis or equivalent study shall be the responsibility of the proponent. Upon completion of the use attainability analysis or equivalent study, the proponent shall submit the data, findings and conclusions to the department and the commission.

F. If the department determines that the analysis or equivalent study was conducted in accordance with the approved work plan and the findings and conclusions are based upon sound scientific rationale, and demonstrates that it is not feasible to attain the designated use, the department or the proponent may request the commission to initiate rulemaking proceedings to modify the designated use for the surface water of the state that was reviewed.

[20.6.4.15 NMAC - Rp 20 NMAC 6.1.1107, 10-12-00; Rn, 20.6.4.14 NMAC, 05-23-05; A, 05-23-05; A, 07-17-05]

20.6.4.16 PLANNED USE OF A PISCICIDE: The use of a piscicide registered under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), 7 U.S.C. Section 136 *et seq*., and under the New Mexico Pesticide Control Act (NMPCA), Section 76-4-1 *et seq*. NMSA 1978 (1973) in a surface water of the state, shall not be a violation of Subsection F of 20.6.4.13 NMAC when such use has been approved by the commission under procedures provided in this section. The commission may approve the reasonable use of a piscicide under this section to further a Clean Water Act objective to restore and maintain the physical or biological integrity of surface waters of the state, including restoration of native species.

A. Any person seeking commission approval of the use of a piscicide shall file a written petition concurrently with the commission and the surface water bureau of the department. The petition shall contain, at a minimum, the following information:

(1) petitioner's name and address;

(2) identity of the piscicide and the period of time (not to exceed five years) or number of applications for which approval is requested;

(3) documentation of registration under FIFRA and NMPCA and certification that the petitioner intends to use the piscicide according to the label directions, for its intended function;

(4) target and potential non-target species in the treated waters and adjacent riparian area, including threatened or endangered species;

(5) potential environmental consequences to the treated waters and the adjacent riparian area, and protocols for limiting such impacts;

(6) surface water of the state proposed for treatment;

(7) results of pre-treatment survey;

(8) evaluation of available alternatives and justification for selecting piscicide use;

(9) post-treatment assessment monitoring protocol; and

(10) any other information required by the commission.

B. Within thirty days of receipt of the petition, the department shall review the petition and file a recommendation with the commission to grant, grant with conditions or deny the petition. The recommendation shall include reasons, and a copy shall be sent to the petitioner by certified mail.

C. The commission shall review the petition and the department's recommendation and shall within 90 days of receipt of the department's recommendation hold a public hearing in the locality affected by the proposed use in accordance with Adjudicatory Procedures, 20.1.3 NMAC. In addition to the public notice requirements in Adjudicatory Procedures, 20.1.3 NMAC, the petitioner shall provide written notice to:

(1) local political subdivisions;

(2) local water planning entities;

(3) local conservancy and irrigation districts; and

(4) local media outlets, except that the petitioner shall only be required to publish notice in a newspaper of circulation in the locality affected by the proposed use.

D. In a hearing provided for in this Section, registration of a piscicide under FIFRA and NMPCA shall provide a rebuttable presumption that the determinations of the EPA Administrator in registering the piscicide, as outlined in 7 U.S.C. Section 136a(c)(5), are valid. For purposes of this Section the rebuttable presumptions regarding the piscicide include:

(1) Its composition is such as to warrant the proposed claims for it;

(2) Its labeling and other material submitted for registration comply with the requirements of FIFRA and NMPCA;

(3) It will perform its intended function without unreasonable adverse effects on the environment; and

(4) When used in accordance with all FIFRA label requirements it will not generally cause unreasonable adverse effects on the environment.

(5) "Unreasonable adverse effects on the environment" has the meaning provided in FIFRA, 7 U.S.C. Section 136(bb): "any unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits of the use of any pesticide."

E. After a public hearing, the commission may grant the petition in whole or in part, may grant the petition subject to conditions, or may deny the petition. In granting any petition in whole or part or subject to conditions, the commission shall require the petitioner to implement post-treatment assessment monitoring and provide notice to the public in the immediate and near downstream vicinity of the application prior to and during the application.

[20.6.4.16 NMAC - Rn, Paragraph (6) of Subsection F of 20.6.4.12 NMAC, 05-23-05; A, 05-23-05]

20.6.4.17 - 20.6.4.49: [RESERVED]

20.6.4.50 BASINWIDE PROVISIONS - Special provisions arising from interstate compacts, international treaties or court decrees or that otherwise apply to a basin are contained in 20.6.4.51 through 20.6.4.59 NMAC.

[20.6.4.50 NMAC - N, 05-23-05]

20.6.4.51 - 20.6.4.53: [RESERVED]

20.6.4.54 COLORADO RIVER BASIN - For the tributaries of the Colorado river system, the state of New Mexico will cooperate with the Colorado river basin states and the federal government to support and implement the salinity policy and program outlined in the most current "review, water quality standards for salinity, Colorado river system" or equivalent report by the Colorado river salinity control forum.

A. Numeric criteria expressed as the flow-weighted annual average concentration for salinity are established at three points in the Colorado river basin as follows: below Hoover dam, 723 mg/L; below Parker dam, 747 mg/L; and at Imperial dam, 879 mg/L.

B. As a part of the program, objectives for New Mexico shall include the elimination of discharges of water containing solids in solution as a result of the use of water to control or convey fly ash from coal-fired electric generators, wherever practicable.

[20.6.4.54 NMAC - Rn, Paragraphs (1) through (3) of Subsection K of 20.6.4.12 NMAC, 05-23-05; A, 05-23-05]

20.6.4.55 - 20.6.4.96: [RESERVED]

20.6.4.97 EPHEMERAL WATERS - All ephemeral surface waters of the state that are not included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC.

A. Designated Uses: livestock watering, wildlife habitat, limited aquatic life and secondary contact.

B. Criteria:

(1) The use-specific criteria in 20.6.4.900 NMAC, with the exception of the chronic criteria for aquatic life, are applicable for the designated uses listed in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria shall not exceed 548 cfu/100 mL, no single sample shall exceed 2507 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.97 NMAC - N, 05-23-05]

20.6.4.98 INTERMITTENT WATERS - All intermittent surface waters of the state that are not included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC.

A. Designated Uses: livestock watering, wildlife habitat, aquatic life and secondary contact.

B. Criteria:

(1) The use-specific criteria in 20.6.4.900 NMAC.

(2) The monthly geometric mean of E. coli bacteria shall not exceed 548 cfu/100 mL, no single sample shall exceed 2507 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.98 NMAC - N, 05-23-05]

20.6.4.99 PERENNIAL WATERS - All perennial surface waters of the state that are not included in a classified water of the state in 20.6.4.101 through 20.6.4.899 NMAC.

A. Designated Uses: aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) Temperature shall not exceed 34°C (93.2°F). The use-specific criteria in 20.6.4.900 NMAC are applicable to the designated uses listed in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria shall not exceed 548 cfu/100 mL, no single sample shall exceed 2507 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.99 NMAC - N, 05-23-05]

20.6.4.100: [RESERVED]

20.6.4.101 RIO GRANDE BASIN - The main stem of the Rio Grande from the international boundary with Mexico upstream to one mile below Percha dam.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH: within the range of 6.6 to 9.0 and temperature 34°C (93.2°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).

(3) At mean monthly flows above 350 cfs, the monthly average concentration for: TDS 2,000 mg/L or less, sulfate 500 mg/L or less and chlorides 400 mg/L or less.

C. Remarks: Sustained flow in the Rio Grande below Caballo reservoir is dependent on release from Caballo reservoir during the irrigation season; at other times of the year, there may be little or no flow.

[20.6.4.101 NMAC - Rp 20 NMAC 6.1.2101, 10-12-00; A, 12-15-01; A, 05-23-05]

20.6.4.102 RIO GRANDE BASIN - The main stem of the Rio Grande from one mile below Percha dam upstream to Caballo dam.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

C. Remarks: Sustained flow in the Rio Grande below Caballo reservoir is dependent on release from Caballo reservoir during the irrigation season; at other times of the year, there may be little or no flow.

[20.6.4.102 NMAC - Rp 20 NMAC 6.1.2102, 10-12-00; A, 05-23-05]

20.6.4.103 RIO GRANDE BASIN - The main stem of the Rio Grande from the headwaters of Caballo reservoir upstream to Elephant Butte dam and perennial reaches of tributaries to the Rio Grande in Sierra and Socorro counties.

A. Designated Uses: fish culture, irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life, secondary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

C. Remarks: Flow in this reach of the Rio Grande main stem is dependent upon release from Elephant Butte dam.

[20.6.4.103 NMAC - Rp 20 NMAC 6.1.2103, 10-12-00; A, 05-23-05]

20.6.4.104 RIO GRANDE BASIN - Caballo and Elephant Butte reservoir.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.104 NMAC - Rp 20 NMAC 6.1.2104, 10-12-00; A, 05-23-05]

20.6.4.105 RIO GRANDE BASIN - The main stem of the Rio Grande from the headwaters of Elephant Butte reservoir upstream to Alameda bridge (Corrales bridge) and intermittent water below the perennial reaches of the Rio Puerco that enters the main stem of the Rio Grande.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At mean monthly flows above 100 cfs, the monthly average concentration for: TDS l,500 mg/L or less, sulfate 500 mg/L or less and chloride 250 mg/L or less.

[20.6.4.105 NMAC - Rp 20 NMAC 6.1.2105, 10-12-00; A, 05-23-05]

20.6.4.106 RIO GRANDE BASIN - The main stem of the Rio Grande from Alameda bridge (Corrales bridge) upstream to the Angostura diversion works and intermittent water in the Jemez river below the Jemez pueblo boundary that enters the main stem of the Rio Grande.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: dissolved oxygen greater than 5.0 mg/L, pH within the range of 6.6 to 9.0 and temperature less than 32.2°C (90°F). The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At mean monthly flows above 100 cfs, the monthly average concentration for: TDS 1,500 mg/L or less, sulfate 500 mg/L or less and chloride 250 mg/L or less.

[20.6.4.106 NMAC - Rp 20 NMAC 6.1.2105.1, 10-12-00; A, 05-23-05]

20.6.4.107 RIO GRANDE BASIN - The Jemez river from the Jemez pueblo boundary upstream to Soda dam near the town of Jemez Springs and perennial reaches of Vallecito creek.

A. Designated Uses: coldwater aquatic life, primary contact, irrigation, livestock watering and wildlife habitat.

B. Criteria:

(1) In any single sample: temperature 25°C (77°F) and pH within the range of 6.6 to 8.8. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.107 NMAC - Rp 20 NMAC 6.1.2105.5, 10-12-00; A, 05-23-05]

20.6.4.108 RIO GRANDE BASIN - Perennial reaches of the Jemez river and all its tributaries above Soda dam near the town of Jemez Springs, except Sulphur creek above its confluence with Redondo creek, and perennial reaches of the Guadalupe river and all its tributaries.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 400 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.108 NMAC - Rp 20 NMAC 6.1.2106, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.124 NMAC.**]

20.6.4.109 RIO GRANDE BASIN - Perennial reaches of Bluewater creek, Rio Moquino, Seboyeta creek, Rio Paguate, the Rio Puerco above the village of Cuba and all other perennial reaches of tributaries to the Rio Puerco including the Rio San Jose in Cibola county from the USGS gaging station at Correo upstream to Horace springs.

A. Designated Uses: coldwater aquatic life, domestic water supply, fish culture, irrigation, livestock watering, wildlife habitat and primary contact.

B. Criteria:

(1) In any single sample: pH shall be within the range of 6.6 to 8.8, temperature 20°C (68°F) or less and total phosphorus (as P) 0.1 mg/L. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.109 NMAC - Rp 20 NMAC 6.1.2107, 10-12-00; A, 05-23-05]

20.6.4.110 RIO GRANDE BASIN - The main stem of the Rio Grande from Angostura diversion works upstream to Cochiti dam.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, secondary contact, coldwater aquatic life and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.110 NMAC - Rp 20 NMAC 6.1.2108, 10-12-00; A, 05-23-05]

20.6.4.111 RIO GRANDE BASIN - Perennial reaches of Las Huertas creek.

A. Designated Uses: high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.111 NMAC - Rp 20 NMAC 6.1.2108.5, 10-12-00; A, 7-25-01; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.125 NMAC**.]

20.6.4.112 RIO GRANDE BASIN - Cochiti reservoir.

A. Designated Uses: livestock watering, wildlife habitat, warmwater aquatic life, coldwater aquatic life and primary contact.

B. Criteria:

(l) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 25°C (77°F). The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.112 NMAC - Rp 20 NMAC 6.1.2109, 10-12-00; A, 05-23-05]

20.6.4.113 RIO GRANDE BASIN - The Santa Fe river and perennial reaches of its tributaries from Cochiti reservoir upstream to the outfall of the Santa Fe wastewater treatment facility.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life, secondary contact, and warmwater aquatic life.

B. Criteria:

(l) In any single sample: pH within the range of 6.6 to 9.0, temperature 30°C (86°F) or less and dissolved oxygen 4.0 mg/L or more. Dissolved oxygen 5.0 mg/L or more as a 24-hour average. Values used in the calculation of the 24-hour average for dissolved oxygen shall not exceed the dissolved oxygen saturation value. For a measured value above the dissolved oxygen saturation value, the dissolved oxygen saturation value will be used in calculating the 24-hour average. The dissolved oxygen saturation value shall be determined from the table set out in Subsection N of 20.6.4.900 NMAC. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.113 NMAC - Rp 20 NMAC 6.1.2110, 10-12-00; A, 10-11-02; A, 05-23-05]

20.6.4.114 RIO GRANDE BASIN - The main stem of the Rio Grande from the headwaters of Cochiti reservoir upstream to Rio Pueblo de Taos, Embudo creek from its mouth on the Rio Grande upstream to the junction of the Rio Pueblo and the Rio Santa Barbara, the Santa Cruz river below Santa Cruz dam, the Rio Tesuque below the Santa Fe national forest and the Pojoaque river below Nambe dam.

A. **Designated Uses**: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life, primary contact and warmwater aquatic life.

B. **Criteria**:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 22°C (71.6°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At mean monthly flows above 100 cfs, the monthly average concentration for: TDS 500 mg/L or less, sulfate 150 mg/L or less and chloride 25 mg/L or less.

[20.6.4.114 NMAC - Rp 20 NMAC 6.1.2111, 10-12-00; A, 05-23-05]

20.6.4.115 RIO GRANDE BASIN - The perennial reaches of Rio Vallecitos and its tributaries, and perennial reaches of Rio del Oso and perennial reaches of El Rito creek above the town of El Rito.

A. **Designated Uses**: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. **Criteria**:

(1) In any single sample: specific conductance 300 μmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.115 NMAC - Rp 20 NMAC 6.1.2112, 10-12-00; A, 05-23-05]

20.6.4.116 RIO GRANDE BASIN - The Rio Chama from its mouth on the Rio Grande upstream to Abiquiu reservoir, perennial reaches of the Rio Tusas, perennial reaches of the Rio Ojo Caliente, perennial reaches of Abiquiu creek and perennial reaches of El Rito creek below the town of El Rito.

A. **Designated Uses**: irrigation, livestock watering, wildlife habitat, coldwater aquatic life, warmwater aquatic life and secondary contact.

B. **Criteria**:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 31°C (87.8°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.116 NMAC - Rp 20 NMAC 6.1.2113, 10-12-00; A, 05-23-05]

20.6.4.117 RIO GRANDE BASIN - Abiquiu reservoir.

A. **Designated Uses**: irrigation storage, livestock watering, wildlife habitat, primary contact, coldwater aquatic life and warmwater aquatic life.

B. **Criteria**:

(1) At any sampling site: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.117 NMAC - Rp 20 NMAC 6.1.2114, 10-12-00; A, 05-23-05]

20.6.4.118 RIO GRANDE BASIN - The Rio Chama from the headwaters of Abiquiu reservoir upstream to El Vado reservoir and perennial reaches of the Rio Gallina and Rio Puerco de Chama north of state highway 96.

A. **Designated Uses**: irrigation, livestock watering, wildlife habitat, coldwater aquatic life, warmwater aquatic life and secondary contact.

B. **Criteria**:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 26°C (78.8°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.118 NMAC - Rp 20 NMAC 6.1.2115, 10-12-00; A, 05-23-05]

20.6.4.119 RIO GRANDE BASIN - All perennial reaches of tributaries to the Rio Chama above Abiquiu dam except the Rio Gallina and Rio Puerco de Chama north of state highway 96 and the main stem of the Rio Chama from the headwaters of El Vado reservoir upstream to the New Mexico-Colorado line.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 500 µmhos/cm or less (1,000 µmhos or less for Coyote creek), pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.119 NMAC - Rp 20 NMAC 6.1.2116, 10-12-00; A, 05-23-05]

20.6.4.120 RIO GRANDE BASIN - El Vado and Heron reservoirs.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and coldwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.120 NMAC - Rp 20 NMAC 6.1.2117, 10-12-00; A. 05-23-05]

20.6.4.121 RIO GRANDE BASIN - Perennial tributaries to the Rio Grande in Bandelier national monument and their headwaters in Sandoval county and all perennial reaches of tributaries to the Rio Grande in Santa Fe county unless included in other segments.

A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply, secondary contact and primary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.121 NMAC - Rp 20 NMAC 6.1.2118, 10-12-00; A. 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segments are under 20.6.4.126, 20.6.4.127 and 20.6.4.128 NMAC.**]

20.6.4.122 RIO GRANDE BASIN - The main stem of the Rio Grande from Rio Pueblo de Taos upstream to the New Mexico-Colorado line, the Red river from its mouth on the Rio Grande upstream to the mouth of Placer creek, and the Rio Pueblo de Taos from its mouth on the Rio Grande upstream to the mouth of the Rio Grande del Rancho.

A. Designated Uses: coldwater aquatic life, fish culture, irrigation, livestock watering, wildlife habitat and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.122 NMAC - Rp 20 NMAC 6.1.2119, 10-12-00; A, 05-23-05]

20.6.4.123 RIO GRANDE BASIN - Perennial reaches of the Red river upstream of the mouth of Placer creek, all perennial reaches of tributaries to the Red river, and all other perennial reaches of tributaries to the Rio Grande in Taos and Rio Arriba counties unless included in other segments.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 400 µmhos/cm or less (500 µmhos or less for the Rio Fernando de Taos) and pH within the range of 6.6 to 8.8, temperature 20°C (68°F) or less. For the Red river in this segment, total phosphorus (as P) less than 0.1 mg/L. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.123 NMAC - Rp 20 NMAC 6.1.2120, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.129 NMAC**.]

20.6.4.124 RIO GRANDE BASIN - Perennial reaches of Sulphur creek from its headwaters to its confluence with Redondo creek.

A. Designated Uses: limited aquatic life, wildlife habitat, livestock watering and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 2.0 to 9.0 and temperature 30ºC (86ºF) or less. The use-specific criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) The chronic aquatic life criteria of Subsections I and J of 20.6.4.900 NMAC shall also apply.

[20.6.4.124 NMAC - N, 05-23-05]

20.6.4.125 RIO GRANDE BASIN - Perennial reaches of San Pedro creek.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.125 NMAC - N, 05-23-05]

20.6.4.126 RIO GRANDE BASIN - Perennial portions of Cañon deValle from Los Alamos national laboratory (LANL) stream gage E256 upstream to Burning Ground spring, Sandia canyon from Sigma canyon upstream to LANL NPDES outfall 001, Pajarito canyon from Arroyo de La Delfe upstream into Starmers gulch and Starmers spring and Water canyon from Area-A canyon upstream to State Route 501.

A. Designated Uses: coldwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 24°C (75.2°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.126 NMAC - N, 05-23-05]

20.6.4.127 RIO GRANDE BASIN - Perennial portions of Los Alamos canyon upstream from Los Alamos reservoir and Los Alamos reservoir.

A. Designated Uses: coldwater aquatic life, livestock watering, wildlife habitat, irrigation and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.127 NMAC - N, 05-23-05]

20.6.4.128 RIO GRANDE BASIN - Ephemeral and intermittent portions of watercourses within lands managed by U.S. department of energy (DOE) within LANL, including but not limited to: Mortandad canyon, Cañada del Buey, Ancho canyon, Chaquehui canyon, Indio canyon, Fence canyon, Potrillo canyon and portions of Cañon de Valle, Los Alamos canyon, Sandia canyon, Pajarito canyon and Water canyon not specifically identified in 20.6.4.126 NMAC. (Surface waters within lands scheduled for transfer from DOE to tribal, state or local authorities are specifically excluded.)

A. Designated Uses: livestock watering, wildlife habitat, limited aquatic life and secondary contact.

B. Criteria:

(1) The use-specific criteria in 20.6.4.900 NMAC, except the chronic criteria for aquatic life are applicable for the designated uses listed in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) The acute total ammonia criteria set forth in Subsection K of 20.6.4.900 NMAC (salmonids absent) are applicable to this use.
[20.6.4.128 NMAC - N, 05-23-05]

20.6.4.129 RIO GRANDE BASIN - Perennial reaches of the Rio Hondo.

A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact**.**

B. Criteria:

(1) In any single sample: specific conductance 400 µmhos/cm or less, pH within the range of 6.6 to 8.8, total phosphorous (as P) less than 0.1 mg/L and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.129 NMAC - N, 05-23-05]

20.6.4.130 - 20.6.4.200: [RESERVED]

20.6.4.201 PECOS RIVER BASIN - The main stem of the Pecos river from the New Mexico-Texas line upstream to the mouth of the Black river (near Loving).

A. Designated Uses: irrigation, livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(l) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 50 cfs: TDS 20,000 mg/L or less, sulfate 3,000 mg/L or less and chloride 10,000 mg/L or less.
[20.6.4.201 NMAC - Rp 20 NMAC 6.1.2201, 10-12-00; A, 05-23-05]

20.6.4.202 PECOS RIVER BASIN - The main stem of the Pecos river from the mouth of the Black river upstream to lower Tansil dam, including perennial reaches of the Black river, the Delaware river and Blue spring.

A. Designated Uses: industrial water supply, irrigation, livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(l) In any single sample: pH within the range of 6.6 to 9.0 and temperature 34°C (93.2°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 50 cfs: TDS 8,500 mg/L or less, sulfate 2,500 mg/L or less and chloride 3,500 mg/L or less.

C. Remarks: Diversion for irrigation frequently limits summer flow in this reach of the main stem Pecos river to that contributed by springs along the watercourse.
[20.6.4.202 NMAC - Rp 20 NMAC 6.1.2202, 10-12-00; A, 05-23-05]
[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.218 NMAC**.]

20.6.4.203 PECOS RIVER BASIN - The main stem of the Pecos river from lower the headwaters of Lake Carlsbad upstream to Avalon dam.

A. Designated Uses: industrial water supply, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 34°C (93.2°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.203 NMAC - Rp 20 NMAC 6.1.2203, 10-12-00; A, 05-23-05]
[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.219 NMAC**.]

20.6.4.204 PECOS RIVER BASIN - The main stem of the Pecos river from the headwaters of Avalon reservoir upstream to Brantley dam.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2880 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.204 NMAC - Rp 20 NMAC 6.1.2204, 10-12-00; A, 05-23-05]

20.6.4.205 PECOS RIVER BASIN - Brantley reservoir.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.205 NMAC - Rp 20 NMAC 6.1.2205, 10-12-00; A, 05-23-05]

20.6.4.206 PECOS RIVER BASIN - The main stem of the Pecos river from the headwaters of Brantley reservoir upstream to Salt creek (near Acme), perennial reaches of the Rio Peñasco downstream from state highway 24 near Dunken, perennial reaches of the Rio Hondo and its tributaries below Bonney canyon and perennial reaches of the Rio Felix.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 50 cfs: TDS 14,000 mg/L or less, sulfate 3,000 mg/L or less and chloride 6,000 mg/L or less.
[20.6.4.206 NMAC - Rp 20 NMAC 6.1.2206, 10-12-00; A, 05-23-05]

20.6.4.207 PECOS RIVER BASIN - The main stem of the Pecos river from Salt creek (near Acme) upstream to Sumner dam.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 50 cfs: TDS 8,000 mg/L or less, sulfate 2,500 mg/L or less and chloride 4,000 mg/L or less.
[20.6.4.207 NMAC - Rp 20 NMAC 6.1.2207, 10-12-00; A, 05-23-05]

20.6.4.208 PECOS RIVER BASIN - Perennial reaches of the Rio Peñasco and its tributaries above state highway 24 near Dunken, perennial reaches of the Rio Bonito downstream from state highway 48 (near Angus), the Rio Ruidoso downstream of the U.S. highway 70 bridge near Seeping Springs lakes, perennial reaches of the Rio Hondo upstream from Bonney canyon and perennial reaches of Agua Chiquita.

A. Designated Uses: fish culture, irrigation, livestock watering, wildlife habitat, coldwater aquatic life and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8, temperature 30°C (86°F) or less and total phosphorus (as P) less than 0.1 mg/L. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.208 NMAC - Rp 20 NMAC 6.1.2208, 10-12-00; A, 05-23-05]

20.6.4.209 PECOS RIVER BASIN - Perennial reaches of Eagle creek above Alto reservoir, perennial reaches of the Rio Bonito and its tributaries upstream of state highway 48 (near Angus) and perennial reaches of the Rio Ruidoso and its tributaries upstream of the U.S. highway 70 bridge near Seeping Springs lakes.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 600 µmhos/cm or less in Eagle creek, 1,100 µmhos or less in Bonito creek, and 1,500 µmhos or less in the Rio Ruidoso, pH within the range of 6.6 to 8.8, total phosphorus (as P) less than 0.1 mg/L and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.209 NMAC - Rp 20 NMAC 6.1.2209, 10-12-00; A, 05-23-05]

20.6.4.210 PECOS RIVER BASIN - Sumner reservoir.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.210 NMAC - Rp 20 NMAC 6.1.2210, 10-12-00; A, 05-23-05]

20.6.4.211 PECOS RIVER BASIN - The main stem of the Pecos river from the headwaters of Sumner reservoir upstream to Tecolote creek.

A. Designated Uses: fish culture, irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 50 cfs: TDS 3,000 mg/L or less, sulfate 2,000 mg/L or less and chloride 400 mg/L or less.

[20.6.4.211 NMAC - Rp 20 NMAC 6.1.2211, 10-12-00; A, 05-23-05]

20.6.4.212 PECOS RIVER BASIN - Perennial tributaries to the main stem of the Pecos river from the headwaters of Sumner reservoir upstream to Santa Rosa dam.

A. Designated Uses: irrigation, coldwater aquatic life, livestock watering, wildlife habitat and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.212 NMAC - Rp 20 NMAC 6.1.2211.1, 10-12-00; A, 05-23-05]

20.6.4.213 PECOS RIVER BASIN - McAllister lake.

A. Designated Uses: coldwater aquatic life, secondary contact, livestock watering and wildlife habitat.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.213 NMAC - Rp 20 NMAC 6.1.2211.3, 10-12-00; A, 05-23-05]

20.6.4.214 PECOS RIVER BASIN - Storrie lake.

A. Designated Uses: coldwater aquatic life, warmwater aquatic life, primary contact, livestock watering, wildlife habitat, municipal water supply and irrigation storage.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.214 NMAC - Rp 20 NMAC 6.1.2211.5, 10-12-00; A, 05-23-05]

20.6.4.215 PECOS RIVER BASIN - Perennial reaches of the Gallinas river and all its tributaries above the diversion for the Las Vegas municipal reservoir and perennial reaches of Tecolote creek and its perennial tributaries.

A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less except specific conductance 450 µmhos/cm or less in Wright Canyon creek, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.215 NMAC - Rp 20 NMAC 6.1.2212, 10-12-00; A, 05-23-05]

20.6.4.216 PECOS RIVER BASIN - The main stem of the Pecos river from Tecolote creek upstream to Cañon de Mazanita.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 30°C (86°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

(3) At all flows above 10 cfs: TDS 250 mg/L or less, sulfate 25 mg/L or less and chloride 5 mg/L or less.

[20.6.4.216 NMAC - Rp 20 NMAC 6.1.2213, 10-12-00; A, 05-23-05]

20.6.4.217 PECOS RIVER BASIN - Perennial reaches of Cow creek and all perennial reaches of its tributaries and the main stem of the Pecos river from Cañon de Manzanita upstream to its headwaters, including perennial reaches of all tributaries thereto.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.217 NMAC - Rp 20 NMAC 6.1.2214, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segments are under 20.6.4.220 and 20.6.4.221 NMAC**.]

20.6.4.218 PECOS RIVER BASIN - Tansil lake and Lake Carlsbad.

A. Designated Uses: industrial water supply, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 34°C (93.2°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.218 NMAC - N, 05-23-05]

20.6.4.219 PECOS RIVER BASIN - Avalon reservoir.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.219 NMAC - N, 05-23-05]

20.6.4.220 PECOS RIVER BASIN - Perennial reaches of the Gallinas river and its tributaries from its mouth upstream to the diversion for the Las Vegas municipal reservoir, except Pecos Arroyo.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 30°C (86°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section. (see Subsection B of 20.6.4.14 NMAC)

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less, single sample 410 cfu/100 mL or less.

[20.6.4.220 NMAC - N, 05-23-05]

20.6.4.221 PECOS RIVER BASIN - Pecos Arroyo.

A. Designated Uses: livestock watering, wildlife habitat, warmwater aquatic life and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.221 NMAC - N, 05-23-05]

20.6.4.222 - 20.6.4.300: [RESERVED]

20.6.4.301 CANADIAN RIVER BASIN - The main stem of the Canadian river from the New Mexico-Texas line upstream to Ute dam, and any flow that enters the main stem from Revuelto creek.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0, temperature 32.2°C (90°F) or less and TDS 6,500 mg/L or less at flows above 25 cfs. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.301 NMAC - Rp 20 NMAC 6.1.2301, 10-12-00; A, 05-23-05]

20.6.4.302 CANADIAN RIVER BASIN - Ute reservoir.

A. Designated Uses: livestock watering, wildlife habitat, municipal and industrial water supply, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.302 NMAC - Rp 20 NMAC 6.1.2302, 10-12-00; A, 05-23-05]

20.6.4.303 CANADIAN RIVER BASIN - The main stem of the Canadian river from the headwaters of Ute reservoir upstream to Conchas dam, the perennial reaches of Pajarito and Ute creeks and their perennial tributaries.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.303 NMAC - Rp 20 NMAC 6.1.2303, 10-12-00; A, 05-23-05]

20.6.4.304 CANADIAN RIVER BASIN - Conchas reservoir.

A. Designated Uses: irrigation storage, livestock watering, wildlife habitat, primary contact and warmwater aquatic life.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.304 NMAC - Rp 20 NMAC 6.1.2304, 10-12-00; A, 05-23-05]

20.6.4.305 CANADIAN RIVER BASIN - The main stem of the Canadian river from the headwaters of Conchas reservoir upstream to the New Mexico-Colorado line, perennial reaches of the Conchas river, the Mora river downstream from the USGS gaging station near Shoemaker, the Vermejo river downstream from Rail canyon and perennial reaches of Raton, Chicorica and Uña de Gato creeks.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0, temperature 32.2°C (90°F) or less and TDS 3,500 mg/L or less at flows above 10 cfs. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.305 NMAC - Rp 20 NMAC 6.1.2305, 10-12-00; A, 05-23-05]

20.6.4.306 CANADIAN RIVER BASIN - The Cimarron river downstream from state highway 21 in Cimarron to the Canadian river and all perennial reaches of tributaries to the Cimarron river downstream from state highway 21 in Cimarron.

A. Designated Uses: irrigation, warmwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0, temperature 32.2°C (90°F) or less and TDS 3,500 mg/L or less at flows above 10 cfs. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.306 NMAC - Rp 20 NMAC 6.1.2305.1, 10-12-00; A, 7-19-01; A, 05-23-05]

20.6.4.307 CANADIAN RIVER BASIN - Perennial reaches of the Mora river from the USGS gaging station near Shoemaker upstream to the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river downstream from the USGS gaging station at La Cueva in San Miguel and Mora counties, perennial reaches of Ocate creek and its tributaries downstream of Ocate, and perennial reaches of Rayado creek downstream of Miami lake diversion in Colfax county.

A. Designated Uses: marginal coldwater aquatic life, warmwater aquatic life, secondary contact, irrigation, livestock watering and wildlife habitat.

B. Criteria:

(1) In any single sample: temperature 25°C (77°F) or less and pH within the range of 6.6 to 9.0. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.307 NMAC - Rp 20 NMAC 6.1.2305.3, 10-12-00; A, 05-23-05]

20.6.4.308 CANADIAN RIVER BASIN - Charette lakes.

A. Designated Uses: coldwater aquatic life, warmwater aquatic life, secondary contact, livestock watering and wildlife habitat.

B. Criteria:

(1) At any sampling site: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.308 NMAC - Rp 20 NMAC 6.1.2305.5, 10-12-00; A, 05-23-05]

20.6.4.309 CANADIAN RIVER BASIN - The Mora river and perennial reaches of its tributaries upstream from the state highway 434 bridge in Mora, all perennial reaches of tributaries to the Mora river upstream from the USGS gaging station at La Cueva, perennial reaches of Coyote creek and its tributaries, the Cimarron river and its perennial tributaries above state highway 21 in Cimarron, all perennial reaches of tributaries to the Cimarron river north and northwest of highway 64, perennial reaches of Rayado creek and its tributaries above Miami lake diversion, Ocate creek and perennial reaches of its tributaries upstream of Ocate, perennial reaches of the Vermejo river upstream from Rail canyon and all other perennial reaches of tributaries to the Canadian river northwest and north of U.S. highway 64 in Colfax county unless included in other segments.

A. Designated Uses: domestic water supply, irrigation, high quality coldwater aquatic life, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 500 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.309 NMAC - Rp 20 NMAC 6.1.2306, 10-12-00; A, 7-19-01; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.310 NMAC**.]

20.6.4.310 CANADIAN RIVER BASIN - Perennial reaches of Corrumpa creek and perennial reaches of tributaries of the Canadian river north of U.S. highway 54/66 and east and northeast of the Ute creek drainage.

A. Designated Uses: livestock watering, wildlife habitat, secondary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less, single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.310 NMAC - N, 05-23-05]

20.6.4.311 - 20.6.4.400: [RESERVED]

20.6.4.401 SAN JUAN RIVER BASIN - The main stem of the San Juan river from the Navajo Nation boundary at the Hogback upstream to its confluence with the Animas river.

A. Designated Uses: municipal and industrial water supply, irrigation, livestock watering, wildlife habitat, secondary contact, marginal coldwater aquatic life and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.401 NMAC - Rp 20 NMAC 6.1.2401, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.408 NMAC**.]

20.6.4.402 SAN JUAN RIVER BASIN - La Plata river from its confluence with the San Juan river upstream to the New Mexico-Colorado line.

A. Designated Uses: irrigation, marginal warmwater aquatic life, marginal coldwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.402 NMAC - Rp 20 NMAC 6.1.2402, 10-12-00; A, 05-23-05]

20.6.4.403 SAN JUAN RIVER BASIN - The Animas river from its confluence with the San Juan upstream to Estes Arroyo.

A. Designated Uses: municipal and industrial water supply, irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life, primary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 27°C (80.6°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.403 NMAC - Rp 20 NMAC 6.1.2403, 10-12-00; A, 05-23-05]

20.6.4.404 SAN JUAN RIVER BASIN - The Animas river from Estes Arroyo upstream to the New Mexico-Colorado line.

A. **Designated Uses**: coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. **Criteria**:

(1) In any single sample: pH within the range of 6.6 to 8.8, temperature 20°C (68°F) or less and total phosphorus (as P) 0.l mg/L or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.404 NMAC - Rp 20 NMAC 6.1.2404, 10-12-00; A, 05-23-05]

20.6.4.405 SAN JUAN RIVER BASIN - The main stem of the San Juan river from Canyon Largo upstream to the Navajo dam.

A. **Designated Uses**: high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. **Criteria**:

(1) In any single sample: specific conductance 400 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.405 NMAC - Rp 20 NMAC 6.1.2405, 10-12-00; A, 05-23-05]

20.6.4.406 SAN JUAN RIVER BASIN - Navajo reservoir in New Mexico.

A. **Designated Uses**: coldwater aquatic life, warmwater aquatic life, irrigation storage, livestock watering, wildlife habitat, municipal and industrial water storage and primary contact.

B. **Criteria**:

(1) At any sampling site: pH within the range of 6.6 to 8.8, temperature 20°C (68°F) or less and total phosphorus (as P) 0.1 mg/L or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.406 NMAC - Rp 20 NMAC 6.1.2406, 10-12-00; A, 05-23-05]

20.6.4.407 SAN JUAN RIVER BASIN - Perennial reaches of the Navajo and Los Pinos rivers in New Mexico.

A. **Designated Uses**: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. **Criteria**:

(1) In any single sample: pH within the range of 6.6 to 8.8, temperature 20°C (68°F) or less and total phosphorus (as P) 0.1 mg/L or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.407 NMAC - Rp 20 NMAC 6.1.2407, 10-12-00; A, 05-23-05]

20.6.4.408 SAN JUAN RIVER BASIN - The main stem of the San Juan river from its confluence with the Animas river upstream to its confluence with Canyon Largo.

A. **Designated Uses:** municipal and industrial water supply, irrigation, livestock watering, wildlife habitat, secondary contact, marginal coldwater aquatic life and warmwater aquatic life.

B. **Criteria:**

(1) In any single sample: pH within the range of 6.6 to 9.0, and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.408 NMAC - N, 05-23-05]

20.6.4.409 - 20.6.4.500: [RESERVED]

20.6.4.501 GILA RIVER BASIN - The main stem of the Gila river from the New Mexico-Arizona line upstream to Redrock canyon and perennial reaches of streams in Hidalgo county.

A. Designated Uses: irrigation, marginal warmwater aquatic life, livestock watering, wildlife habitat and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.501 NMAC - Rp 20 NMAC 6.1.2501, 10-12-00; A, 05-23-05]

20.6.4.502 GILA RIVER BASIN - The main stem of the Gila river from Redrock canyon upstream to the confluence of the West Fork Gila river and East Fork Gila river and perennial reaches of tributaries to the Gila river below Mogollon creek.

A. Designated Uses: industrial water supply, irrigation, livestock watering, wildlife habitat, marginal coldwater aquatic life, primary contact and warmwater aquatic life.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 28°C (82.4°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.502 NMAC - Rp 20 NMAC 6.1.2502, 10-12-00; A, 05-23-05]

20.6.4.503 GILA RIVER BASIN - All perennial tributaries to the Gila river above and including Mogollon creek.

A. Designated Uses: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less for the main stem of the Gila river above Gila hot springs and 400 µmhos or less for other reaches, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less except 32.2°C (90°F) or less in the east fork of the Gila river and Sapillo creek below lake Roberts. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.503 NMAC - Rp 20 NMAC 6.1.2503, 10-12-00; A, 05-23-05]

20.6.4.504 GILA RIVER BASIN - Wall lake, Lake Roberts and Snow lake.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 22°C (72°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.504 NMAC - Rp 20 NMAC 6.1.2504, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.806 NMAC**.]

20.6.4.505 - 20.6.4.600: [RESERVED]

20.6.4.601 SAN FRANCISCO RIVER BASIN - The main stem of the San Francisco river from the New Mexico-Arizona line upstream to state highway 12 at Reserve and perennial reaches of Mule creek.

A. Designated Uses: irrigation, marginal warmwater and marginal coldwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 32.2°C (90°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.601 NMAC - Rp 20 NMAC 6.1.2601, 10-12-00; A, 05-23-05]

20.6.4.602 SAN FRANCISCO RIVER BASIN - The main stem of the San Francisco river from state highway 12 at Reserve upstream to the New Mexico-Arizona line.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and primary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.602 NMAC - Rp 20 NMAC 6.1.2602, 10-12-00; A, 05-23-05]

20.6.4.603 SAN FRANCISCO RIVER BASIN - All perennial reaches of tributaries to the San Francisco river above the confluence of Whitewater creek and including Whitewater creek.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 400 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less except 25°C (77°F) or less in Tularosa creek. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.603 NMAC - Rp 20 NMAC 6.1.2603, 10-12-00; A, 05-23-05]

20.6.4.604 - 20.6.4.700: [RESERVED]

20.6.4.701 DRY CIMARRON RIVER - Perennial portions of the Dry Cimarron river above Oak creek and perennial reaches of Oak creek.

A. Designated Uses: marginal coldwater aquatic life, warmwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8, temperature 25°C (77°F) or less, TDS 1,200 mg/L or less, sulfate 600 mg/L or less, and chloride 40 mg/L or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.701 NMAC - Rp 20 NMAC 6.1.2701, 10-12-00; A, 05-23-05]

[**NOTE: The segment covered by this section was divided effective 05-23-05. The standards for the additional segment are under 20.6.4.702 NMAC.**]

20.6.4.702 DRY CIMARRON RIVER - Perennial portions of the Dry Cimarron river below Oak creek, and perennial portions of Long canyon and Carrizozo creeks.

A. Designated Uses: warmwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8, temperature 32.2°C (90°F) or less, TDS 1,200 mg/L or less, sulfate 600 mg/L or less and chloride 40 mg/L or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.702 NMAC - N, 05-23-05]

20.6.4.703 - 20.6.4.800: [RESERVED]

20.6.4.801 CLOSED BASINS - Rio Tularosa lying east of the old U.S. highway 70 bridge crossing east of Tularosa and all perennial tributaries to the Tularosa basin except Three Rivers.

A. Designated Uses: coldwater aquatic life, fish culture, irrigation, livestock watering, wildlife habitat, municipal and industrial water supply and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.801 NMAC - Rp 20 NMAC 6.1.2801, 10-12-00; A, 05-23-05]

20.6.4.802 CLOSED BASINS - Perennial reaches of Three Rivers.

A. Designated Uses: irrigation, domestic water supply, high quality coldwater aquatic life, secondary contact, livestock watering and wildlife habitat.

B. Criteria:

(1) In any single sample: specific conductance 500 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.802 NMAC - Rp 20 NMAC 6.1.2802, 10-12-00; A, 05-23-05]

20.6.4.803 CLOSED BASINS - Perennial reaches of the Mimbres river downstream of the confluence with Willow Springs canyon and all perennial reaches of tributaries thereto.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.803 NMAC - Rp 20 NMAC 6.1.2803, 10-12-00; A, 05-23-05]

20.6.4.804 CLOSED BASINS - Perennial reaches of the Mimbres river upstream of the confluence with Willow Springs canyon and all perennial tributaries thereto.

A. Designated Uses: irrigation, domestic water supply, high quality coldwater aquatic life, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos or less, pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235

cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.804 NMAC - Rp 20 NMAC 6.1.2804, 10-12-00; A, 05-23-05]

20.6.4.805 CLOSED BASINS - Perennial reaches of the Sacramento river (Sacramento-Salt Flat closed basin) and all perennial tributaries thereto.

A. Designated Uses: domestic and municipal water supply, livestock watering, wildlife habitat, marginal coldwater aquatic life and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 9.0 and temperature 25°C (77°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.805 NMAC - Rp 20 NMAC 6.1.2805, 10-12-00; A, 05-23-05]

20.6.4.806 CLOSED BASINS - Bear canyon reservoir.

A. Designated Uses: coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 300 µmhos/cm or less, pH within the range of 6.6 to 8.8 and temperature 22°C (72°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).
[20.6.4.806 NMAC - N, 05-23-05]

20.6.4.807 - 20.6.4.899: [RESERVED]

20.6.4.900 CRITERIA APPLICABLE TO ATTAINABLE OR DESIGNATED USES UNLESS OTHERWISE SPECIFIED IN 20.6.4.97 THROUGH 20.6.4.899 NMAC.

A. Fish Culture, Water Supply and Storage: Fish culture and municipal and industrial water supply and storage are designated uses in particular classified waters of the state where these uses are actually being realized. However, no numeric criteria apply uniquely to these uses. Water quality adequate for these uses is ensured by the general criteria and numeric criteria for bacterial quality, pH and temperature that are established for all classified waters of the state listed in 20.6.4.97 through 20.6.4.899 NMAC.

B. Domestic Water Supply: Surface waters of the state designated for use as domestic water supplies shall not contain substances in concentrations that create a lifetime cancer risk of more than one cancer per 100,000 exposed persons. Those criteria listed under domestic water supply in Subsection J of this section apply to this use.

C. Irrigation and Irrigation Storage: The following numeric criteria and those criteria listed under irrigation in Subsection J of this section apply to this use:

(1) dissolved selenium 0.13 mg/L

(2) dissolved selenium in presence of >500 mg/L SO_4 0.25 mg/L

D. Primary Contact: The monthly geometric mean of E. coli bacteria of 126 cfu/100 mL and single sample of 410 cfu/100 mL, apply to this use and pH shall be within the range of 6.6 to 9.0.

E. Secondary Contact: The monthly geometric mean of E. coli bacteria of 548 cfu/100 mL and single sample of 2507 cfu/100 mL apply to this use.

F. Livestock Watering: The criteria listed in Subsection J for livestock watering apply to this use.

G. Wildlife Habitat: Wildlife habitat shall be free from any substances at concentrations that are toxic to or will adversely affect plants and animals that use these environments for feeding, drinking, habitat or propagation; can bioaccumulate; or might impair the community of animals in a watershed or the ecological integrity of surface waters of the state. The discharge of substances that bioaccumulate, in excess of levels listed in Subsection J for wildlife habitat is allowed if, and only to the extent that, the substances are present in the intake waters that are diverted and utilized prior to discharge, and then only if the discharger utilizes best available treatment technology to reduce the amount of bioaccumulating substances that are discharged. The numeric criteria

listed in Subsection J for wildlife habitat apply to this use except when a site-specific or segment-specific criterion has been adopted under 20.6.4.101 through 20.6.4.899 NMAC.

H. **Aquatic Life:** Surface waters of the state with a designated, existing or attainable use of aquatic life shall be free from any substances at concentrations that can impair the community of plants and animals in or the ecological integrity of surface waters of the state. Except as provided in paragraph 6 below, the acute and chronic aquatic life criteria set out in subsections I and J of this section are applicable to this use. In addition, the specific criteria for aquatic life subcategories in the following paragraphs shall apply to waters classified under the respective designations

(1) **High Quality Coldwater:** Dissolved oxygen 6.0 mg/L or more, temperature 20°C (68°F) or less, pH within the range of 6.6 to 8.8 and specific conductance a limit varying between 300 µmhos/cm and 1,500 µmhos /cm depending on the natural background in particular surface waters of the state (the intent of this criterion is to prevent excessive increases in dissolved solids which would result in changes in community structure). The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria for pollutants listed in Subsection J of this section are applicable to this use.

(2) **Coldwater:** Dissolved oxygen 6.0 mg/L or more, temperature 20°C (68°F) or less and pH within the range of 6.6 to 8.8. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(3) **Marginal Coldwater:** Dissolved oxygen than 6 mg/L or more, on a case by case basis maximum temperatures may exceed 25°C (77°F) and the pH may range from 6.6 to 9.0. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(4) **Warmwater:** Dissolved oxygen 5 mg/L or more, temperature 32.2°C (90°F) or less, and pH within the range of 6.6 to 9.0. The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(5) **Marginal Warmwater:** Dissolved oxygen 5 mg/L or more, pH within the range of 6.6 to 9.0 and on a case by case basis maximum temperatures may exceed 32.2°C (90°F). The total ammonia criteria set out in Subsections K, L and M of this section and the human health criteria listed in Subsection J of this section are applicable to this use.

(6) **Limited Aquatic Life:** Criteria shall be developed on a segment-specific basis. The acute aquatic life criteria of Subsections I and J of this section shall apply. Chronic aquatic life criteria do not apply unless adopted on a segment specific basis.

I. The following schedule of equations for the determination of numeric criteria for the substances listed and those criteria listed in Subsection J for aquatic life shall apply to the subcategories of aquatic life identified in this section.

(1) **Acute criteria:**

(a) dissolved silver $0.85\ e^{(1.72(\ln(\text{hardness}))-6.59)}$ µg/L

(b) dissolved cadmium $(e^{(1.0166(\ln(\text{hardness}))-3.924)})\text{cf}$ µg/L, the hardness-dependent formulae for cadmium must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute factor for cadmium is cf = 1.136672 - ((ln hardness)(0.041838))

(c) dissolved chromium $0.316\ e^{(0.819(\ln(\text{hardness}))+3.7256)}$ µg/L

(d) dissolved copper $0.960\ e^{(0.9422(\ln(\text{hardness}))-1.700)}$ µg/L

(e) dissolved lead $(e^{(1.273(\ln(\text{hardness}))-1.46)})\text{cf}$ µg/L, the hardness-dependent formulae for lead must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute and chronic factor for lead is cf = 1.46203 - ((ln hardness)(0.145712))

(f) dissolved nickel $0.998\ e^{(0.8460(\ln(\text{hardness}))+2.255)}$ µg/L

(g) dissolved zinc $0.978\ e^{(0.8473(\ln(\text{hardness}))+0.884)}$ µg/L

(2) **Chronic criteria:**

(a) dissolved cadmium $(e^{(0.7409(\ln(\text{hardness}))-4.719)})\text{cf}$ µg/L, the hardness-dependent formulae for cadmium must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the chronic factor for cadmium is cf = 1.101672 - ((ln hardness)(0.041838))

(b) dissolved chromium $0.860\ e^{(0.819(\ln(\text{hardness}))+0.6848)}$ µg/L

(c) dissolved copper $0.960\ e^{(0.8545(\ln(\text{hardness}))-1.702)}$ µg/L

(d) dissolved lead $(e^{(1.273(\ln(\text{hardness}))-4.705)})\text{cf}$ µg/L, the hardness-dependent formulae for lead must be multiplied by a conversion factor (cf) to be expressed as dissolved values; the acute and chronic factor for lead is cf = 1.46203 - ((ln hardness)(0.145712))

(e) dissolved nickel $0.997\ e^{(0.846(\ln(\text{hardness}))+0.0584)}$ µg/L

(f) dissolved zinc $0.986\ e^{(0.8473(\ln(hardness))+0.884)}$ µg/L

J. Numeric criteria. The following table sets forth the numeric criteria adopted by the commission to protect existing, designated and attainable uses. Additional criteria that are not compatible with this table are found in Subsections A through I of this section.

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Aluminum, dissolved	7429-90-5		5,000			750	87		
Antimony, dissolved	7440-36-0	5.6						640	P
Arsenic, dissolved	7440-38-2	2.3	100	200		340	150	9.0	C,P
Asbestos	1332-21-4	7,000,000 fibers/L							
Barium, dissolved	7440-39-3	2,000							
Beryllium, dissolved	7440-41-7	4							
Boron, dissolved	7440-42-8		750	5,000					
Cadmium, dissolved	7440-43-9	5	10	50		see 20.6.4.900.I	see 20.6.4.900.I		
Chlorine residual	7782-50-5				11	19	11		
Chromium, dissolved	18540-29-9	100	100	1,000		see 20.6.4.900.I	see 20.6.4.900.I		
Cobalt, dissolved	7440-48-4		50	1,000					
Copper, dissolved	7440-50-8	1300	200	500		see 20.6.4.900.I	see 20.6.4.900.I		
Cyanide, dissolved	57-12-5	200							
Cyanide, weak acid dissociable	57-12-5	700			5.2	22.0	5.2	220,000	
Lead, dissolved	7439-92-1	50	5,000	100		see 20.6.4.900.I	see 20.6.4.900.I		
Mercury	7439-97-6	2		10	0.77				
Mercury, dissolved	7439-97-6					1.4	0.77		
Methymercury	22967-92-6							0.3 mg/kg in fish tissue	P
Molybdenum, dissolved	7439-98-7		1,000						
Nickel, dissolved	7440-02-0	100				see 20.6.4.900.I	see 20.6.4.900.I	4,600	P
Nitrate as N		10 mg/L							
Nitrite + Nitrate				132 mg/L					
Selenium, dissolved	7782-49-2	50	see 20.6.4.900.C	50				4,200	P
Selenium, total recoverable	7782-49-2				5.0	20.0	5.0		

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Silver, dissolved	7440-22-4					see 20.6.4 .900.I			
Thallium, dissolved	7440-28-0	1.7						6.3	P
Uranium, dissolved	7440-61-1	5,000							
Vanadium, dissolved	7440-62-2		100	100					
Zinc, dissolved	7440-66-6	7,400	2,000	25,000		see 20.6.4 .900.I	see 20.6.4.900. I	26,000	P
Adjusted gross alpha (see 20.6.4.900.B and .F)		15 pCi/L		15 pCi/L					
Radium 226 + Radium 228		5 pCi/L		30.0 pCi/L					
Strontium 90		8 pCi/L							
Tritium		20,000 pCi/L		20,000 pCi/L					
Acenaphthene	83-32-9	670						990	
Acrolein	107-02-8	190						290	
Acrylonitrile	107-13-1	0.51						2.5	C
Aldrin	309-00-2	0.00049				3.0		0.00050	C,P
Anthracene	120-12-7	8,300						40,000	
Benzene	71-43-2	22						510	C
Benzidine	92-87-5	0.00086						0.0020	C
Benzo(a)anthracene	56-55-3	0.038						0.18	C
Benzo(a)pyrene	50-32-8	0.038						0.18	C,P
Benzo(b)fluoranthene	205-99-2	0.038						0.18	C
Benzo(k)fluoranthene	207-08-9	0.038						0.18	C
alpha-BHC	319-84-6	0.026						0.049	C
beta-BHC	319-85-7	0.091						0.17	C
Gamma-BHC (Lindane)	58-89-9	0.19				0.95		0.63	C
Bis(2-chloroethyl) ether	111-44-4	0.30						5.3	C
Bis(2-chloroisopropyl) ether	108-60-1	1,400						65,000	
Bis(2-ethylhexyl) phthalate	117817	12						22	C
Bromoform	75-25-2	43						1,400	C
Butylbenzyl phthalate	85-68-7	1,500						1,900	
Carbon tetrachloride	56-23-5	2.3						16	C
Chlordane	57-74-9	0.0080				2.4	0.0043	0.0081	C,P

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Chlorobenzene	108-90-7	680						21,000	
Chlorodibromomethane	124-48-1	4.0						130	C
Chloroform	67-66-3	57						4,700	C
2-Chloronaphthalene	91-58-7	1,000						1,600	
2-Chlorophenol	95-57-8	81						150	
Chrysene	218-01-9	0.038						0.18	C
4,4'-DDT and derivatives		0.0022			0.001	1.1	0.001	0.0022	C,P
Dibenzo(a,h)anthracene	53-70-3	0.038						0.18	C
Dibutyl phthalate	84-74-2	2,000						4,500	
1,2-Dichlorobenzene	95-50-1	2,700						17,000	
1,3-Dichlorobenzene	541-73-1	320						960	
1,4-Dichlorobenzene	106-46-7	400						2,600	
3,3'-Dichlorobenzidine	91-94-1	0.21						0.28	C
Dichlorobromomethane	75-27-4	5.5						170	C
1,2-Dichloroethane	107-06-2	3.8						370	C
1,1-Dichloroethylene	75-35-4	0.57						32	C
2,4-Dichlorophenol	120-83-2	77						290	
1,2-Dichloropropane	78-87-5	5.0						150	C
1,3-Dichloropropene	542-75-6	10						1,700	
Dieldrin	60-57-1	0.00052				0.24	0.056	0.00054	C,P
Diethyl phthalate	84-66-2	17,000						44,000	
Dimethyl phthalate	131-11-3	270,000						1,100,000	
2,4-Dimethylphenol	105-67-9	380						850	
2,4-Dinitrophenol	51-28-5	69						5,300	
2,4-Dinitrotoluene	121-14-2	1.1						34	C
2,3,7,8-TCDD Dioxin	1746-01-6	5.0E-08						5.1E-08	C,P
1,2-Diphenylhydrazine	122-66-7	0.36						2.0	C
alpha-Endosulfan	959-98-8	62				0.22	0.056	89	
beta-Endosulfan	33213-65-9	62				0.22	0.056	89	
Endosulfan sulfate	1031-07-8	62						89	
Endrin	72-20-8	0.76				0.086	0.036	0.81	
Endrin aldehyde	7421-93-4	0.29						0.30	
Ethylbenzene	100-41-4	3,100						29,000	
Fluoranthene	206-44-0	130						140	
Fluorene	86-73-7	1,100						5,300	

Pollutant total, unless indicated	**CAS Number**	**Domestic Water Supply** µg/L unless indicated	**Irrigation** µg/L unless indicated	**Livestock Watering** µg/L unless indicated	**Wildlife Habitat** µg/L unless indicated	**Aquatic Life**		**Human Health** µg/L	**Cancer Causing (C) or Persistent (P)**
						Acute µg/L	**Chronic** µg/L		
Heptachlor	76-44-8	0.00079				0.52	0.0038	0.00079	C
Heptachlor epoxide	1024-57-3	0.00039				0.52	0.0038	0.00039	C
Hexachlorobenzene	118-74-1	0.0028						0.0029	C,P
Hexachlorobutadiene	87-68-3	4.4						180	C
Hexachlorocyclopentadiene	77-47-4	240						17,000	
Hexachloroethane	67-72-1	14						33	C
Ideno(1,2,3-cd)pyrene	193-39-5	0.038						0.18	C
Isophorone	78-59-1	350						9,600	C
Methyl bromide	74-83-9	47						1,500	
2-Methyl-4,6-dinitrophenol	534-52-1	13						280	
Methylene chloride	75-09-2	46						5,900	C
Nitrobenzene	98-95-3	17						690	
N-Nitrosodimethylamine	62-75-9	0.0069						30	C
N-Nitrosodi-n-propylamine	621-64-7	0.050						5.1	C
N-Nitrosodiphenylamine	86-30-6	33						60	C
PCBs	1336-36-3	0.00064			0.014		0.014	0.00064	C,P
Pentachlorophenol	87-86-5	2.7				19	15	30	C
Phenol	108-95-2	21,000						1,700,000	
Pyrene	129-00-0	830						4,000	
1,1,2,2-Tetrachloroethane	79-34-5	1.7						40	C
Tetrachloroethylene	127-18-4	6.9						33	C,P
Toluene	108-88-3	6,800						200,000	
Toxaphene	8001-35-2	0.0028				0.73	0.0002	0.0028	C
1,2-Trans-dichloroethylene	156-60-5	700						140,000	
1,2,4-Trichlorobenzene	120-82-1	260						940	
1,1,2-Trichloroethane	79-00-5	5.9						160	C
Trichloroethylene	79-01-6	25						300	C
2,4,6-Trichlorophenol	88-06-2	14						24	C
Vinyl chloride	75-01-4	20						5,300	C

K. Acute Criteria, Total Ammonia (mg/L as N)

pH	**Salmonids Present**	**Salmonids Absent**

pH	Salmonids Present	Salmonids Absent
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88
8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.885	1.32

L. Chronic Criteria, Total Ammonia (mg/L as N), Fish Early Life Stages Present

pH	Temperature (°C)										
	0	14	15	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.46	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	6.36	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	6.25	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	6.10	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.93	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.73	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.49	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	5.22	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.92	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.59	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	4.23	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.85	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.47	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	3.09	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.71	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.36	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	2.10	2.10	2.03	1.91	1.68	1.47	1.29	1.14	1.00	0.879	0.773
8.2	1.79	1.79	1.74	1.63	1.43	1.26	1.11	0.973	0.855	0.752	0.661
8.3	1.52	1.52	1.48	1.39	1.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	1.29	1.29	1.25	1.17	1.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	1.09	1.09	1.06	0.990	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.920	0.920	0.892	0.836	0.735	0.646	0.568	0.499	0.439	0.386	0.339

pH	Temperature (°C)										
	0	14	15	16	18	20	22	24	26	28	30
8.7	0.778	0.778	0.754	0.707	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.661	0.661	0.641	0.601	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.565	0.565	0.548	0.513	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.486	0.486	0.471	0.442	0.389	0.342	0.300	0.264	0.232	0.204	0.179

M. Chronic Criteria, Total Ammonia (mg/L as N), Fish Early Life Stages Absent

pH	Temperature (°C)									
	0	7	8	9	10	11	12	13	14	15
6.5	10.8	10.8	10.1	9.51	8.92	8.36	7.84	7.35	6.89	6.46
6.6	10.7	10.7	9.99	9.37	8.79	8.24	7.72	7.24	6.79	6.36
6.7	10.5	10.5	9.81	9.20	8.62	8.08	7.58	7.11	6.66	6.25
6.8	10.2	10.2	9.58	8.98	8.42	7.90	7.40	6.94	6.51	6.10
6.9	9.93	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.93
7.0	9.60	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.73
7.1	9.20	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.49
7.2	8.75	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	5.22
7.3	8.24	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.92
7.4	7.69	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.59
7.5	7.09	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	4.23
7.6	6.46	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.85
7.7	5.81	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.47
7.8	5.17	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	3.09
7.9	4.54	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.71
8.0	3.95	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.36
8.1	3.41	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	2.03
8.2	2.91	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.74
8.3	2.47	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.48
8.4	2.09	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.25
8.5	1.77	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	1.06
8.6	1.49	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.892
8.7	1.26	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.754
8.8	1.07	1.07	1.01	0.944	0.855	0.829	0.778	0.729	0.684	0.641
8.9	0.917	0.917	0.860	0.806	0.756	0.709	0.664	0.623	0.584	0.548
9.0	0.790	0.790	0.740	0.694	0.651	0.610	0.572	0.536	0.503	0.471
At 15º C and above, the criterion for fish early life stages absent is the same as the criterion for fish early life stages present (refer to Subsection L of 20.6.4.900 NMAC).										

N. Dissolved oxygen saturation based on temperature and elevation.

(1) Elevation 5,000 feet or less:

		Elevation (feet)										
		0	**500**	**1,000**	**1,500**	**2,000**	**2,500**	**3,000**	**3,500**	**4,000**	**4,500**	**5,000**
Temperature (°C)	**0**	14.6	14.3	14.1	13.8	13.6	13.3	13.1	12.8	12.6	12.3	12.1
	1	14.2	13.9	13.7	13.4	13.2	12.9	12.7	12.5	12.2	12.0	11.8
	2	13.8	13.6	13.3	13.1	12.8	12.6	12.4	12.1	11.9	11.7	11.5
	3	13.4	13.2	13.0	12.7	12.5	12.3	12.0	11.8	11.6	11.4	11.1
	4	13.1	12.8	12.6	12.4	12.2	11.9	11.7	11.5	11.3	11.1	10.9
	5	12.7	12.5	12.3	12.1	11.8	11.6	11.4	11.2	11.0	10.8	10.6
	6	12.4	12.2	12.0	11.8	11.5	11.3	11.1	10.9	10.7	10.5	10.3
	7	12.1	11.9	11.7	11.5	11.3	11.1	10.8	10.6	10.4	10.2	10.1
	8	11.8	11.6	11.4	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8

	Elevation (feet)										
	0	**500**	**1,000**	**1,500**	**2,000**	**2,500**	**3,000**	**3,500**	**4,000**	**4,500**	**5,000**
9	11.5	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.8	9.6
10	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.7	9.5	9.4
11	11.0	10.8	10.6	10.4	10.2	10.0	9.9	9.7	9.5	9.3	9.1
12	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.5	9.3	9.1	8.9
13	10.5	10.3	10.1	9.9	9.8	9.6	9.4	9.2	9.1	8.9	8.7
14	10.3	10.1	9.9	9.7	9.6	9.4	9.2	9.0	8.9	8.7	8.5
15	10.1	9.9	9.7	9.5	9.3	9.2	9.0	8.8	8.7	8.5	8.4
16	9.8	9.7	9.5	9.3	9.2	9.0	8.8	8.7	8.5	8.3	8.2
17	9.6	9.5	9.3	9.1	9.0	8.8	8.6	8.5	8.3	8.2	8.0
18	9.4	9.3	9.1	8.9	8.8	8.6	8.5	8.3	8.1	8.0	7.8
19	9.3	9.1	8.9	8.8	8.6	8.4	8.3	8.1	8.0	7.8	7.7
20	9.1	8.9	8.7	8.6	8.4	8.3	8.1	8.0	7.8	7.7	7.5
21	8.9	8.7	8.6	8.4	8.3	8.1	8.0	7.8	7.7	7.5	7.4
22	8.7	8.6	8.4	8.2	8.1	8.0	7.8	7.7	7.5	7.4	7.2
23	8.6	8.4	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1
24	8.4	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0
25	8.2	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8
26	8.1	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8	6.7
27	7.9	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.8	6.7	6.6
28	7.8	7.7	7.5	7.4	7.2	7.1	7.0	6.9	6.7	6.6	6.5
29	7.7	7.5	7.4	7.3	7.1	7.0	6.9	6.7	6.6	6.5	6.4
30	7.5	7.4	7.3	7.1	7.0	6.9	6.7	6.6	6.5	6.4	6.3

(2) Elevation greater than 5,000 feet:

		Elevation (feet)									
		5,500	**6,000**	**6,500**	**7,000**	**7,500**	**8,000**	**8,500**	**9,000**	**9,500**	**10,000**
Temperature (°C)	**0**	11.9	11.6	11.4	11.2	11.0	10.8	10.6	10.3	10.1	9.9
	1	11.5	11.3	11.1	10.9	10.7	10.5	10.3	10.1	9.9	9.7
	2	11.2	11.0	10.8	10.6	10.4	10.2	10.0	9.8	9.6	9.4
	3	10.9	10.7	10.5	10.3	10.1	9.9	9.7	9.5	9.3	9.1
	4	10.7	10.4	10.2	10.0	9.8	9.7	9.5	9.3	9.1	8.9
	5	10.4	10.2	10.0	9.8	9.6	9.4	9.2	9.0	8.9	8.7
	6	10.1	9.9	9.7	9.5	9.4	9.2	9.0	8.8	8.6	8.5
	7	9.9	9.7	9.5	9.3	9.1	8.9	8.8	8.6	8.4	8.2
	8	9.6	9.4	9.3	9.1	8.9	8.7	8.6	8.4	8.2	8.0
	9	9.4	9.2	9.0	8.9	8.7	8.5	8.3	8.2	8.0	7.8
	10	9.2	9.0	8.8	8.7	8.5	8.3	8.1	8.0	7.8	7.7
	11	9.0	8.8	8.6	8.5	8.3	8.1	8.0	7.8	7.6	7.5
	12	8.8	8.6	8.4	8.3	8.1	7.9	7.8	7.6	7.5	7.3
	13	8.6	8.4	8.2	8.1	7.9	7.8	7.6	7.5	7.3	7.2
	14	8.4	8.2	8.1	7.9	7.7	7.6	7.4	7.3	7.1	7.0
	15	8.2	8.0	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8
	16	8.0	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8	6.7
	17	7.9	7.7	7.6	7.4	7.3	7.1	7.0	6.8	6.7	6.6
	18	7.7	7.5	7.4	7.3	7.1	7.0	6.8	6.7	6.6	6.4
	19	7.5	7.4	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3
	20	7.4	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2
	21	7.2	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.0
	22	7.1	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9
	23	7.0	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9	5.8
	24	6.8	6.7	6.6	6.4	6.3	6.2	6.1	5.9	5.8	5.7

	25	6.7	6.6	6.5	6.3	6.2	6.1	6.0	5.8	5.7	5.6
	26	6.6	6.5	6.3	6.2	6.1	6.0	5.8	5.7	5.6	5.5
	27	6.5	6.3	6.2	6.1	6.0	5.9	5.7	5.6	5.5	5.4
	28	6.4	6.2	6.1	6.0	5.9	5.8	5.6	5.5	5.4	5.3
	29	6.2	6.1	6.0	5.9	5.8	5.7	5.5	5.4	5.3	5.2
	30	6.1	6.0	5.9	5.8	5.7	5.6	5.4	5.3	5.2	5.1

[20.6.4.900 NMAC - Rp 20 NMAC 6.1.3100, 10-12-00; A, 10-11-02; A, 05-23-05; A, 07-17-05]

20.6.4.901 PUBLICATION REFERENCES: These documents are intended as guidance and are available for public review during regular business hours at the offices of the surface water quality bureau and the New Mexico environment department public library. Copies of these documents have also been filed with the New Mexico state records center in order to provide greater access to this information.

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[20.6.4.901 NMAC - Rp 20 NMAC 6.1.4000, 10-12-00; A, 05-23-05]

HISTORY of 20.6.4 NMAC:

Pre-NMAC History:

Material in the part was derived from that previously filed with the commission of public records - state records center and archives:

WQC 67-1, Water Quality Standards, filed 7-17-67, effective 8-18-67

WQC 67-1, Amendment Nos. 1-6, filed 3-21-68, effective 4-22-68

WQC 67-1, Amendment No. 7, filed 2-27-69, effective 3-30-69

WQC 67-1, Amendment No. 8, filed 7-14-69, effective 8-15-69

WQC 70-1, Water Quality Standards for Intrastate Waters and Tributaries to Interstate Streams, filed July 17, 1970;

WQC 67-1, Amendment Nos. 9 and 10, filed 2-12-71, effective 3-15-71
WQC 67-1, Amendment No. 11, filed 3-4-71, effective 4-5-71
WQC 73-1, New Mexico Water Quality Standards, filed 9-17-73, effective 10-23-73
WQC 73-1, Amendment Nos. 1 and 2, filed 10-3-75, effective 11-4-75
WQC 73-1, Amendment No. 3, filed 1-19-76, effective 2-14-76
WQC 77-2, Amended Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 2-24-77, effective 3-11-77
WQC 77-2, Amendment No. 1, filed 3-23-78, effective 4-24-78
WQC 77-2, Amendment No. 2, filed 6-12-79, effective 7-13-79
WQCC 80-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 8-28-80, effective 9-28-80
WQCC 81-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 5-5-81, effective 6-4-81
WQCC 81-1, Amendment No. 1, filed 5-19-82, effective 6-18-82
WQCC 81-1, Amendment No. 2, filed 6-24-82, effective 7-26-82
WQCC 85-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 1-16-85, effective 2-15-85
WQCC 85-1, Amendment No. 1, filed 8-28-87, effective 9-28-87
WQCC 88-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 3-24-88, effective 4-25-88
WQCC 91-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, filed 5-29-91, effective 6-29-91
WQCC 91-1, Amendment No. 1, filed 10-11-91, effective 11-12-91

History of the Repealed Material:
WQC 67-1, Water Quality Standards, - Superseded, 10-23-73
WQC 73-1, New Mexico Water Quality Standards, - Superseded, 3-11-77
WQC 77-2, Amended Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 9-28-80
WQCC 80-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 6-4-81
WQCC 81-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 2-15-85
WQCC 85-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 4-25-88
WQCC 88-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 6-29-91
WQCC 91-1, Water Quality Standards for Interstate and Intrastate Streams in New Mexico, - Superseded, 1-23-95
20 NMAC 6.1, Standards for Interstate and Intrastate Streams, - Repealed, 2-23-00
20 NMAC 6.1, Standards for Interstate and Intrastate Surface Waters, - Repealed, 10-12-00

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Cibola County, New Mexico
Hydrologic Unit Code 13020207
Latitude 35°09'16", Longitude 107°52'11" NAD27
Drainage area 1,020 square miles
Gage datum 6,468.34 feet above sea level NGVD29

Output formats
HTML table with channel data
HTML table without channel data
Tab-separated data with channel data
Tab-separated data without channel data
Graph of data
Reselect output format

Meas. Number	Date	Time	Who	Stream flow (ft^3/s)	Gage Height (ft)	Rating No.	Shift Adj. (ft)	% Diff.	GH Change (ft)	Meas. Duration (hr)	Meas. Rated	Control	Flow Adjust. Code
305	2007-08-07	15:18	mls	0.025	1.91	8.0	-0.630		0.00	0.30	FAIR	MDDB	MEAS
304	2002-09-11	08:14	mls	10.8	2.36	6.0	-0.530	7.50	-0.05	1.00	FAIR	LGDB	MEAS
303	2002-09-10	16:01	mls	0.010	1.66	4.0	-0.380	50.0	0.00	0.20	GOOD	LGDB	MEAS
302	1993-09-01	11:15	SAK/KCG	2.27	1.82	6.0	-0.260				FAIR	LGDB	MEAS
301	1993-08-29	10:13	DJM/GHS	0.548	1.69	6.0	-0.270				GOOD	CLER	MEAS
300	1993-08-26	14:12	DJM	0.076	1.52	6.0	-0.210				GOOD	CLER	MEAS
299	1985-04-25	-- --	LM	10.1	1.82	5.0	0.00		0.00	0.40	GOOD	CLER	UNSP
298	1985-04-25	-- --	MAD	10.1	1.82	5.0	0.00		0.00	0.40	GOOD		MEAS
298	1985-04-18	-- --	LM	9.67	1.75	5.0	0.050		0.00	0.40	GOOD	CLER	MEAS
297	1985-04-15	-- --	LM /PG	17.4	1.95	5.0	0.00		0.00	0.40	GOOD	CLER	MEAS
296	1984-10-18	-- --	LM /GY	0.130	1.33	5.0	0.00				UNSP	CLER	MEAS
295	1983-08-23	-- --	BOR/MAD	0.120	1.35	5.0	-0.030				UNSP		MEAS
294	1983-05-11	-- --	MAD	29.5	2.08	5.0	0.220		0.00	0.40	GOOD		MEAS
293	1983-05-04	-- --	YOU	53.5	2.34	5.0	0.260		0.00	0.75	UNSP		MEAS
292	1983-04-27	-- --	YOU/MAD	168.0	3.32	5.0	0.160		0.00	0.50	UNSP		MEAS
291	1983-04-21	-- --	MAD	99.1	2.80	5.0	0.220		0.00	0.50	GOOD		MEAS
290	1983-04-19	-- --	YOU	4.63	1.64	5.0	0.050		0.00	0.75	GOOD		MEAS
289	1983-04-14	-- --	ORT	15.7	1.94	5.0	0.110		0.00	0.50	GOOD		MEAS
288	1980-05-14	-- --	MAD/FIS	15.0	2.04	4.0	0.00	-3.10	0.00	0.70	UNSP		MEAS
287	1980-05-02	-- --	ORT	21.5	2.13	4.0	0.020	4.90	0.00	0.50	FAIR		MEAS
286	1980-04-29	-- --	MAD	76.4	2.82	4.0	0.00	1.30	-0.04	0.50	GOOD		MEAS
285	1980-04-24	-- --	ROT/MAD	185.0	3.60	4.0	0.00	-2.60	0.00	0.50	GOOD		MEAS
284	1980-04-22	-- --	BOR/QUI	246.0	3.90	4.0	0.00		-0.01	0.50	GOOD		MEAS
283	1980-04-21	-- --	MAD/QUI	366.0	4.40	4.0	0.00	1.70	0.00	0.56	GOOD		MEAS

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282	1980-04-19	-- --	MAD	163.0	3.50	4.0	0.010 -	-4.40	0.00	0.50	FAIR	MEAS
281	1980-04-18	-- --	ROT/SCH	45.4	2.60	4.0	0.070 -	-2.80	0.01	0.33	UNSP	MEAS
280	1980-04-18	-- --	ROT/SCH	42.1	2.57	4.0	0.070 -	-4.30	0.02	0.25	UNSP	MEAS
279	1975-09-04	-- --	ORT/MAD	0.730	1.70	4.0	0.340 -		0.00	0.40	GOOD	MEAS
278	1975-07-31	-- --	ORR	0.480	1.61	4.0	0.290 -		0.00	0.25	FAIR	MEAS
277	1972-10-20	-- --	ORR	38.5	2.47	4.0	0.260 -		0.00	0.30	FAIR	MEAS
276	1972-07-21	-- --	ORT/H	10.4	1.90	4.0	0.110 -		-0.03	0.25	GOOD	MEAS
275	1972-07-21	-- --	ORT/H	23.9	2.06	4.0	0.030 -		-0.04	0.25	GOOD	MEAS
274	1972-07-19	-- --	ORT/DEN	1.06	1.54	4.0	0.130 -		0.00	-999.0	UNSP	MEAS

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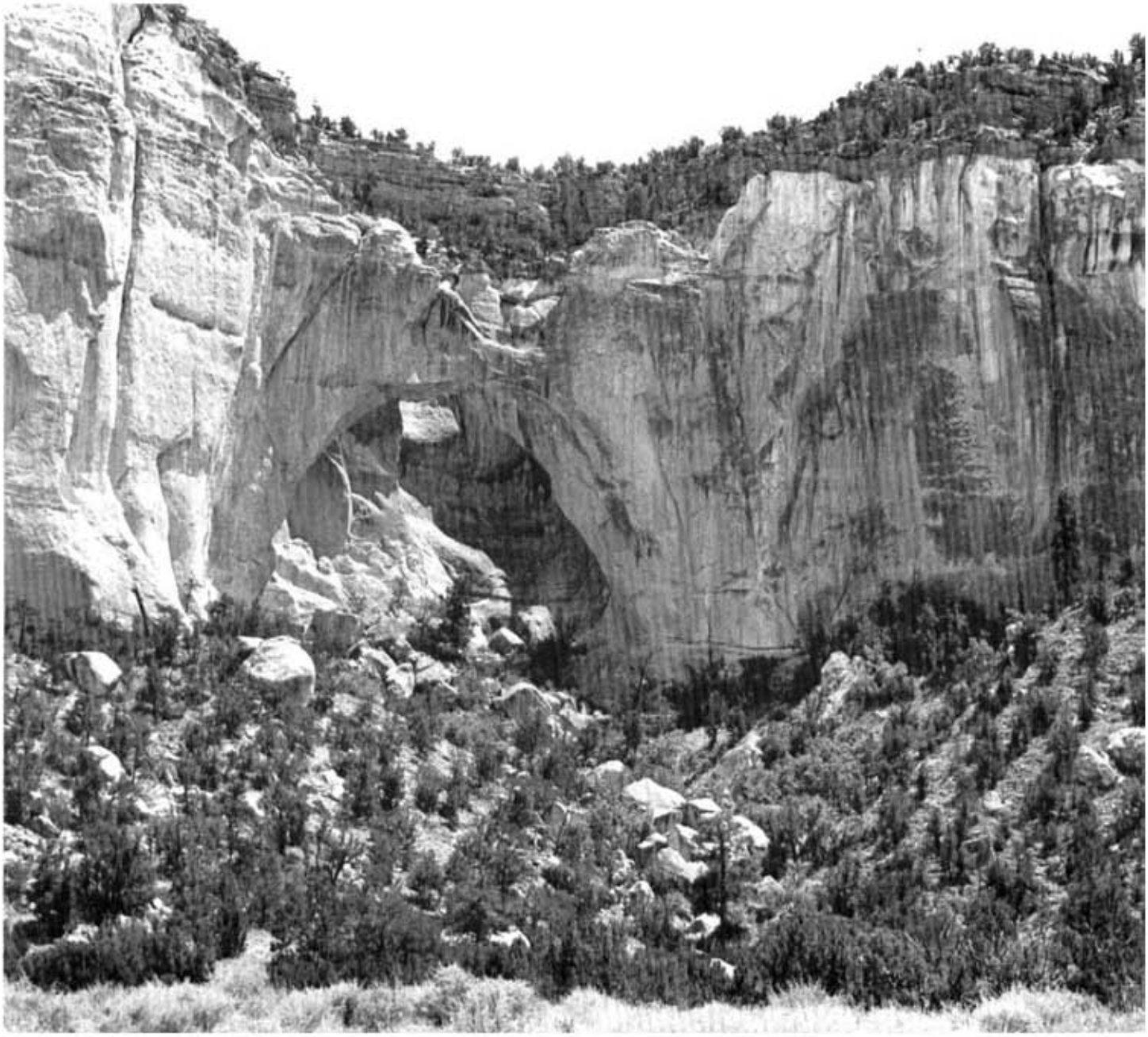
Soil
Conservation
Service

In cooperation with
United States Department
of the Interior, Bureau of
Indian Affairs and Bureau
of Land Management,
and New Mexico
Agricultural Experiment
Station

Soil Survey of Cibola Area, New Mexico,

Parts of Cibola, McKinley, and Valencia Counties



220001

How To Use This Soil Survey

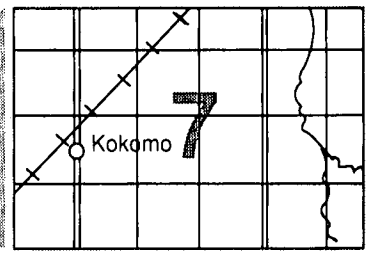
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

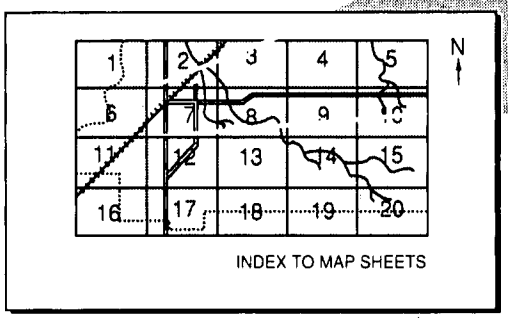
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.



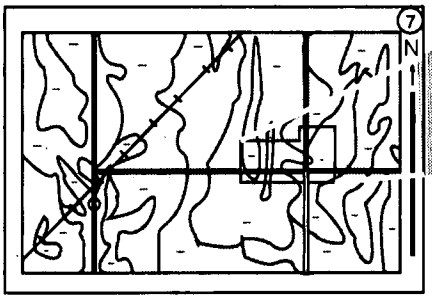
MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

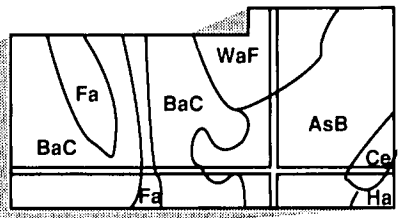


INDEX TO MAP SHEETS

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



MAP SHEET



AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service; United States Department of the Interior, Bureau of Indian Affairs and Bureau of Land Management; and the New Mexico Agricultural Experiment Station. It is part of the technical assistance furnished to the Lava, McKinley, Quemado, and Valencia Soil and Water Conservation Districts.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

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Cover: La Ventana, a sandstone landmark east of The Narrows, in an area of Rock outcrop-Vessilla-Mion complex, 3 to 55 percent slopes.

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Foreword

This soil survey contains information that can be used in land-planning programs in the survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

Ray T. Margo, Jr.
State Conservationist
Soil Conservation Service

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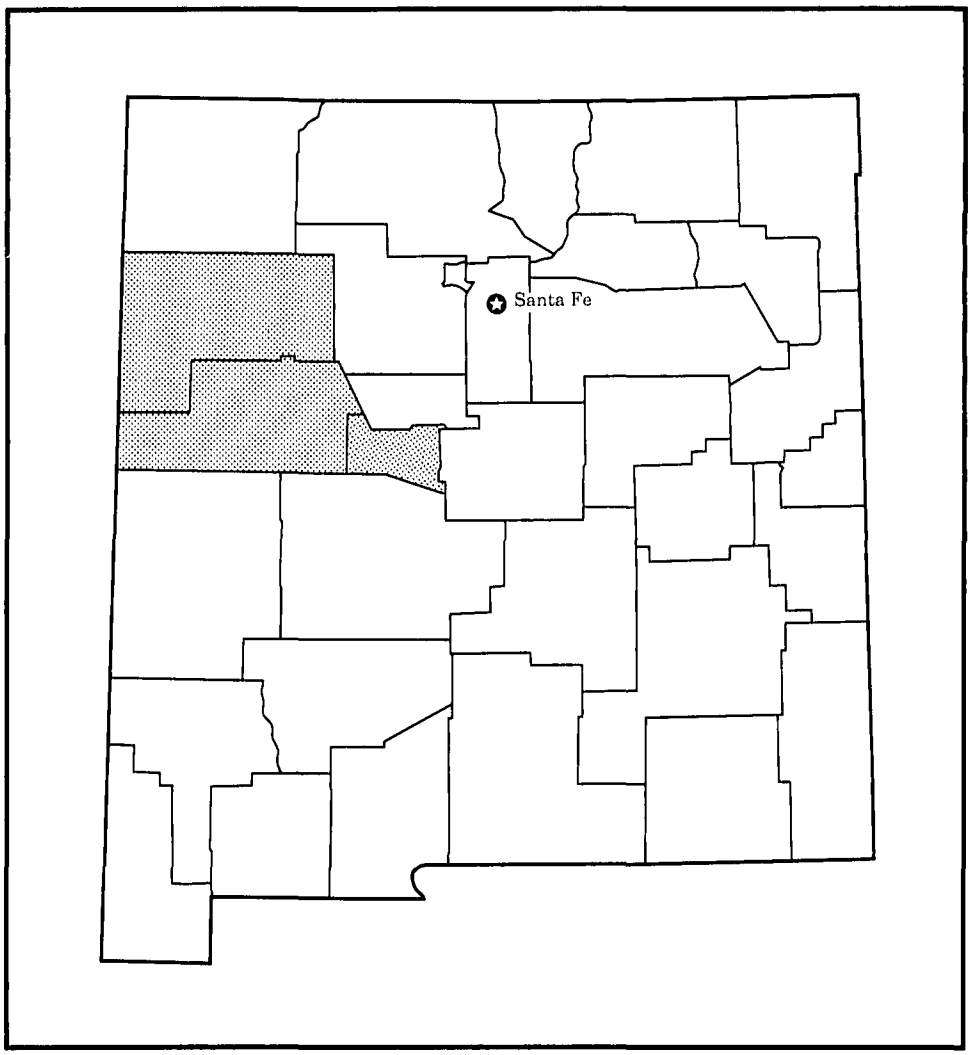

Location of Cibola Area in New Mexico.

Soil Survey of Cibola Area, New Mexico,

Parts of Cibola, McKinley, and Valencia Counties

By Tommie Lee Parham, Soil Conservation Service

Fieldwork by Tommie Lee Parham, Clarence L. Chavez, Clarence E. Montoya, Michael W. Roybal, and Jon K. Melhus, Soil Conservation Service, and William M. Rigdon, Bureau of Indian Affairs

Vegetative work by Michael J. Delancey and Richard J. Reioux, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, in cooperation with United States Department of the Interior, Bureau of Indian Affairs and Bureau of Land Management, and New Mexico Agricultural Experiment Station

This survey area is in the west-central part of New Mexico. It has a total area of 2,696,480 acres, or about 4,213 square miles. In 1980, Cibola County had a population of 30,109 and Grants, the largest city in the survey area, had a population of about 11,635. Grants became the county seat when Cibola County was established in 1981. The county was originally part of Valencia County.

Elevation in the survey area ranges from about 5,250 feet in an area near the Rio Puerco to 10,300 feet in an area north of Water Canyon, near Mount Taylor. Most areas are at elevations of 6,000 to 8,000 feet.

The eastern one-fifth of the survey area is mainly rangeland and does not support trees. It is characterized by limestone and gypsum hills and a few basalt-capped mesas.

The western part of the survey area, which is within the Colorado Plateau physiographic province, generally is characterized by rough, broken terrain, including small, steep mountainous areas, plateaus, and mesas intermingled with steep canyon walls, escarpments, and valleys.

The part of the survey area that has been subject to the most volcanic activity extends from Mount Taylor to the southwestern corner of the survey area. This part includes numerous volcanic plugs, such as Bandera Crater and Cerro Alto.

The survey area has very little surface water. The major bodies of water are Bluewater and Ramah Lakes (fig. 1). The Rio San Jose, in the central part of the area, and the Rio Puerco, in the eastern part, are the major tributaries.

Precipitation in the survey area varies with elevation. It ranges from about 7 inches in one of the lowest areas near the Rio Puerco to 25 inches east of Mount Taylor, the highest mountain in the area.

Coal mining, commercial woodcutting, and ranching are the most important enterprises in the survey area. Uranium mining formerly was important, but a decrease in demand has resulted in the closing of most uranium mines in the area. The ranches are mainly cow-calf enterprises, but some are yearling enterprises. Parts of the Bluewater Valley, the San Mateo area, the Grants-Milan area, the Seboyeta-Bibo area, and the Ramah Valley are used for farming. The survey area has about 4,500 acres of irrigated cropland and 1,500 acres of nonirrigated cropland. The main crops are alfalfa hay, corn, and wheat. Other crops include vegetables, orchard crops, and Irish potatoes. Some areas are used as irrigated pasture.

Parts of this survey area were included in the soil surveys of the Bluewater Area, New Mexico, published in 1958, and the Zuni Mountain Area, New Mexico, published in 1967. This survey updates the earlier surveys. It provides additional information and has larger maps, which show the soils in greater detail.

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Figure 1.—Bluewater Lake, in the northwestern part of the survey area, is a popular recreation area in New Mexico.

Climate

Prepared by the State Climatologist, Las Cruces, New Mexico.

The average annual precipitation in this survey area generally ranges from about 9 inches at elevations of less than 6,000 feet to more than 12 inches at elevations of about 7,000 feet. The higher mountain peaks receive as much as 25 inches or more. The amounts can vary greatly from year to year. For example, San Fidel received a total of 22.41 inches in 1941, but Laguna received only 1.96 inches in 1956. The highest monthly total, recorded at the El Morro National Monument in August 1947, was 8.93 inches.

The average number of days with 0.1 inch or more of precipitation ranges from 25 at the lower elevations to 40 or more at the higher elevations. Generally, 3 to 6 days a year receive at least 0.5 inch of precipitation.

The rainy season is in summer. About half of the average annual precipitation falls during the period July through September, mostly during brief thunderstorms that are sometimes heavy. The thunderstorms are occasionally accompanied by hail and strong, gusty winds. Nearly three-fourths of the annual precipitation falls during the period May through October.

The main source of moisture in summer is the Gulf of Mexico. Moisture is carried into New Mexico by southeasterly winds from the Bermuda high pressure area. Occasionally, some moisture also is received from the eastern subtropical Pacific. In winter most of the precipitation is from storms that originate in the Pacific Ocean and move inland. Because much of the moisture from these storms is removed by the mountains to the west of New Mexico, precipitation generally is light in winter.

The average annual snowfall ranges from about 1 foot at the lower elevations to 4 feet or more at the higher elevations. In the winter of 1974-75, a total of 102.8 inches of snow fell at the El Morro National Monument. Most of the snow falls during the period November through March, but it can fall as late as May at the higher elevations.

The average annual temperature ranges from about 54 degrees F at the lower elevations to about 47 degrees at the higher elevations. It may be even lower, however, in the highest mountainous areas. The diurnal temperature range is quite wide. It averages about 33 degrees. The highest recorded temperature is 104 degrees, which occurred at San Fidel on July 7, 1966, and the lowest is -38 degrees, which occurred at the El Morro National Monument on January 13 and 15, 1963. The average number of days when temperatures of 90 degrees or higher occur ranges from about 50 per year at the lower elevations to 15 or less at the higher elevations. The average number cf days with freezing temperatures ranges from 150 at the lower elevations to 200 or more at the higher elevations. The average number of days when temperatures of zero or below occur ranges from 2 at the lower elevations to 11 or more at the higher elevations.

The freeze-free period ranges from about 110 days at the El Morro National Monument, which has an elevation of 7,225 feet, to 156 days at Laguna, which has an elevation of 5,800 feet. The sun shines an average of 3,100 hours annually, or 70 percent of the time possible. The range is 65 percent of the time possible in January to 75 percent in July. At the El Morro National Monument, the relative humidity averages 77 percent early in the morning. It averages 39 percent in the afternoon during all months of the year, except for June, when it averages only about 25 percent. Estimated evaporation ranges from about 50 inches per year at the higher elevations to 60 inches per year at the lower elevations. The average annual windspeed is 10 miles per hour at Acomita. The windiest period is in March. The winds are most frequently from the west.

Table 1 gives temperature and precipitation data as recorded at Grants and Laguna.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils

systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils in this survey do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or in the extent of the soils in the survey areas.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The general map units in this survey have been grouped for broad interpretive purposes. Each of the broad groups and the map units in each group are described on the following pages.

Soil Descriptions

Lava Flows, Dry Soils, and Rock Outcrop in Areas of Hills, Mesas, Ridges, Valleys Between Lava Ridges, Cuestas, Fan Terraces, and Swales

This group consists of six map units. It makes up about 23 percent of the survey area. The native vegetation is grasses, shrubs, and scattered trees. Elevation is 5,800 to 7,100 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 145 days.

The soils in this group formed in alluvial and eolian material. They are used mainly for livestock grazing and wildlife habitat.

1. Lava Flows-Viuda

Lava flows and shallow soils, mainly on hills and ridges

This map unit is mainly on hills and ridges in the central part of the survey area. Slope is 1 to 15 percent. The vegetation is mainly grasses, shrubs, and scattered trees. Elevation is 6,200 to 7,100 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 145 days.

This unit makes up about 3.3 percent of the survey area. It is about 85 percent Lava flows and similar miscellaneous areas, 10 percent Viuda and similar soils, and 5 percent soils of minor extent.

Lava flows occur as barren or nearly barren areas of exposed lava. They have very sharp, jagged surfaces. Vegetation generally is limited to cracks and crevasses and included soils.

Viuda soils are on hills and ridges. These soils are shallow and well drained. They formed in alluvium and windblown sediments over basalt. Typically, the surface layer is brown very cobbly sandy loam about 3 inches thick. The subsoil is about 16 inches of brown and light brown clay and cobbly clay loam. Basalt is at a depth of about 19 inches.

Of minor extent in this unit are the deep Penistaja and moderately deep Hagerman soils in valleys between lava ridges.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the rough, broken terrain, the depth to bedrock, rock outcrops, a restricted rooting depth, and stones on the surface. The vegetation is sparse.

This unit of limited grassland supports a diverse plant community of shrubs and junipers, which enhance the habitat for wildlife. Local areas receive surface runoff and support a more dense shrub or woodland habitat. Characteristic wildlife include coyote, bobcat, gray fox, cottontail, wood rat, rock wren, brown towhee, chipping sparrow, short-horned lizard, and black-tailed rattlesnake.

2. Poley-Rock Outcrop-Flaco

Moderately deep and deep soils and Rock outcrop, mainly on hills, ridges, and mesas

This map unit is mainly on hills, ridges, and mesas in the southeastern and south-central parts of the survey area. Slope is 1 to 25 percent. The vegetation is mainly

grasses, shrubs, and scattered juniper. Elevation is 5,900 to 7,100 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 145 days.

This unit makes up about 6.9 percent of the survey area. It is about 40 percent Poley and similar soils, 25 percent Rock outcrop, 20 percent Flaco and similar soils, and 15 percent soils of minor extent. Areas near the Socorro County line may have a higher percentage of minor soils.

Poley soils are on hills and ridges. These soils are deep and well drained. They formed in alluvium and colluvium derived dominantly from shale. Typically, the surface layer is reddish brown very cobbly loam about 3 inches thick. The upper part of the subsoil is reddish brown and yellowish red clay about 19 inches thick, and the lower part to a depth of 60 inches or more is light reddish brown and pink clay and clay loam.

Rock outcrop consists of barren or nearly barren areas of exposed basalt and sandstone.

Flaco soils are on basalt-capped mesas. These soils are moderately deep and well drained. They formed in mixed alluvium and windblown sediments. Typically, the surface layer is yellowish brown loam about 2 inches thick. The subsoil is about 27 inches thick. The upper 9 inches is yellowish brown loam and clay loam, and the lower 18 inches is yellowish brown and light yellowish brown clay loam and loam. Unweathered basalt is at a depth of about 29 inches.

Of minor extent in this unit are the shallow Berto soils on mesa tops, the moderately deep Hagerman and deep Harvey and Penistaja soils on mesas, the deep Pojoaque and Rana soils on mesa breaks, and the shallow Mion soils on hills.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the Rock outcrop, the depth to bedrock in the Flaco soils, and the clayey texture of the Poley soils.

The ledges and rocky areas in this unit provide habitat for some kinds of wildlife. The unit supports a plant community of grasses, shrubs, and scattered juniper. Characteristic wildlife include coyote, cottontail, bobcat, wood rat, rock squirrel, flycatcher, wren, and crow. Most areas support only a few mule deer, but larger populations are on Sierra Lucero.

3. Viuda-Penistaja

Shallow and deep soils, mainly on hills and ridges and in valleys between lava ridges

This map unit is mainly on hills and ridges and in valleys between lava ridges in the south-central part of the survey area. Slope is 1 to 12 percent. The vegetation is mainly grasses and shrubs. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit makes up about 2.9 percent of the survey area. It is about 40 percent Viuda and similar soils, 35 percent Penistaja and similar soils, and 25 percent components of minor extent. Areas near the Catron County line may have a higher percentage of some minor components.

Viuda soils are on hills and ridges. These soils are shallow and well drained. They formed in alluvium and windblown sediments. Typically, the surface layer is brown very cobbly sandy loam about 3 inches thick. The subsoil is about 16 inches of brown clay and light brown cobbly clay loam. Unweathered basalt is at a depth of about 19 inches.

Penistaja soils are on ridges and in valleys between lava ridges. These soils are deep and well drained. They formed in wind-modified, mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 20 inches thick. The lower part of the subsoil and the substratum to a depth of 60 inches are light brown and reddish brown sandy loam.

Of minor extent in this unit are Rock outcrop on lava ridges, the deep Aparejo and Venadito soils in valleys, and the deep Ildefonso soils on ridges.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the depth to bedrock and rock fragments on the surface in areas of the Viuda soils.

This unit, which is referred to as the North Plains, is a large, open area of grassland that supports extensive stands of snakeweed and rubber rabbitbrush. Small, shallow playas retain surface water during wet periods.

This unit provides good habitat for pronghorn antelope. Other characteristic wildlife include black-tailed jackrabbit, coyote, ground squirrel, horned lark, golden eagle, and loggerhead shrike. During wet periods migrating waterfowl and shore birds frequent the shallow playas.

4. Hagerman-Rock Outcrop-Mion

Shallow and moderately deep soils and Rock outcrop, mainly on mesas, cuestas, hills, and ridges

This map unit is mainly on mesas, cuestas, hills, and ridges in the northeastern part of the survey area. Slope is 1 to 65 percent. The vegetation is mainly grasses, shrubs, and scattered oneseed juniper. Elevation is

6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit makes up about 6.1 percent of the survey area. It is about 40 percent Hagerman and similar soils, 25 percent Rock outcrop, 15 percent Mion and similar soils, and 20 percent components of minor extent. Areas near the Bernalillo County line may have a higher percentage of some minor components.

Hagerman soils are on mesas and cuestas. These soils are moderately deep and well drained. They formed in eolian and alluvial material derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 3 inches thick. The subsurface layer is dark brown fine sandy loam about 3 inches thick. The upper part of the subsoil is brown sandy clay loam about 17 inches thick, and the lower part is strong brown and light brown sandy loam about 11 inches thick. Sandstone is at a depth of about 34 inches.

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on hills and ridges.

Mion soils are on hills and ridges. These soils are shallow and well drained. They formed in alluvium and colluvium derived dominantly from shale. Typically, the surface layer is light olive brown stony loam about 3 inches thick. The underlying material is about 10 inches of grayish brown silty clay and silty clay loam. Shale is at a depth of about 13 inches.

Of minor extent in this unit are the shallow Bond and Skyvillage soils on cuestas and mesas, Badland on hills and ridges, and the deep Penistaja soils on cuestas.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the depth to bedrock, the slope, and the Rock outcrop.

This unit provides grassland habitat that supports only scattered oneseed juniper. Characteristic wildlife include coyote, black-tailed jackrabbit, prairie dog, mourning dove, toad, and prairie rattlesnake.

5. Winona-Rock Outcrop-Tanbark

Shallow and very shallow soils and Rock outcrop, mainly on mesas, hills, and ridges

This map unit is on mesas, hills, and ridges in the southeastern part of the survey area. Slope is 1 to 60 percent. The vegetation is mainly grasses and shrubs. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit makes up about 1.9 percent of the survey area. It is about 40 percent Winona and similar soils, 25 percent Rock outcrop, 20 percent Tanbark and similar soils, and 15 percent soils of minor extent. Areas near the Socorro County line may have a higher percentage of minor soils.

Winona soils are on mesas, hills, and ridges. These soils are shallow or very shallow and are well drained. They formed in windblown sediments derived dominantly from limestone. Typically, the surface layer is brown very gravelly loam about 3 inches thick. The subsoil is pale brown and very pale brown very cobbly loam about 7 inches thick. Unweathered limestone is at a depth of about 10 inches.

Rock outcrop consists of barren or nearly barren areas of exposed limestone on hills and ridges.

Tanbark soils are on ridges and hills. These soils are shallow and well drained. They formed in eolian material derived dominantly from gypsum. Typically, the surface layer is very pale brown loam about 2 inches thick. The underlying material is about 15 inches of very pale brown and white, gypsiferous silt loam and sandy loam. Unweathered gypsum is at a depth of about 17 inches.

Of minor extent in this unit are the deep Harvey soils on mesa tops, the shallow Rizozo and Mion soils on hills, and the deep Oelop soils in swales.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the slope, the depth to bedrock, and the content of gypsum in the Tanbark soils.

This unit consists of desert grassland that includes areas of sparse shrubs along drainageways and areas that are barren and eroded. The unit provides fair habitat for pronghorn antelope, but the habitat for mule deer is very poor. Characteristic wildlife include coyote, badger, kangaroo rat, black-tailed jackrabbit, prairie lark, scaled quail, and prairie rattlesnake.

6. Harvey-Netoma-Oelop

Deep soils, mainly on mesas, fan terraces, and hills and in swales

This map unit is on mesas, fan terraces, and hills and in swales in the southeastern part of the survey area. Slope is 0 to 12 percent. The vegetation is mainly grasses and shrubs. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit makes up about 1.7 percent of the survey area. It is about 35 percent Harvey and similar soils, 25

percent Netoma and similar soils, 20 percent Oelop and similar soils, and 20 percent soils of minor extent. Areas near the Socorro County line and the Valencia County line may have a higher percentage of minor soils.

Harvey soils are on mesas. These soils are deep and well drained. They formed in mixed alluvium and windblown sediments. Typically, the surface layer is brown loam about 2 inches thick. The upper part of the subsoil is reddish yellow and light brown clay loam about 16 inches thick, and the lower part to a depth of 60 inches is pink loam.

Netoma soils are on fan terraces and hills. These soils are deep and well drained. They formed in alluvium derived dominantly from gypsiferous material. Typically, the surface layer is strong brown sandy loam about 4 inches thick. The upper part of the subsoil is strong brown sandy loam about 8 inches thick, and the lower part to a depth of 60 inches is light brown and reddish yellow, gypsiferous sandy loam.

Oelop soils are in swales. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is dark yellowish brown loam about 3 inches thick. The upper part of the subsoil is dark yellowish brown clay loam about 13 inches thick, and the lower part to a depth of 60 inches is dark yellowish brown clay loam and loam.

Of minor extent in this unit are the deep Penistaja soils on cuestas, the shallow Bond and Rizozo soils on hills and ridges, and the gypsiferous Tanbark and Saido soils on hills and plains.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the high content of calcium carbonate in the Harvey soils and the high content of gypsum in the Netoma soils.

This unit consists of desert grassland that includes areas of sparse shrubs along drainageways and areas that are barren and eroded. The unit provides fair habitat for pronghorn antelope, but the habitat for mule deer is very poor. Characteristic wildlife include coyote, badger, kangaroo rat, meadowlark, prairie lark, scaled quail, and prairie rattlesnake.

Moist Soils and Rock Outcrop in Areas of Hills, Ridges, Mesas, Fan Terraces, Alluvial Fans, Valleys Between Lava Ridges, Other Valleys, and Plateaus

This group consists of six map units. It makes up about 51 percent of the survey area. The native vegetation is pinyon, juniper, shrubs, and grasses. Elevation is 6,400 to 7,500 feet. The average annual precipitation is about 12 to 16 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 100 to 135 days.

The soils in this group formed in alluvial and eolian material. They are used mainly for livestock grazing, fuel wood production, and wildlife habitat.

7. Laporte-Rock Outcrop

Shallow soils and Rock outcrop, mainly on hills and ridges

This map unit is on hills and ridges in the central part of the survey area. Slope is 1 to 60 percent. The vegetation is mainly trees, shrubs, and an understory of grasses. Elevation is 6,500 to 7,200 feet. The average annual precipitation is about 12 to 15 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 110 to 135 days.

This unit makes up about 2.3 percent of the survey area. It is about 50 percent Laporte and similar soils, 35 percent Rock outcrop, and 15 percent soils of minor extent.

Laporte soils are on hills and ridges. These soils are shallow and well drained. They formed in mixed colluvium and windblown sediments. Typically, the surface layer is dark brown gravelly loam about 3 inches thick. The underlying material is dark grayish brown gravelly loam about 8 inches thick. Limestone is at a depth of about 11 inches.

Rock outcrop consists of barren or nearly barren areas of exposed limestone on hills and ridges.

Of minor extent in this unit are the moderately deep Celacy soils on hills; the shallow Atarque, Mion, and Vessilla soils on hills and ridges; and the deep Flugle and Goesling soils on hills.

This unit is used for livestock grazing, limited wood products, and wildlife habitat (fig. 2). The main limitations are the slope, the depth to bedrock, and the windthrow hazard.

This unit of rocky hillsides and ledges provides brushy habitat for mule deer, cottontail, bobcat, ring-tailed cat, scrub jay, great horned owl, chickadee, and raven. Areas in and around Bluewater Lake and Bluewater Creek provide aquatic and riparian habitat for coot, herons, mallard, teal, muskrat, raccoon, toads, and frogs.

8. Flugle-Catman-Rock Outcrop

Deep soils and Rock outcrop, mainly on mesas, fan terraces, and alluvial fans and in valleys

This map unit is on mesas, fan terraces, and alluvial fans and in valleys in the western and south-central parts of the survey area (fig. 3). Slope is 1 to 8 percent. The vegetation is mainly grasses, shrubs, and trees. Elevation is 6,400 to 7,300 feet. The average annual

Figure 2.—Typical area of the Laporte-Rock outcrop general soil map unit, near Bluewater Lake. This unit provides brushy habitat for a variety of wildlife.

precipitation is about 11 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 135 days.

This unit makes up about 19.2 percent of the survey area. It is about 40 percent Flugle and similar soils, 25 percent Catman and similar soils, 15 percent Rock outcrop, and 20 percent soils of minor extent. Areas near the Catron County line may have a higher percentage of some minor soils.

Flugle soils are on mesas and fan terraces. These soils are deep and well drained. They formed in wind-modified alluvium. Typically, the surface layer is brown loamy fine sand about 5 inches thick. The upper part of the subsoil is strong brown and brown sandy clay loam about 22 inches thick, and the lower part to a depth of 60 inches is light brown and pink sandy clay loam and sandy loam.

Catman soils are on alluvial fans and in valleys.

These soils are deep and well drained. They formed in alluvium derived dominantly from shale. Typically, the surface layer is light olive brown clay loam about 3 inches. The underlying material to a depth of 60 inches is light olive brown clay.

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on the edges of mesas.

Of minor extent in this unit are the deep Moncha, Goesling, and Teco soils on mesas and fan terraces; the deep Venadito, Hickman, and Catman Variant soils in valleys and on flood plains; the shallow Mion and Vessilla soils on hills; the shallow Atarque and moderately deep Celacy soils on mesas; and the deep Silkie soils on valley sides.

This unit is used for livestock grazing, fuel wood production, and wildlife habitat.

This unit is mainly grassland that supports only scattered shrubs and juniper. Sagebrush and greasewood are the dominant plants on the eroded bottom of some drainageways. Areas of wetland and riparian habitat are along Cebolla Creek. Areas of Catman Variant soils, which have a high water table, provide riparian habitat. Areas of nonirrigated and irrigated cropland contribute to the diverse habitat in this unit.

Characteristic wildlife include pronghorn antelope, black-tailed jackrabbit, coyote, prairie dog, ground squirrel, meadowlark, prairie lark, and prairie rattlesnake. The wildlife in the aquatic areas include

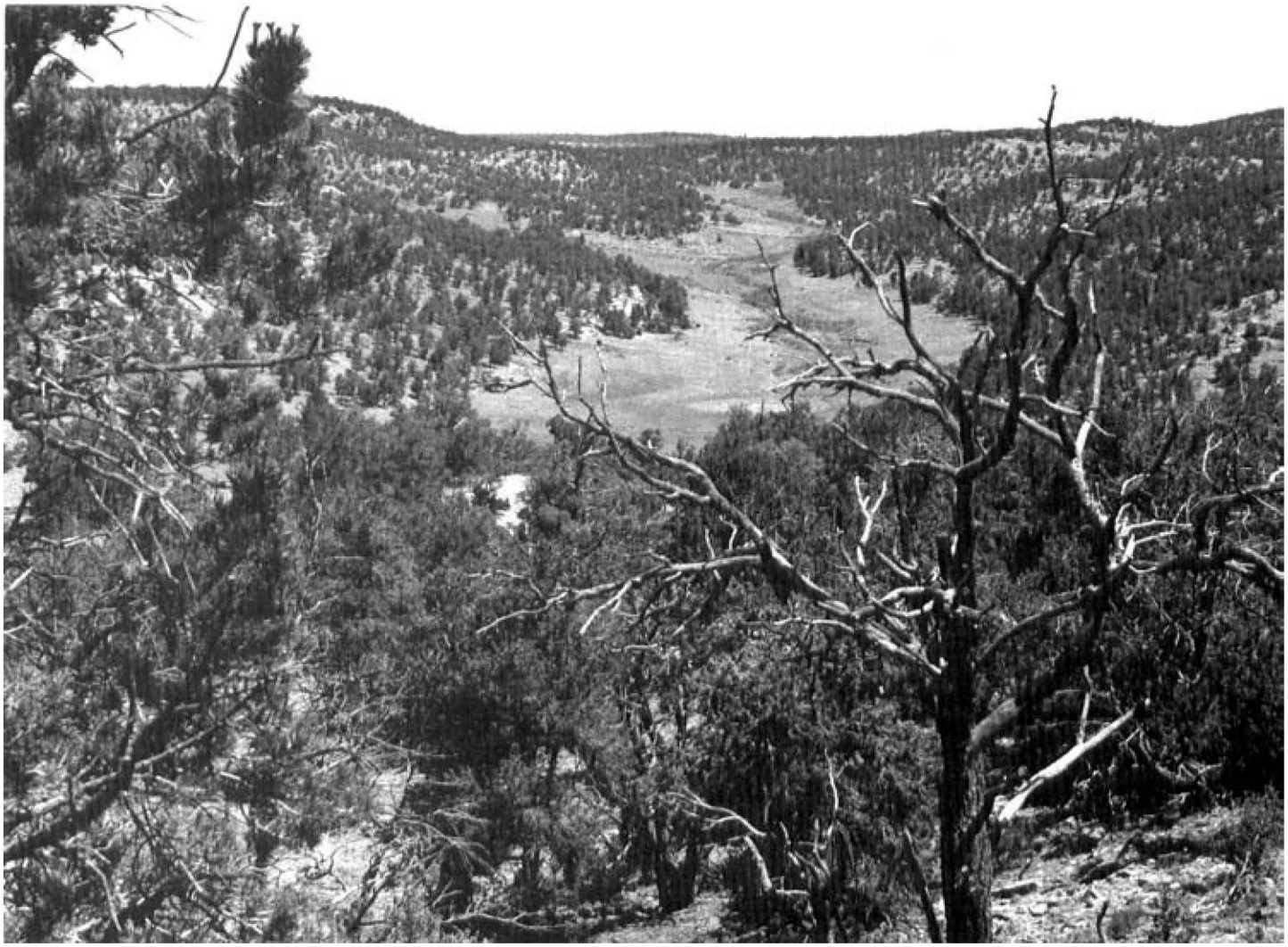

Figure 3.—Typical area of the Flugle-Catman-Rock outcrop general soil map unit.

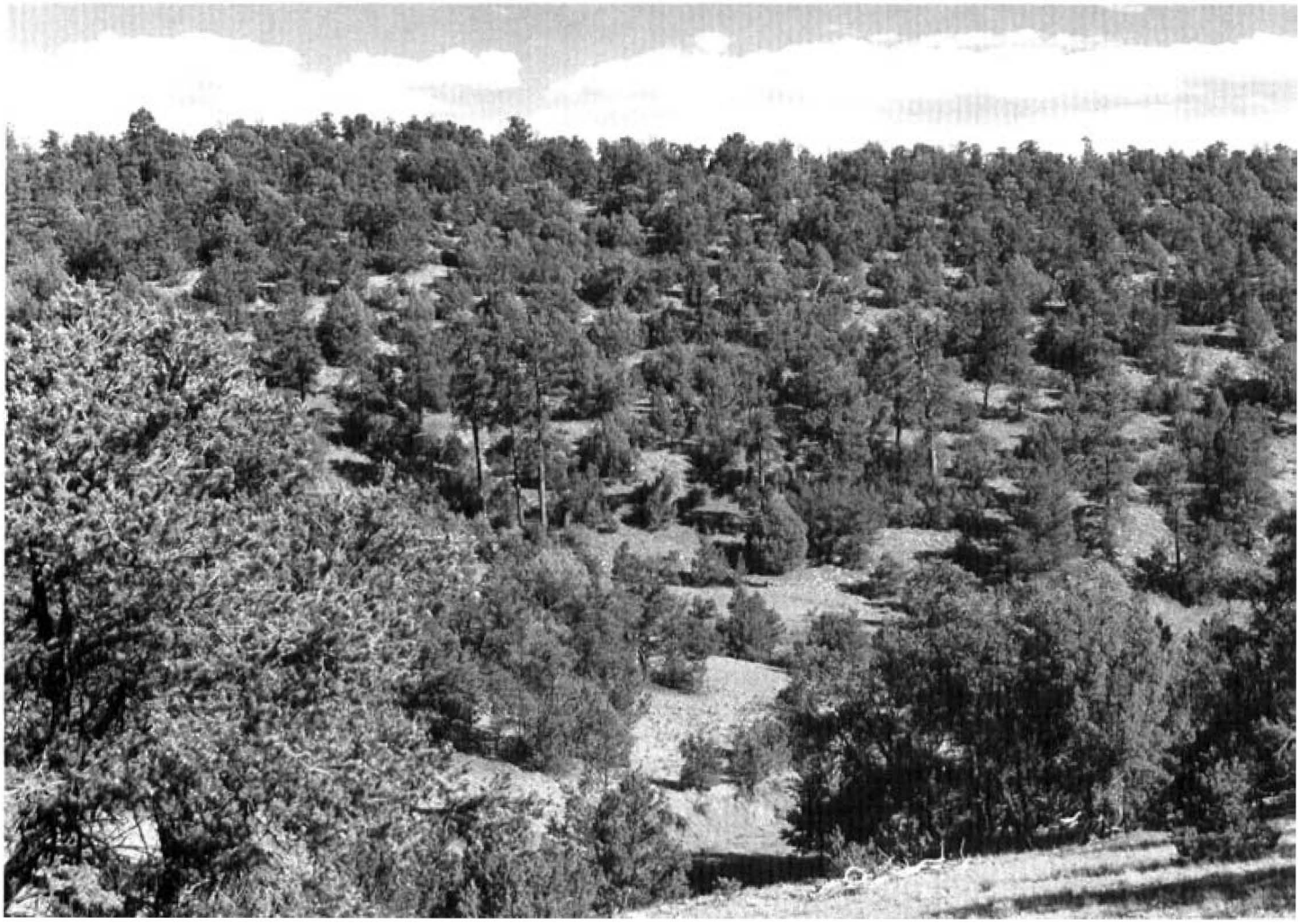

Figure 4.—Typical area of the Pinitos-Galestina-Mion general soil map unit.

muskrat, raccoon, rail, blackbird, coot, leopard frog, and garter snake.

9. Pinitos-Galestina-Mion

Shallow and deep soils, mainly on mesas, hills, and ridges

This map unit is on mesas, hills, and ridges in the western and south-central parts of the survey area (fig. 4). Slope is 1 to 55 percent. The vegetation is mainly trees, grasses, and shrubs. Elevation is 6,800 to 7,500 feet. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit makes up about 12.7 percent of the survey area. It is about 35 percent Pinitos and similar soils, 25 percent Galestina and similar soils, 20 percent Mion and similar soils, and 20 percent components of minor extent. Areas near the Catron County line and the Socorro County line may have a higher percentage of some minor components.

Pinitos soils are on mesas and hills. These soils are deep and well drained. They formed in wind-modified alluvium. Typically, the surface layer is light brown sandy loam about 2 inches thick. The upper part of the subsoil is brown and light brown sandy clay loam about 22 inches thick, and the lower part to a depth of 60 inches is light yellowish brown sandy loam.

Galestina soils are on hills and mesas. These soils are deep and well drained. They formed in alluvium derived dominantly from shale. Typically, the surface layer is yellowish brown sandy loam about 2 inches thick. The subsurface layer is yellowish brown loam

about 5 inches thick. The upper 24 inches of the subsoil is yellowish brown clay, and the lower 15 inches is yellowish brown and light yellowish brown clay and clay loam. Shale is at a depth of 46 inches.

Mion soils are on ridges. These soils are shallow and well drained. They formed in colluvium and alluvium derived dominantly from shale. Typically, the surface layer is light olive brown stony loam about 3 inches thick. The underlying material is about 8 inches of grayish brown silty clay and silty clay loam. Shale is at a depth of about 13 inches.

Of minor extent in this unit are the deep Catman and Hickman soils on valley bottoms; the deep Montecito, Loarc, Millpaw, and Teco soils on mesas; the moderately deep Ribera and Nogal soils on mesas; the shallow Vessilla soils on hills; and Rock outcrop on hills and ridges.

This unit is used for fuel wood production, livestock grazing, and wildlife habitat. The main limitations are the clayey texture of the Galestina and Mion soils and the shallow depth of the Mion soils.

This unit provides large areas of brushy habitat on breaks and mesas and scattered areas of oak, ponderosa pine, and large pinyon. Characteristic wildlife include mule deer, fox, bobcat, wood rat, chipmunk, scrub jay, kestrel, turkey, great horned owl, flycatcher, nuthatch, and junco. Areas along the Arizona border provide habitat for a fair number of pronghorn antelope. The habitat for mule deer in this unit is fair in the western part of the survey area but is poor in the areas south and east of Ramah. The area west of Cebollita Mesa provides good winter range for mule deer.

10. Teco-Cabezon

Shallow and deep soils, mainly on mesas and ridges

This map unit is mainly on mesas and ridges in the northwestern part of the survey area. Slope is 1 to 12 percent. The vegetation is grasses, shrubs, and trees. Elevation is 6,600 to 7,100 feet. The average annual precipitation is about 11 to 15 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 110 to 135 days.

This unit makes up about 9.3 percent of the survey area. It is about 40 percent Teco and similar soils, 40 percent Cabezon and similar soils, and 20 percent soils of minor extent.

Teco soils are on mesas. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is light brown fine sandy loam about 6 inches thick. The upper part of the subsoil is reddish brown and brown clay loam about 18 inches thick, and the lower part to a depth of 60 inches is light brown, pink, and reddish yellow clay loam, sandy clay loam, and gravelly sandy loam.

Cabezon soils are on ridges. These soils are shallow and well drained. They formed in windblown sediments and alluvium over basalt. Typically, the surface layer is brown very cobbly loam about 2 inches thick. The subsoil is brown clay about 16 inches thick. Basalt is at a depth of about 18 inches.

Of minor extent in this unit are the shallow Atarque and deep Montecito, Torreon, and Flugle soils on mesas.

This unit is used for livestock grazing, fuel wood production, and wildlife habitat. The main limitations are the stones on the surface and depth to bedrock in areas of the Cabezon soils.

This unit is dominantly grassland. The eroded bottom of some drainageways dominantly supports sagebrush. The area near Ramah provides fair habitat for pronghorn antelope. Characteristic wildlife include black-tailed jackrabbit, prairie dog, ground squirrel, meadowlark, horned lark, marsh hawk, and sage sparrow.

11. Cabezon-Cantina-Millpaw

Shallow and deep soils, mainly on hills and ridges, in valleys between lava ridges, and in other valleys

This map unit is on hills and ridges, in valleys between lava ridges, and in other valleys in the southwestern part of the survey area. Slope is 1 to 10 percent. The vegetation is mainly grasses and trees. Elevation is 6,800 to 7,300 feet. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit makes up about 5.6 percent of the survey area. It is about 35 percent Cabezon and similar soils, 25 percent Cantina and similar soils, 20 percent Millpaw and similar soils, and 20 percent components of minor extent.

Cabezon soils are on hills and ridges. These soils are shallow and well drained. They formed in windblown sediments and alluvium over basalt. Typically, the surface layer is brown very cobbly loam about 2 inches thick. The subsoil is brown clay about 16 inches thick. Basalt is at a depth of about 18 inches.

Cantina soils are on hills and in valleys between lava ridges. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper 29 inches of the subsoil is brown sandy clay and sandy clay loam, and the lower 23 inches is brown sandy clay loam. Basalt is at a depth of about 54 inches.

Millpaw soils are in valleys. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is brown loam about 3 inches thick. The upper 26 inches of the subsoil is dark brown clay loam and clay, the next 12 inches is brown sandy clay loam, and the lower part to a depth of 60 inches is brownish yellow sandy clay loam.

Of minor extent in this unit are the deep, cindery Bandera and Timhus soils on cinder cones, the deep Loarc and Montecito soils on mesas, and Rock outcrop on lava ridges.

This unit is used for livestock grazing, fuel wood production, nonirrigated crops, and wildlife habitat. The main limitations are the depth to bedrock, the rock fragments on and in the Cabezon soils, and the Rock outcrop.

This unit is dominantly grassland that has sizable areas of pinyon and juniper. Some areas are used as nonirrigated cropland. Characteristic wildlife include pronghorn antelope, mule deer, coyote, black-tailed jackrabbit, ground squirrel, marsh hawk, bluebird, crow, and horned lark. The unit provides poor or fair habitat for mule deer.

12. Paguate-Hackroy

Moderately deep and shallow soils, mainly on mesas and plateaus

This map unit is mainly on mesas and plateaus in the northeastern, central, and south-central parts of the survey area. Slope is 1 to 5 percent. The vegetation is mainly grasses, shrubs, and trees. Elevation is 6,400 to 7,000 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 100 to 120 days.

This unit makes up about 2.3 percent of the survey area. It is about 70 percent Paguate and similar soils, 15 percent Hackroy and similar soils, and 15 percent soils of minor extent.

Paguate soils are on mesas and plateaus. These soils are moderately deep and well drained. They formed in alluvium and windblown sediments. Typically, the surface layer is dark brown loam about 3 inches thick. The upper 16 inches of the subsoil is reddish brown clay and clay loam, and the lower 14 inches is pink gravelly clay loam. Unweathered basalt is at a depth of about 33 inches.

Hackroy soils are on mesas and plateaus. These soils are shallow and well drained. They formed in alluvium and windblown sediments. Typically, the surface layer is brown cobbly loam about 3 inches thick. The subsoil is about 11 inches of reddish brown clay loam and clay. Basalt is at a depth of about 14 inches.

Of minor extent in this unit are the deep Catman, Millpaw, and Silkie soils in valleys, the deep Loarc soils on mesas, and the shallow Cabezon soils on ridges.

This unit is used for livestock grazing, fuel wood production, and wildlife habitat. The main limitations are the depth to bedrock, the clayey texture, and the rock fragments on the surface.

This unit generally supports a plant community of pinyon and juniper. Numerous small, seasonal ponds on Cebollita Mesa provide habitat for aquatic wildlife. The La Mesa del Canon Seco, south of Marquez, is an important winter range area for elk. Characteristic wildlife include mule deer, coyote, wood rat, pinyon mouse, porcupine, scrub jay, plain titmouse, shore birds, waterfowl, tiger salamander, toads, and leopard frog.

Dry Soils in Areas of Cuestas, Fan Terraces, Flood Plains, Alluvial Fans, Drainageways, Hills, and Ridges

This group consists of two map units. It makes up about 18 percent of the survey area. The native vegetation is grasses and shrubs. Elevation is 5,400 to 7,000 feet. The annual precipitation is about 7 to 12 inches, the average annual air temperature is 49 to 55 degrees F, and average frost-free period is 115 to 160 days.

The soils in this group formed in alluvial and eolian material. They are used mainly for livestock grazing and wildlife habitat.

13. Penistaja-San Mateo-Sparank

Deep soils, mainly on cuestas, fan terraces, flood plains, and alluvial fans

This map unit is on cuestas, fan terraces, flood plains, and alluvial fans in the north-central and northeastern parts of the survey area. Slope is 1 to 10 percent. The vegetation is mainly grasses and shrubs. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 150 days.

This unit makes up about 11.3 percent of the survey area. It is about 40 percent Penistaja and similar soils, 20 percent San Mateo and similar soils, 20 percent Sparank and similar soils, and 20 percent components of minor extent. Areas near the Socorro County line may have a higher percentage of minor components.

Penistaja soils are on cuestas and fan terraces. These soils are deep and well drained. They formed in wind-modified alluvium derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 2 inches thick. The upper part of the

subsoil is brown and strong brown sandy clay loam about 20 inches thick. The lower part of the subsoil and the substratum to a depth of 60 inches are light brown and reddish brown sandy loam.

San Mateo soils are on flood plains and alluvial fans. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is light yellowish brown loam about 2 inches thick. The underlying material to a depth of 60 inches is light olive brown loam and sandy clay loam.

Sparank soils are on flood plains and alluvial fans. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is light yellowish brown clay loam about 2 inches thick. The underlying material to a depth of 60 inches is light yellowish brown and light olive brown silty clay.

Of minor extent in this unit are the moderately deep Hagerman soils on cuestas; the deep Clovis soils on fan terraces; the deep Aparejo and Venadito soils on flood plains; the deep, somewhat poorly drained Warm Springs soils in old lakebeds; the deep Mespun soils on dunes; and Pits and Dumps on hills and flats.

This unit is used for livestock grazing, irrigated crops, urban development, and wildlife habitat. The main limitations are the hazard of flooding on the San Mateo and Sparank soils and the clayey texture and content of salts in the Sparank soils.

This unit is dominantly grassland that is in poor condition. Shrubs are in drainageways and eroded areas. The downstream reaches of Bluewater Creek and the Rio San Jose traverse the unit and provide degraded aquatic, wetland, and riparian habitat. Springs are in the San Rafael area, which supports emergent wetland vegetation. Areas of nonirrigated and irrigated cropland contribute to the diversity of the habitat in this unit. Characteristic wildlife include black-tailed jackrabbit, pocket gopher, striped skunk, raccoon, prairie dog, meadowlark, swallow, mourning dove, tiger salamander, toads, and garter snake.

14. Navajo-Grieta

Deep soils, mainly on flood plains and alluvial fans, in drainageways, and on fan terraces, hills, and ridges

This map unit is mainly on flood plains and alluvial fans, in drainageways, and on fan terraces, hills, and ridges in the eastern part of the survey area. Slope is 1 to 10 percent. The vegetation is mainly grasses and shrubs. Elevation is 5,400 to 6,000 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

This unit makes up about 6.5 percent of the survey area. It is about 40 percent Navajo and similar soils, 30 percent Grieta and similar soils, and 30 percent components of minor extent. Areas near the Socorro County line may have a higher percentage of minor components.

Navajo soils are on flood plains and alluvial fans and in drainageways. These soils are deep and well drained. They formed in mixed alluvium. Typically, the surface layer is reddish brown silty clay loam about 3 inches thick. The underlying material to a depth of 60 inches is reddish brown silty clay and clay.

Grieta soils are on fan terraces, hills, and ridges. These soils are deep and well drained. They formed in wind-modified, mixed alluvium. Typically, the surface layer is strong brown sandy loam about 3 inches thick. The upper 25 inches of the subsoil is strong brown sandy loam and sandy clay loam, and the lower part to a depth of 60 inches is pink and pinkish white sandy loam.

Of minor extent in this unit are the shallow Mion soils on hills, the gypsiferous Saido soils on fans and knolls, the deep Sheppard soils on dunes, and Rock outcrop on ridges and hills.

This unit is used for livestock grazing and wildlife habitat. The main limitations are the clayey texture of the Navajo soils and the low precipitation.

This unit is dominantly desert grassland that has scattered shrubs along the drainageways. Characteristic wildlife include coyote, black-tailed jackrabbit, scaled quail, mockingbird, curve-billed thrasher, and bullsnake.

Moist Soils, Lava Flows, and Rock Outcrop in Areas of Basalt Plains, Swales, Ridges, Hills, Mesas, Plateaus, and Mountains

This group consists of three map units. It makes up about 8 percent of the survey area. The native vegetation is mainly ponderosa pine, shrubs, and grasses. Elevation is 7,200 to 10,300 feet. The average annual precipitation is about 16 to 24 inches, the average annual air temperature is 42 to 47 degrees F, and the average frost-free period is 80 to 110 days.

The soils in this group formed in alluvial and eolian sediments. They are used mainly for commercial wood products, livestock grazing, and wildlife habitat.

15. Raton-Lava Flows-Charo

Very shallow, shallow, and moderately deep soils and Lava flows, mainly on basalt plains, in swales, and on ridges

This map unit is mainly on basalt plains, in swales, and on ridges in the central part of the survey area. Slope is 1 to 45 percent. The vegetation is mainly trees. Elevation is 7,200 to 8,300 feet. The average annual precipitation is about 16 to 20 inches, the average

annual air temperature is 40 to 46 degrees F, and the average frost-free period is 90 to 110 days.

This unit makes up about 2.8 percent of the survey area. It is about 30 percent Raton and similar soils, 30 percent Lava flows, 25 percent Charo and similar soils, and 15 percent soils of minor extent.

Raton soils are on basalt plains, in swales, and on ridges. These soils are very shallow or shallow and are well drained. They formed in alluvium and eolian sediments derived dominantly from basalt. Typically, the surface layer is dark reddish brown very cobbly loam about 5 inches thick. The subsoil is reddish brown very cobbly clay about 8 inches thick. Unweathered basalt is at a depth of about 13 inches.

Lava flows occur as barren or nearly barren areas of exposed lava. They have very sharp, jagged surfaces. Vegetation generally is limited to cracks and crevasses and included soils.

Charo soils are in swales. These soils are moderately deep and well drained. They formed in mixed alluvium and windblown sediments. Typically, the surface layer is dark brown loam about 5 inches thick. The subsoil is about 23 inches of reddish brown clay loam and clay. Basalt is at a depth of about 28 inches.

Of minor extent in this unit are the deep Bandera soils on cinder hills and the shallow Borrego soils on basalt-capped mesas.

This unit is used for livestock grazing and wood products. The main limitations are the depth to bedrock, the Lava flows, and the windthrow hazard.

This unit generally is forested with ponderosa pine and some oak brush. Characteristic wildlife include mule deer, coyote, porcupine, Steller's jay, Cooper's hawk, screech owl, hairy woodpecker, and chipmunk.

16. Cinnadale-Valnor-Techado

Shallow and moderately deep soils, mainly on ridges, hills, mesas, plateaus, and mountains

This map unit is mainly on ridges, hills, mesas, plateaus, and mountains in the northwestern and south-central parts of the survey area. It is in the foothills of the Zuni Mountains. Slope is 1 to 25 percent. The vegetation is mainly trees, shrubs, and an understory of grasses. Elevation is 7,500 to 8,900 feet. The average annual precipitation is about 18 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 80 to 100 days.

This unit makes up about 2.1 percent of the survey area. It is about 30 percent Cinnadale and similar soils, 25 percent Valnor and similar soils, 20 percent Techado and similar soils, and 25 percent soils of minor extent. Areas near the Catron County line may have a higher percentage of some minor soils.

Cinnadale soils are on ridges and hills. These soils are shallow and well drained. They formed in alluvium and windblown sediments derived dominantly from siltstone and sandstone. Typically, the surface layer is light reddish brown gravelly very fine sandy loam about 4 inches thick. The subsoil is light reddish brown very channery loam about 8 inches thick. Sandstone is at a depth of about 12 inches.

Valnor soils are on hills, mesas, and plateaus. These soils are moderately deep and well drained. They formed in alluvium derived dominantly from interbedded shale and sandstone. Typically, the surface layer is yellowish brown clay loam about 2 inches thick. The upper part of the subsoil is dark yellowish brown and yellowish brown clay about 16 inches thick, and the lower part is light yellowish brown clay about 20 inches thick. Shale is at a depth of about 38 inches.

Techado soils are on hills, ridges, and mountains. These soils are shallow and well drained. They formed in alluvium and colluvium derived dominantly from shale and sandstone. Typically, the surface layer is light olive brown channery clay loam about 3 inches thick. The underlying material is light olive brown clay about 13 inches thick. Soft shale is at a depth of about 16 inches.

Of minor extent in this unit are the moderately deep Abersito soils on hills; the deep Moreno, Moreno Variant, Saladon, and Yankee soils on fan terraces and in valleys; the deep Kenray soils on dunes; the shallow Stout soils on mountains; and the moderately deep Mirabal soils on hills.

This unit is used for livestock grazing, wildlife habitat, and wood products. The main limitations are the depth to bedrock and the slope.

This unit consists mainly of forests and wet meadows. The area east of Oso Ridge is an important winter range area for mule deer. The northern part of the unit provides range for elk. Characteristic wildlife include coyote, porcupine, chipmunk, tree swallow, raven, chickadee, toads, and frogs. The areas of dense forest provide habitat for black bear.

17. Cebolleta-Charo-Rock Outcrop

Moderately deep soils and Rock outcrop, mainly on hills, mountains, and mesas

This map unit is mainly on hills, mountains, and mesas in the northeastern and central parts of the survey area. Slope is 1 to 15 percent. The vegetation is mainly grasses and trees. Elevation is 7,500 to 10,300 feet. The average annual precipitation is about 18 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 80 to 100 days.

This unit makes up about 3.1 percent of the survey

area. It is about 40 percent Cebolleta and similar soils, 25 percent Charo and similar soils, 15 percent Rock outcrop, and 20 percent soils of minor extent.

Cebolleta soils are on hills, mountains, and mesas. These soils are moderately deep and well drained. They formed in windblown sediments and alluvium. Typically, the surface layer is very dark grayish brown very cobbly loam about 10 inches thick. The subsoil is reddish brown and brown very cobbly clay about 15 inches thick. Basalt is at a depth of about 25 inches.

Charo soils are on mesas and hills. These soils are moderately deep and well drained. They formed in windblown sediments and mixed alluvium. Typically, the surface layer is dark brown loam about 5 inches thick. The subsoil is about 23 inches of reddish brown clay loam and clay. Basalt is at a depth of about 28 inches.

Rock outcrop consists of barren or nearly barren areas of exposed igneous rocks on hills and mountains.

Of minor extent in this unit are the shallow Borrego, Raton, and Techado soils on ridges; the moderately deep Microy soils on hills; and the deep Parkay and Trag soils on mountains.

This unit is used for wood products, livestock grazing, and wildlife habitat. The main limitations are the depth to bedrock, the content of rock fragments, and the Rock outcrop.

This unit is dominantly forested. Several small streams provide aquatic and riparian habitat. Parts of the eastern slopes of Mount Taylor and the Negra and Cebolleta Mesas provide important range for mule deer and winter range for elk. Other characteristic wildlife species include wild turkey, blue grouse, rosy finch, black bear, mountain lion, Aberti's squirrel, chipmunk, Clark nutcracker, and Cooper's hawk.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Penistaja fine sandy loam, 1 to 3 percent slopes, is a phase of the Penistaja series.

Some map units are made up of two or more major soils. These map units are called soil complexes or associations.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Bond-Penistaja-Rock outcrop complex, 2 to 15 percent slopes, is an example.

A *soil association* is made up of two or more geographically associated soils that are shown as one unit on the maps. Because of present or anticipated soil uses in the survey area, it was not considered practical or necessary to map the soils separately. The pattern and relative proportion of the soils are somewhat similar. Catman-Silkie association, 1 to 10 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Lava flows is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

This survey area was mapped at two levels of detail. At the most detailed level, map units are narrowly defined. Map unit boundaries were plotted and verified at closely spaced intervals. At the less detailed level, map units are broadly defined. Boundaries were plotted and verified at wider intervals. The detail of mapping was selected to meet the anticipated long-term use of the survey, and the map units were designed to meet the needs for that use.

Table 2 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

10—Lava flows. This map unit is on old lava plains. Areas are irregular in shape and are 100 to 4,000 acres in size. The vegetation, which is anchored in cracks and

crevices, is mainly grasses, shrubs, and trees. Elevation is 6,000 to 7,600 feet. The average annual precipitation is about 10 to 16 inches, the average annual air temperature is 46 to 54 degrees F, and the average frost-free period is 100 to 150 days.

Lava flows consist of areas of exposed basalt. They have sharp, jagged surfaces, crevices, and angular blocks. They support essentially no vegetation, but the amount and kind of vegetation change with elevation and precipitation.

Included in this unit are small areas of sandy soils that are shallow to basalt, Viuda and Bond soils on lava ridges, Penistaja and Hagerman soils in depressions, and Mespun soils on dunes. Included areas make up about 15 percent of the total acreage.

This unit is used mainly for wildlife habitat and recreation. It is not suitable for grazing by livestock because of the extremely rough, broken terrain and the sparse vegetation. The vegetation on the included soils and anchored in the cracks and crevices is dominantly Apacheplume, skunkbush sumac, sideoats grama, little bluestem, and muttongrass. Scattered oneseed juniper and pinyon are at the lower elevations. Areas at the higher elevations support stands of ponderosa pine and scattered Douglas fir and aspen. The understory is dominantly currant, pine dropseed, Arizona fescue, and mountain muhly. The suitability for wood products is extremely limited because of the rough, broken terrain.

20—Penistaja fine sandy loam, 1 to 3 percent slopes. This deep, well drained soil is on fan terraces. It formed in mixed alluvium and eolian material. Areas are irregular in shape and are 20 to 400 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,700 to 6,600 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature 48 to 53 degrees F, and the average frost-free period is 115 to 140 days.

Typically, the surface layer is strong brown and brown fine sandy loam about 6 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 13 inches thick, and the lower part to a depth of 60 inches is brown and strong brown sandy clay loam. The surface layer is sandy clay loam in some areas.

Included in this unit are small areas of Clovis and Mikim soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Penistaja soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazard is soil blowing. Stubble and other crop residue can provide protection against soil blowing in spring. Border, furrow, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops.

This unit is well suited to urban development. It has few limitations. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this unit. Cultivation or applications of herbicide can help to remove competing vegetation. Properly designed and managed windbreaks can reduce the risk of soil blowing.

21—Clovis sandy clay loam, 1 to 3 percent slopes. This deep, well drained soil is on fan terraces. It formed in mixed alluvium and eolian material. Areas are irregular in shape and are 30 to 550 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 5,750 to 5,900 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 125 to 140 days.

Typically, the surface layer is dark yellowish brown sandy clay loam about 8 inches thick. The subsoil to a depth of 60 inches or more is sandy clay loam. The upper part is strong brown, and the lower part is pink. A strongly calcareous layer is at a depth of about 21 inches. The surface layer is sandy loam in some areas.

Included in this unit are small areas of Penistaja and Hagerman soils on fan terraces and Mikim soils on fans. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Clovis soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are soil blowing and a high content of calcium carbonate. Stubble and other crop residue can provide protection against soil blowing in spring. Crops that are sensitive to calcium carbonate should not be grown on this unit. Furrow, border, sprinkler, and corrugation irrigation systems are suitable.

If this unit is used for urban development, the main management concerns are soil blowing and a high content of calcium carbonate. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines,

shade trees, or ornamental trees.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and the high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation. Properly designed and managed windbreaks can reduce the risk of soil blowing. Species that are sensitive to large amounts of calcium carbonate should not be selected for planting.

25—Hickman-Catman complex, 1 to 6 percent slopes. This map unit is in valleys and swales and on alluvial fans. Areas are irregular in shape and are 50 to 1,000 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,500 to 7,500 feet. The average annual precipitation is about 12 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 115 to 135 days.

This unit is 45 percent Hickman loam, 2 to 6 percent slopes, and 40 percent Catman silty clay loam, 1 to 3 percent slopes. The Hickman soil is in valleys and on alluvial fans, and the Catman soil is on valley bottoms and in swales. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in some areas near the boundary of Apache County, Arizona, have a higher content of silt.

Included in this unit are small areas of Silkie and Flugle soils on valley sides, Vessilla and Mion soils on hills, and Goesling soils on fan terraces. Included areas make up about 15 percent of the total acreage.

The Hickman soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is pale brown loam about 4 inches thick. The underlying material to a depth of 60 inches is brown and light yellowish brown clay loam, sandy clay loam, loam, and sandy loam.

Permeability is moderately slow in the Hickman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. This soil is occasionally flooded for very brief periods in summer.

The Catman soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is dark grayish brown silty clay loam about 4 inches thick. The subsurface layer is grayish brown silty clay loam about 4 inches thick. The underlying material to a depth of 60 inches is brown clay.

Permeability is very slow in the Catman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. This soil is slightly saline. It often has cracks in the upper 25 inches. It is occasionally flooded for long periods in summer.

This unit is used for livestock grazing. The potential natural plant community on the Hickman soil is mainly western wheatgrass, alkali sacaton, blue grama, and winterfat. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. The average annual production of air-dry vegetation ranges from 3,000 pounds per acre in favorable years to 1,200 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, alkali sacaton, spike muhly, and winterfat decrease in abundance and blue grama, galleta, broom snakeweed, and rabbitbrush increase. The increasers generally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, alkali sacaton, Indian ricegrass, and winterfat. The Hickman soil is suited to such management practices as fencing, livestock pipelines, and range seeding. It is not suitable as a site for livestock ponds because of seepage.

The potential natural plant community on the Catman soil is mainly western wheatgrass, spike muhly, alkali sacaton, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 1,250 pounds in unfavorable years. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. If the plant community deteriorates, western wheatgrass, alkali sacaton, and spike muhly decrease in abundance and blue grama, galleta, ring muhly, rabbitbrush, and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community.

Properly managing livestock grazing can protect the Catman soil against water erosion. Deterioration of the plant community on this soil often results in the formation of very deep gullies that drain the site and hinder the production of vegetation. After very deep gullies have artificially drained the site, a combination of grazing management and engineering practices may be required to return the site to its productive potential.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, spike muhly, and alkali sacaton. The Catman soil is suited to such management practices as fencing, livestock pipelines, livestock ponds, and range seeding.

Good management is needed to protect the soils in this unit against excessive water erosion. If the plant

cover is disturbed, treatment is needed to control sheet erosion and gullying.

30—Warm Springs loam, 0 to 2 percent slopes. This deep, somewhat poorly drained soil is in old lakebeds and on flood plains. It formed in mixed alluvium and lacustrine material. Areas are irregular in shape and are 75 to 200 acres in size. The native vegetation is mainly scattered grasses and forbs. Elevation is 6,300 to 6,600 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 135 days.

Typically, the surface layer is brown and dark gray loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is light brownish gray gravelly sandy loam, the next part is very pale brown and light brownish gray loam, and the lower part is light brownish gray sandy loam. In some areas the soil is clay loam throughout.

Included in this unit are small areas of Aparejo, Sparank, and Venadito soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Warm Springs soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. A seasonal high water table fluctuates between depths of 12 and 30 inches during the year. It reaches its highest level during the period April through July. This soil is slightly saline. The sodium absorption ratio is more than 13. The soil is frequently flooded for brief periods late in summer.

This unit generally is used for livestock grazing. In areas near San Rafael, it is used for urban development.

The potential natural plant community on this unit is mainly inland saltgrass, alkali sacaton, fourwing saltbush, and iodinebush. The average annual production of air-dry vegetation ranges from 2,000 pounds per acre in favorable years to 1,200 pounds in unfavorable years. If the plant community deteriorates, alkali sacaton and fourwing saltbush decrease in abundance and inland saltgrass and iodinebush increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as fencing and range seeding. Good grazing management can increase the productivity and reproduction potential of alkali sacaton. Loss of the surface layer results in a severe decrease in productivity and in the potential of the soil to produce plants suitable for grazing. The main management concerns are the content of salts, depth to the water table, and the hazards of flooding and soil blowing.

If this unit is used for urban development, the main management concerns are the content of salts, depth to the water table, and the hazards of soil blowing and flooding. Plants that can tolerate the seasonal high water table, the salts, and droughtiness should be selected unless drainage and irrigation systems are installed. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The selection of suitable trees and shrubs for windbreaks and environmental plantings is limited. The high water table, a high pH, and the content of salts affect the selection and growth of species. Seedling mortality may be severe because of the wetness. Cultivation or applications of herbicide can help to remove competing vegetation. Spring planting may be delayed because of the excessive moisture.

40—Aparejo clay loam, 0 to 1 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 200 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,200 to 6,600 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is reddish brown clay loam about 6 inches thick. The upper part of the underlying material is reddish brown and light reddish brown clay loam about 41 inches thick, and the lower part to a depth of 60 inches or more is light reddish brown clay loam. In some areas the soil is sandy below a depth of 40 inches.

Included in this unit are small areas of Glenberg and San Mateo soils on flood plains and alluvial fans and the saline Aparejo soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Aparejo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. Thin strata of coarser textured material are throughout the profile. This soil is occasionally flooded for very brief periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazards are flooding and soil blowing. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted

crops. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main hazards are soil blowing and flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

41—Aparejo clay loam, sandy substratum, 0 to 1 percent slopes. This deep, well drained soil is on alluvial fans and flood plains. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 150 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,200 to 6,600 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is reddish brown clay loam about 6 inches thick. The upper 18 inches of the underlying material is reddish brown clay loam, the next 8 inches is light reddish brown sandy clay loam, and the lower part to a depth of 60 inches is light yellowish brown fine sand that has some thin strata of clay loam. In some areas the lower part of the underlying material is not sandy.

Included in this unit are small areas of Venadito and Glenberg soils on alluvial fans and flood plains and the saline Aparejo soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Aparejo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazards are soil blowing and flooding. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main hazards are soil blowing and flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

45—Aparejo clay, 0 to 1 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 50 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,200 to 6,600 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is reddish brown clay about 3 inches thick. The subsurface layer also is reddish brown clay. It is about 12 inches thick. The underlying material is yellowish brown. The upper 23 inches is sandy clay loam, and the lower part to a depth of 60 inches is dominantly sandy clay loam but includes some fine sandy loam. In some areas the surface layer is clay loam.

Included in this unit are small areas of Venadito and Glenberg soils on flood plains and alluvial fans and the saline Aparejo soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Aparejo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazards of soil blowing and flooding and the clayey surface layer. Furrow, border, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops (fig. 5), but it generally is best suited to small grain and pasture. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of soil blowing and flooding, the clayey surface layer, and a high

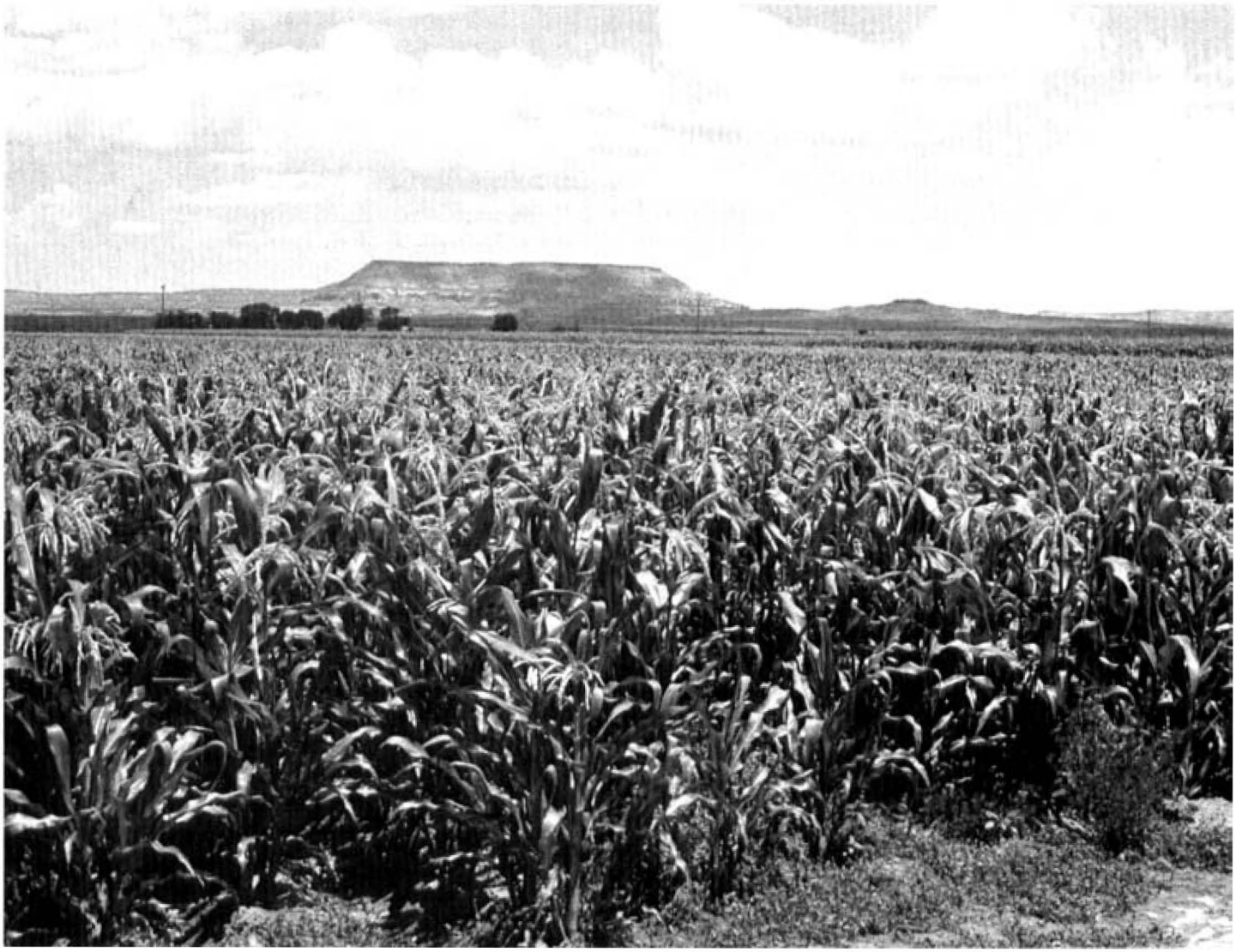

Figure 5.—Irrigated corn in an area of Aparejo clay, 0 to 1 percent slopes. Haystack Mountain, in the background, is the site of the first uranium mine in the Grants-Milan area.

shrink-swell potential. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

50—Venadito clay loam, 0 to 1 percent slopes. This deep, well drained soil is on alluvial fans and flood plains and in valleys. It formed in alluvium derived dominantly from shale. Areas are irregular in shape and are 5 to 150 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,200 to 6,800 feet. The average annual precipitation is about 10 to 13 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is reddish brown clay loam about 3 inches thick. The upper part of the underlying material is reddish brown clay loam about 11 inches thick, and the lower part to a depth of 60 inches

is reddish brown and dark reddish brown clay. In some areas the surface layer is sandy clay loam.

Included in this unit are small areas of Aparejo soils on alluvial fans, in valleys, and on flood plains; Glenberg soils on flood plains; and the saline Venadito soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Venadito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil has a high shrink-swell potential. Unless protected, it is occasionally flooded for very brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazards of soil blowing and flooding, the clayey texture, and the high shrink-swell potential. Furrow, border, and corrugation irrigation systems are suitable. The unit generally is best suited to small grain and pasture. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of soil blowing and flooding, the clayey texture, and the high shrink-swell potential. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is high because of the high content of clay, which causes moisture stress in the seedlings. Extra care is needed during planting to ensure that the soil is firmly packed around the roots. Cultivation or applications of herbicide can help to remove competing vegetation.

51—Venadito sandy clay loam, 0 to 1 percent slopes. This deep, well drained soil is on alluvial fans, in valleys, and on flood plains. It formed in alluvium derived dominantly from shale. Areas are irregular in shape and are 5 to 80 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,200 to 6,800 feet. The average annual precipitation is about 10 to 13 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is pale brown sandy clay loam about 6 inches thick. The upper part of the underlying material is pale brown clay loam about 13 inches thick, and the lower part to a depth of 60 inches is reddish brown clay. In some areas the surface layer is clay loam.

Included in this unit are small areas of Aparejo soils on flood plains, in valleys, and on alluvial fans and Glenberg soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Venadito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazards of flooding and soil blowing, the clayey texture, and a high shrink-swell potential. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops, but it generally is best suited to small grain and pasture. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of flooding and soil blowing, the clayey texture, and a high shrink-swell potential. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is high because of the high content of clay, which causes moisture stress in the seedlings. Extra care is needed during planting to ensure that the soil is firmly packed around the roots. Cultivation or applications of herbicide can help to remove competing vegetation.

52—Venadito Variant clay loam, 0 to 1 percent slopes. This moderately deep, well drained soil is in valleys and on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 50 acres in size. The native vegetation is mainly

grasses and forbs. Elevation is 6,200 to 6,600 feet. The average annual precipitation is about 10 to 13 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is reddish brown clay loam about 3 inches thick. The upper part of the underlying material is reddish brown clay about 15 inches thick, and the lower part is dark brown clay about 17 inches thick. Basalt is at a depth of about 35 inches.

Included in this unit are small areas of soils that are similar to the Venadito Variant soil but have bedrock within a depth of 20 inches, soils that are similar to Aparejo soils but are moderately deep, and Aparejo soils on flood plains and alluvial fans and in valleys. Included areas make up about 20 percent of the total acreage.

Permeability is very slow in the Venadito Variant soil. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil has a high shrink-swell potential. Unless protected, it is occasionally flooded for very brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazards of flooding and soil blowing, the clayey texture, the high shrink-swell potential, and the depth to bedrock. Furrow, border, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops, but it is best suited to small grain and pasture. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of flooding and soil blowing, the clayey texture, the high shrink-swell potential, and the depth to bedrock. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

55—Glenberg-San Mateo complex, 0 to 2 percent slopes. This map unit is on alluvial fans and flood plains. Areas are irregular in shape and are 3 to 200 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,200 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

This unit is 45 percent Glenberg sandy loam, 0 to 2 percent slopes, and 35 percent San Mateo sandy clay loam, 0 to 2 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Aparejo soils on alluvial fans and flood plains, Venadito soils on flood plains, and Mespun soils on small dunes. Also included, on alluvial fans, are soils that are similar to the Glenberg and San Mateo soils but are saline. Included areas make up about 20 percent of the total acreage.

The Glenberg soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is light yellowish brown sandy loam about 11 inches thick. The upper part of the underlying material is light yellowish brown sandy loam about 10 inches thick, and the lower part to a depth of 60 inches is dominantly sandy loam but has strata of loam to loamy sand. In some areas clay is at a depth of about 48 to 60 inches.

Permeability is moderately rapid in the Glenberg soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer.

The San Mateo soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown sandy clay loam about 4 inches thick. The upper 12 inches of the underlying material is brown sandy clay loam. The next 17 inches is pale brown silty clay loam. The lower part to a depth of 60 inches is dominantly pale brown silty clay loam, but it has strata ranging from loam to silty clay loam.

Permeability is moderate in the San Mateo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer.

Most areas of this unit are used for irrigated crops. A few areas are used for urban development.

If this unit is used for irrigated crops, the main management concerns are the hazards of soil blowing and flooding. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of flooding and

soil blowing and the sandy texture. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

56—Mespun loamy sand, 1 to 5 percent slopes. This deep, excessively drained soil is on dunes. It formed in eolian material derived dominantly from sandstone. Areas are irregular in shape and are 15 to 150 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,500 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 135 days.

Typically, the surface layer is yellowish brown loamy sand about 2 inches thick. The underlying material to a depth of 60 inches is strong brown loamy fine sand and fine sand. In some areas the soil has thin strata of sandy loam at a depth of more than 40 inches.

Included in this unit are small areas of Palma soils between dunes, Aparejo and Glenberg soils in swales, and Penistaja soils on fan terraces. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Mespun soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for urban development. It is suited to urban uses. The main management concerns are the sandy texture and the hazard of soil blowing. Excavation for houses and access roads can expose material that is highly susceptible to soil blowing. Properly designed and managed windbreaks can reduce the risk of soil blowing. Cutbanks are not stable and therefore are subject to slumping. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is moderate because of the low available water capacity, which causes moisture stress in the seedlings. Soil blowing is the main hazard on this unit. Unless the young seedlings are protected during high winds, they can be damaged by sand blasting or covered by drifting sand. Soil blowing can be controlled by maintaining strips of native vegetation between the rows of trees and shrubs. Undesirable grasses and weeds can be controlled by applying herbicides or by rototilling or hoeing.

57—San Mateo clay loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 100 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is light brownish gray clay loam about 6 inches thick. The upper part of the underlying material is light brownish gray clay loam about 16 inches thick, and the lower part to a depth of 60 inches is brown sandy clay loam. In some areas the surface layer is sandy clay loam, and in other areas the slope is less than 1 percent.

Included in this unit are small areas of Sparank soils on flood plains, Glenberg soils on flood plains and alluvial fans, and the saline San Mateo soils on alluvial fans. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the San Mateo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazards are soil blowing and flooding. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main hazards are flooding and soil blowing. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium

carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

58—San Mateo sandy clay loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 150 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 110 to 140 days.

Typically, the surface layer is light olive brown sandy clay loam about 4 inches thick. The upper part of the underlying material is light yellowish brown sandy clay loam about 43 inches thick, and the lower part to a depth of 60 inches is light yellowish brown clay loam. In some areas the surface layer is clay loam, and in other areas the slope is less than 1 percent.

Included in this unit are small areas of Sparank soils on flood plains. Also included, on alluvial fans, are small areas of the saline San Mateo soils and small areas of Glenberg soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the San Mateo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate. This soil is occasionally flooded for very brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazards are soil blowing and flooding. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. The unit is suited to all climatically adapted crops. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main hazards are flooding and soil blowing. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

60—Sparank clay loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 10 to 100 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 5,800 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is light brownish gray clay loam about 10 inches thick. The upper part of the underlying material is light brownish gray silty clay about 22 inches thick, and the lower part to a depth of 60 inches is pale brown silty clay. In some areas the surface layer is sandy clay.

Included in this unit are small areas of San Mateo soils on flood plains and alluvial fans and the saline, wet, and sodic Sparank and San Mateo soils on flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Sparank soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. This soil is occasionally flooded for brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the clayey texture and the hazards of flooding and soil blowing. Furrow, border, sprinkler, and corrugation irrigation systems are suitable. Generally, the unit is best suited to small grain and pasture. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the hazards of flooding and soil blowing, the clayey texture, and a high shrink-swell potential. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is high because of the high content of clay, which causes moisture stress in the seedlings. Extra care is needed during planting to ensure that the soil is firmly packed

around the roots. Cultivation or applications of herbicide can help to remove competing vegetation.

61—Sparham clay loam, 0 to 2 percent slopes. This deep, somewhat poorly drained soil is on flood plains. It formed in mixed alluvium. Areas are irregular in shape and are 10 to 90 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,200 to 6,600 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 120 to 140 days.

Typically, the surface layer is grayish brown clay loam about 10 inches thick. The upper part of the underlying material is pale brown silty clay about 34 inches thick, and the lower part to a depth of 60 inches is light olive brown clay.

Included in this unit are small areas of San Mateo and Sparank soils on flood plains and soils that are similar to the Sparham soil but have a water table at a depth of less than 36 inches. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Sparham soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. A seasonal high water table fluctuates between depths of 36 and 48 inches during the period April through September. The soil is moderately saline. It is occasionally flooded for brief periods in summer.

This unit is used for irrigated pasture and urban development.

If this unit is used for irrigated pasture, the main management concerns are the clayey texture, the fluctuating water table, and the hazards of flooding and soil blowing. Furrow, border, sprinkler, and corrugation irrigation systems are suitable.

If this unit is used for irrigated crops, salinity limits the choice of crops. The unit generally is suited to small grain. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

If this unit is used for urban development, the main management concerns are the clayey texture, the fluctuating water table, a high shrink-swell potential, a high content of salts, and the hazards of flooding and soil blowing. In summer, irrigation is needed in areas used for lawn grasses. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks. Properly designing buildings and roads can reduce the damaging effects of wetness and of the shrinking and swelling caused by the clayey texture.

This unit generally is unsuitable for windbreaks and environmental plantings. In some areas trees and shrubs can be grown if special treatment is applied.

62—Sparank sandy clay loam, saline, sodic, 1 to 3 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 10 to 100 acres in size. The native vegetation is mainly grasses. Elevation is 6,200 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is light brownish gray sandy clay loam about 5 inches thick. The underlying material to a depth of 60 inches is light yellowish brown and grayish brown clay. In some areas the surface layer is clay loam or silty clay.

Included in this unit are small areas of San Mateo soils on flood plains and fans and Mikim soils on fans. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Sparank soil. Available water capacity is very low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is severe. The hazard of soil blowing is moderate. The soil is strongly saline. The sodium absorption ratio is more than 13. The soil commonly is eroded and gullied. Where it is not gullied, it is occasionally flooded for brief periods in summer.

This unit is used for livestock grazing. The potential natural plant community is mainly alkali sacaton, fourwing saltbush, blue grama, black greasewood, inland saltgrass, and western wheatgrass. The average annual production of air-dry vegetation ranges from 1,500 pounds per acre in favorable years to 550 pounds in unfavorable years. If the plant community deteriorates, alkali sacaton, western wheatgrass, and blue grama decrease in abundance and black greasewood and inland saltgrass increase. The increasers generally occur in small amounts in the potential natural plant community. The unit is suitable as a site for livestock ponds. Good grazing management can increase the productivity and reproduction potential of alkali sacaton.

This unit generally is unsuitable for windbreaks and environmental plantings. In some areas trees and shrubs can be grown if special treatment is applied.

66—Zia fine sandy loam, 3 to 5 percent slopes. This deep, well drained soil is fan terraces and valley sides. It formed in wind-modified alluvium derived dominantly from sandstone. Areas are irregular in shape and are 10 to 50 acres in size. The native vegetation is mainly grasses. Elevation is 6,000 to

6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 120 to 140 days.

Typically, the surface layer is dark yellowish brown fine sandy loam about 8 inches thick. The upper part of the underlying material is brown fine sandy loam about 39 inches thick, and the lower part to a depth of 60 inches is yellow fine sandy loam.

Included in this unit are small areas of San Mateo soils on flood plains and alluvial fans; Mikim soils on fan terraces; Sparank soils on flood plains, in valleys, and on alluvial fans; and Penistaja soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Zia soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for urban development and irrigated crops.

If this unit is used for irrigated crops, the main hazard is soil blowing. Furrow and sprinkler irrigation systems are suitable. The unit is suited to all climatically adapted crops. Stubble and other crop residue can provide protection against soil blowing in spring.

This unit is suited to urban development. The main management concerns are the hazard of soil blowing and the sandy texture. Excavation for houses and access roads can expose material that is highly susceptible to soil blowing. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Properly designed and managed windbreaks can reduce the risk of soil blowing.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. Soil blowing is the main hazard. During periods of high winds, young seedlings can damaged by sand blasting and covered with drifting sand unless they are protected. Soil blowing can be controlled by maintaining strips of native vegetation between the plantings. Undesirable grasses and weeds can be controlled by applying herbicides or by rototilling or hoeing.

70—Catman clay loam, 1 to 3 percent slopes. This deep, well drained soil is on alluvial fans and flood plains and in valleys. It formed in mixed alluvium. Areas are irregular in shape and are 25 to 200 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,800 to 7,000 feet. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is dark brown clay loam about 6 inches thick. The upper part of the underlying material is dark brown clay about 35 inches thick, and the lower part to a depth of 60 inches is dark yellowish brown clay. In some areas the surface layer is sandy clay loam.

Included in this unit are small areas of Hickman soils on alluvial fans and flood plains, Catman Variant soils on valley bottoms and flood plains, and the saline Catman soils on alluvial fans and valley sides. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Catman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. The soil has very pronounced vertical cracks as a result of shrinking and swelling. It is slightly saline. It is occasionally flooded for long periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the clayey texture, a high shrink-swell potential, and the hazard of flooding. Graded or level border irrigation systems are suitable. The unit generally is best suited to small grain and pasture. Major flood-control structures are needed.

If this unit is used for urban development, the main management concerns are a high shrink-swell potential, the clayey texture, and the hazard of flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is high because of the content of clay, which causes moisture stress in the seedlings. Extra care is needed during planting to ensure that the soil is firmly packed around the roots. Cultivation or applications of herbicide can help to remove competing vegetation. Drip irrigation can help to establish windbreaks.

72—Catman Variant clay loam, 1 to 3 percent slopes. This deep, somewhat poorly drained soil is on alluvial fans and flood plains and in valleys. It formed in mixed alluvium. Areas are irregular in shape and are 25 to 200 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,800 to 6,900 feet. The

average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is dark brown clay loam about 10 inches thick. The upper part of the underlying material is brown clay about 23 inches thick, and the lower part to a depth of 60 inches is yellowish brown clay.

Included in this unit are small areas of Catman soils on alluvial fans, in valleys, and on flood plains and Hickman soils on alluvial fans and flood plains. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Catman Variant soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. A seasonal high water table generally fluctuates between depths of 24 and 40 inches. It occasionally rises to as high as 15 inches sometime during the period April through September. The soil is occasionally flooded for brief periods in summer. It is moderately saline.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazard of flooding, a high shrink-swell potential, a high content of salts, and the fluctuating water table. Graded or level border irrigation systems are suitable. Salinity, the fluctuating water table, and the clayey texture limit the choice of crops. The unit generally is best suited to small grain and pasture. Major flood-control structures are needed.

If this unit is used for urban development, the main management concerns are the hazard of flooding, a high shrink-swell potential, the fluctuating water table, a high content of salts, and the clayey texture. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Properly designing buildings and roads can reduce the damaging effects of wetness, salinity, and shrinking and swelling.

This unit generally is unsuitable as a site for windbreaks and environmental plantings. In some areas trees and shrubs can be grown if special treatment is applied.

73—Catman sandy clay loam, 1 to 3 percent slopes. This deep, well drained soil is on alluvial fans, in valleys, and on flood plains. It formed in mixed alluvium. Areas are irregular in shape and are 20 to 100 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,800 to 7,000 feet. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is light olive brown sandy clay loam about 6 inches thick. The upper part of the underlying material is light olive brown sandy clay loam about 4 inches thick, and the lower part to a depth of 60 inches is light olive brown clay. In some areas the surface layer is clay loam.

Included in this unit are small areas of Hickman soils on flood plains and alluvial fans and the saline Catman soils on alluvial fans and valley sides. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Catman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. The soil is slightly saline. It is occasionally flooded for long periods in summer unless it is protected.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main management concerns are the hazard of flooding, a high shrink-swell potential, and the clayey texture. Graded border and sprinkler irrigation systems are suitable. The unit is suited to all climatically adapted crops, but it generally is best suited to small grain and pasture. Major flood-control structures are needed. Stubble and other crop residue can improve tilth.

If this unit is used for urban development, the main management concerns are a high shrink-swell potential, the clayey texture, and the hazard of flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Properly designing buildings and roads can reduce the damaging effects of the shrinking and swelling caused by the clayey texture.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. The seedling mortality rate is high because of the high content of clay, which causes moisture stress in the seedlings. Extra care is needed during planting to ensure that the soil is firmly packed around the roots. Cultivation or applications of herbicide can help to remove competing vegetation. Drip irrigation can help to establish windbreaks.

75—Hickman sandy clay loam, 1 to 3 percent slopes. This deep, well drained soil is on flood plains and alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 5 to 150 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,800 to 7,000 feet. The average annual precipitation

is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is light olive brown sandy clay loam about 6 inches thick. The underlying material to a depth of 60 inches is stratified, light olive brown and light yellowish brown sandy clay loam, clay loam, sandy loam, and silty clay loam. In some areas the surface layer is clay loam.

Included in this unit are small areas of Catman and Catman Variant soils. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Hickman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. The soil is occasionally flooded for very brief periods in summer.

This unit is used for irrigated crops and urban development.

If this unit is used for irrigated crops, the main hazard is flooding. Graded border and sprinkler irrigation systems are suitable. The unit is suited to all climatically adapted crops, but it generally is best suited to small grain and pasture. Major flood-control structures are needed.

If this unit is used for urban development, the main hazard is flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of alkalinity and a high content of calcium carbonate, which ties up minerals and limits their availability. Cultivation or applications of herbicide can help to remove competing vegetation.

100—Manzano loam, 1 to 5 percent slopes. This deep, well drained soil is on alluvial fans. It formed in mixed alluvium. Areas are irregular in shape and are 10 to 100 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,500 to 7,300 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 135 days.

Typically, the surface layer is brown loam about 4 inches thick. The upper part of the subsoil is brown silt loam about 18 inches thick, and the lower part to a depth of 60 inches is brown and dark yellowish brown loam and clay loam.

Included in this unit are small areas of Aparejo and Venadito soils along drainageways, Millpaw soils in swales, and Teco, Flugle, and Goesling soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Manzano soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe. The soil is occasionally flooded for very brief periods late in spring and in summer.

This unit is used for livestock grazing and urban development.

The potential natural plant community on this unit is mainly blue grama, western wheatgrass, New Mexico feathergrass, and spike muhly. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and spike muhly decrease in abundance and blue grama increases. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as livestock pipelines, range seeding, and brush control. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and New Mexico feathergrass.

If this unit is used for urban development, the main hazards are soil blowing and flooding. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Major flood-control structures are needed. Soil blowing can be controlled by maintaining a good plant cover and establishing windbreaks.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on this unit. Cultivation or applications of herbicide can help to remove competing vegetation.

120—Rock outcrop-Laporte complex, 30 to 60 percent slopes. This map unit is on hills, ridges, and ledges. Areas are irregular in shape and are 100 to 1,500 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 6,650 to 7,500 feet. The average annual precipitation is about 12 to 15 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 110 to 135 days.

This unit is 50 percent Rock outcrop and 35 percent Laporte very cobbly loam, 30 to 60 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of soils that are similar to the Laporte soil but are very cobbly in the subsoil or are moderately deep and small areas of

Atarque, Mion, and Celacy soils on hills. Included areas make up about 15 percent of the total acreage.

The Rock outcrop consists of barren or nearly barren areas of limestone on the upper part of hills and ridges.

The Laporte soil is shallow and well drained. It formed in mixed colluvium and windblown sediments over limestone. Typically, the surface layer is dark yellowish brown very cobbly loam about 2 inches thick. The underlying material is yellowish brown cobbly loam about 9 inches thick. Limestone is at a depth of about 11 inches. In some areas the slope is less than 30 percent.

Permeability is moderate in the Laporte soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

This unit is used for livestock grazing and fuel wood production.

The site index for trees on the Laporte soil ranges from 32 to 42. Based on a site index of 36, the soil can produce 4 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The understory vegetation is blue grama, pine dropseed, and four o'clock.

Good management is needed to protect the Laporte soil against excessive water erosion. The soil is not suitable as a site for livestock pipelines and ponds because of the depth to bedrock and the slope.

130—Laporte-Rock outcrop complex, 3 to 20 percent slopes. This map unit is on ridges and hills. Areas are irregular in shape and are 100 to 2,000 acres in size. The native vegetation is mainly pinyon, juniper, and shrubs. Elevation is 6,800 to 7,500 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 110 to 135 days.

This unit is 55 percent Laporte gravelly loam, 3 to 20 percent slopes, and 30 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of soils that are similar to the Laporte soil but are very cobbly in the subsoil or are moderately deep over limestone, Celacy and Flugle soils on hills, and Winona and Mion soils. Included areas make up about 15 percent of the total acreage.

The Laporte soil is shallow and well drained. It formed in mixed colluvium and windblown sediments over limestone. Typically, the surface layer is dark brown gravelly loam about 3 inches thick. The underlying material is dark grayish brown gravelly loam about 8 inches thick. Limestone is at a depth of about 11 inches.

Permeability is moderate in the Laporte soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Rock outcrop consists of barren or nearly barren areas of exposed limestone on hills and ridges.

This unit is used for livestock grazing and fuel wood production.

The site index for trees on the Laporte soil ranges from 35 to 45. Based on a site index of 40, the soil can produce 5 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The understory vegetation is blue grama, pine dropseed, and four o'clock. As the density of the canopy increases, the abundance of the understory decreases.

Good management is needed to protect the Laporte soil against excessive water erosion. The soil is not suitable as a site for livestock pipelines and ponds because of the depth to bedrock.

200—Penistaja fine sandy loam, 2 to 10 percent slopes. This deep, well drained soil is on the dip slopes of cuestas and on fan terraces and valley sides. It formed in wind-modified alluvium derived dominantly from sandstone. Areas are irregular in shape and are 60 to 1,200 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 115 to 140 days.

Typically, the surface layer is brown fine sandy loam about 2 inches thick. The upper part of the subsoil is brown and strong brown sandy clay loam about 20 inches thick. The lower part of the subsoil and the substratum to a depth of 60 inches are light brown and reddish yellow sandy loam. In some areas near the boundary of Catron County, the subsoil has a higher content of clay. In some areas near the boundary of Socorro County, the soil has a higher content of calcium carbonate and coarse fragments. In some areas near the boundary of Bernalillo County, it is shallow over sandstone.

Included in this unit are small areas of Hagerman and Bond soils on the upper dip slopes of cuestas and on ridgetops, Poley soils on benches, Palma and Mespun soils on hillsides, and Mikim soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Penistaja soil.

Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community is mainly blue grama, western wheatgrass, fourwing saltbush, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and Indian ricegrass decrease in abundance and blue grama, ring muhly, and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community. Pinyon and oneseed juniper may invade.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, spike muhly, and sideoats grama. Properly managing livestock grazing and maintaining enough plant residue on the surface can help to protect the soil against soil blowing.

This unit is suited to such management practices as livestock pipelines, fencing, and range seeding. It is not suitable as a site for livestock ponds because of seepage.

205—Ildefonso very gravelly sandy loam, 3 to 15 percent slopes. This deep, well drained soil is on ridges and fan terraces. It formed in mixed alluvium. Areas are elongated and are 20 to 100 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,900 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is brown very gravelly sandy loam about 3 inches thick. The upper part of the subsoil is light brown very gravelly loam about 5 inches thick, and the lower part to a depth of 60 inches is light brown and pink very gravelly loam. A strongly calcareous layer is at a depth of 20 inches or less.

Included in this unit are small areas of Harvey soils on ridges, Penistaja soils on fan terraces, and Manzano soils on fans. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Ildefonso soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing. The potential natural plant community is mainly blue grama, little bluestem, black grama, and winterfat. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 350 pounds in unfavorable years. If the plant community deteriorates, black grama and winterfat decrease in abundance and blue grama and threeawn increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is limited as a site for livestock ponds because of seepage. Good grazing management can increase the productivity and reproduction potential of winterfat and black grama.

210—Bond-Penistaja-Rock outcrop complex, 2 to 15 percent slopes. This map unit is on valley sides, hills, ridges, and cuestas. Areas are irregular in shape and are 50 to 450 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 115 to 140 days.

This unit is about 45 percent Bond sandy loam, 2 to 15 percent slopes; 25 percent Penistaja sandy loam, 2 to 10 percent slopes; and 20 percent Rock outcrop. The Bond soil is on hills and ridgetops and on cuestas near areas of Rock outcrop. The Penistaja soil is on valley sides, ridges, and cuestas. The Rock outcrop is on escarpments and hills. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Poley soils on benches, Skyvillage soils on hills and ridgetops, Mikim and Mion soils on fan terraces, and Hagerman soils on hills. Included areas make up about 10 percent of the total acreage.

The Bond soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is brown sandy loam about 3 inches thick. The next layer is brown sandy loam about 4 inches thick. The subsoil is reddish brown sandy clay loam about 6 inches thick. The substratum is light brown sandy clay loam about 3 inches thick. Sandstone is at a depth of about 16 inches.

Permeability is moderate in the Bond soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Penistaja soil formed in wind-modified alluvium derived dominantly from sandstone. Typically, the surface layer is reddish brown sandy loam about 3 inches thick. The upper part of the subsoil is reddish brown sandy clay loam about 27 inches thick. The lower part of the subsoil and the substratum to a depth of 60

inches are light reddish brown and reddish brown sandy loam.

Permeability is moderate in the Penistaja soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone on hills, ridges, and escarpments.

This unit is used for livestock grazing. The potential natural plant community on the Bond soil is mainly sideoats grama, New Mexico feathergrass, Indian ricegrass, blue grama, and scattered oneseed juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, New Mexico feathergrass, and Indian ricegrass decrease in abundance and blue grama, broom snakeweed, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The suitability of the Bond soil for such management practices as livestock pipelines, range seeding, and fencing is limited because of the depth to bedrock and the available water capacity. The soil is suited to such practices as deferred grazing and rotation grazing. Good grazing management can increase the productivity and reproduction potential of sideoats grama and New Mexico feathergrass.

The potential natural plant community on the Penistaja soil is mainly blue grama, western wheatgrass, fourwing saltbush, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and Indian ricegrass decrease in abundance and blue grama, ring muhly, sand dropseed, pinyon, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The Penistaja soil is suited to such management practices as livestock pipelines, fencing, and range seeding. It is not suitable as a site for livestock ponds because of seepage. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and Indian ricegrass.

Properly managing livestock grazing and maintaining enough plant residue on the surface can help to protect the soils against soil blowing.

218—Viuda-Penistaja-Rock outcrop complex, 1 to 10 percent slopes. This map unit is on hills and ridges and in valleys between lava ridges. Areas are irregular in shape and are 2,000 to 5,000 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 6,500 to 7,000 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 49 to 52 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 40 percent Viuda very cobbly sandy loam, 2 to 10 percent slopes, very stony; 35 percent Penistaja sandy loam, 1 to 5 percent slopes; and 15 percent Rock outcrop. The Viuda soil and Rock outcrop are on hills and ridges, and the Penistaja soil is in valleys between lava ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Sparank and San Mateo soils on the bottom of valleys between lava ridges; deep, fine textured soils in valleys between lava ridges; and Hagerman and Bond soils on ridges. Included areas make up about 10 percent of the total acreage.

The Viuda soil is shallow and well drained. It formed in alluvium and windblown sediments over basalt. Typically, the surface layer is brown very cobbly sandy loam about 3 inches thick. The upper part of the subsoil is brown clay about 13 inches thick, and the lower part is light brown cobbly clay loam about 3 inches thick. Basalt is at a depth of about 19 inches.

Permeability is slow in the Viuda soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Penistaja soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper part of the subsoil is dark yellowish brown sandy clay loam about 22 inches thick. The lower part of the subsoil and the substratum to a depth of 60 inches are yellowish brown sandy loam.

Permeability is moderate in the Penistaja soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed volcanic rock on ridges and hills.

This unit generally is used for livestock grazing. In areas near Grants, it is used for urban development.

The potential natural plant community on the Viuda soil is mainly blue grama, sideoats grama, black grama, little bluestem, and wolftail. The average annual production of air-dry vegetation ranges from 1,100 pounds per acre in favorable years to 425 pounds in unfavorable years. If the plant community deteriorates,

sideoats grama, black grama, and little bluestem decrease in abundance and blue grama increases. Blue grama generally occurs in small amounts in the potential natural plant community.

The suitability of the Viuda soil for such management practices as livestock pipelines is limited because of the rock fragments and the depth to bedrock.

The potential natural plant community on the Penistaja soil is mainly blue grama, western wheatgrass, fourwing saltbush, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and Indian ricegrass decrease in abundance and blue grama, ring muhly, sand dropseed, pinyon, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The Penistaja soil is suited to such management practices as livestock pipelines, fencing, and range seeding. It is not suitable as a site for livestock ponds because of seepage. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

Properly managing livestock grazing and maintaining enough plant residue on the surface can help to protect the soils in this unit against soil blowing.

The Viuda soil is poorly suited to urban development. The main management concerns are the depth to bedrock, the stones on the surface, and the hazard of soil blowing. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees.

The Penistaja soil is well suited to urban development. The main hazard is soil blowing. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Properly designed and managed windbreaks can reduce the risk of soil blowing.

The Viuda soil generally is unsuitable for windbreaks and environmental plantings. In some areas trees and shrubs can be grown if special treatment is applied.

A wide variety of trees and shrubs can be grown as windbreaks and environmental plantings on the Penistaja soil. Cultivation or applications of herbicide can help to remove competing vegetation.

230—Dumps-Pits complex. This map unit is on hills and flats. Slope is 5 to 90 percent. Areas are irregular in shape and are 200 to 1,000 acres in size. The unit is essentially barren of vegetation. Elevation is 6,000 to 7,500 feet. The average annual precipitation is about 8 to 15 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 100 to 160 days.

This unit is 50 percent Dumps and 35 percent Pits.

Included in this unit are small areas of Atarque, Bond, Hagerman, Penistaja, and Poley soils on mesas, hills, and flats; Mikim soils on fans; and San Mateo and Sparank soils in valleys. Included areas make up about 15 percent of the total acreage.

Dumps occur as areas of waste rock, mine spoil (mainly uranium tailings), and other refuse. Reaction ranges from medium acid to very strongly alkaline.

Pits consist of open excavations from which soil material and some rocks have been removed.

This unit has very limited value as a site for agricultural uses. The main limitations are a shallow depth, poor tilth, low fertility, and extremes in reaction. The unit has some value as a source of construction material.

251—Skyvillage-Rock outcrop-Bond complex, 3 to 40 percent slopes. This map unit is on benches, escarpments, and mesas. Areas are irregular in shape and are 100 to 600 acres in size. The native vegetation is mainly grasses, shrubs, and scattered pinyon and oneseed juniper. Elevation is 6,000 to 6,800 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 150 days.

This unit is 40 percent Skyvillage sandy loam, 3 to 40 percent slopes; 30 percent Rock outcrop; and 20 percent Bond sandy loam, 3 to 8 percent slopes. The Skyvillage soil is on benches, the lee side of mesas, and the edges of mesa tops; the Rock outcrop is on escarpments; and the Bond soil is on benches and the edges of mesas. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of San Mateo and Sparank soils in valleys, Mikim and Mion soils on toe slopes, and Hagerman and Penistaja soils on mesas. Included areas make up about 10 percent of the total acreage.

The Skyvillage soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is light yellowish brown sandy loam about 4 inches thick. The underlying material is dark yellowish brown sandy loam about 8 inches thick. Sandstone is at a depth of about 12 inches.

Permeability is moderately rapid in the Skyvillage soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and

the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone on benches and escarpments.

The Bond soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil is reddish brown sandy clay loam about 6 inches thick. Sandstone is at a depth of about 10 inches.

Permeability is moderate in the Bond soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community is mainly Indian ricegrass, New Mexico feathergrass, blue grama, Mormon tea, and scattered pinyon and oneseed juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, New Mexico feathergrass and Indian ricegrass decrease in abundance and blue grama, threeawn, sandhill muhly, shrubs, and trees increase. The increasers generally occur in small amounts in the potential natural plant community.

In some areas dense stands of pinyon and oneseed juniper may become established. If properly managed, a limited wood crop can be produced in these areas.

This unit is suited to such management practices as deferred grazing and rotation grazing. Because of droughtiness, the shallow depth, and the slope, the unit is not suitable for such management practices as livestock pipelines, livestock ponds, and range seeding.

257—Sparank-San Mateo complex, 0 to 5 percent slopes. This map unit is on flood plains, in broad drainageways, in valleys, and on alluvial fans. Areas are elongated and are 100 to 1,500 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,800 to 6,600 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 145 days.

This unit is 50 percent Sparank clay loam, 0 to 3 percent slopes, and 40 percent San Mateo loam, 1 to 5 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in some areas near the boundary of Catron County are more moist in the underlying material, and those in some areas near the boundary of Bernalillo County are more highly developed.

Included in this unit are small areas of Aparejo, Glenberg, and Venadito soils on flood plains, in valleys, and on alluvial fans and Penistaja soils on fan terraces. Included areas make up about 10 percent of the total acreage.

The Sparank soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is light yellowish brown clay loam about 2 inches thick. The underlying material to a depth of 60 inches is light yellowish brown and light olive brown silty clay.

Permeability is very slow in the Sparank soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. This soil is occasionally flooded for brief periods in summer unless it is protected or gullied.

The San Mateo soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is light yellowish brown loam about 2 inches thick. The upper 27 inches of the underlying material is light olive brown loam and sandy clay loam, and the lower part to a depth of 60 inches is dominantly light olive brown sandy clay loam but has thin strata of sandy loam to silty clay loam.

Permeability is moderate in the San Mateo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer unless it is protected or gullied.

This unit is used for livestock grazing and wildlife habitat.

The potential natural plant community on this unit is mainly western wheatgrass, vine mesquite, alkali sacaton, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 1,250 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, vine mesquite, alkali sacaton, and winterfat decrease in abundance and blue grama, galleta, broom snakeweed, and rabbitbrush increase. The increasers generally occur in small amounts in the potential natural plant community.

Deterioration of the plant community on this unit often results in the formation of gullies that drain the site and hinder the production of vegetation. Where deep gullies have artificially drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

The San Mateo soil is limited as a site for livestock

ponds because of seepage, but the Sparank soil is suitable as a site for these ponds. The soils are suited to such management practices as deferred grazing, rotation grazing, livestock pipelines, and fencing. Good grazing management can increase the productivity and reproduction potential of western wheatgrass, alkali sacaton, and winterfat.

259—Mikim loam, 1 to 5 percent slopes. This deep, well drained soil is on fan terraces and valley sides. It formed in mixed alluvium. Areas are irregular in shape and are 100 to 800 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,800 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is pale brown loam about 4 inches thick. The underlying material to a depth of 60 inches is pale brown and light yellowish brown sandy clay loam and clay loam.

Included in this unit are small areas of San Mateo and Sparank soils in drainageways and depressions; Penistaja, Zia, and Palma soils on fan terraces; and Suwanee soils along drainageways. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Mikim soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, blue grama, New Mexico feathergrass, and galleta. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass decreases in abundance and blue grama increases. Blue grama generally occurs in small amounts in the potential natural plant community.

This unit is suited to such management practices as livestock pipelines, range seeding, and brush control. It is not suitable as a site for livestock ponds because of seepage in the underlying material. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

262—Poley-Pojoaque very cobbly loams, 5 to 30 percent slopes. This map unit is on mesa breaks. Areas are irregular in shape and are 300 to 4,000 acres in size. The native vegetation is mainly grasses, shrubs, and trees. Elevation is 6,200 to 6,900 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 50 percent Poley very cobbly loam and 30 percent Pojoaque very cobbly loam. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Mion soils on hills, Penistaja and Hagerman soils on fan terraces, and Rock outcrop on hills and ridges. Included areas make up about 20 percent of the total acreage.

The Poley soil is deep and well drained. It formed in alluvium and colluvium derived dominantly from sandstone and shale. Typically, the surface layer is dark brown very cobbly loam about 2 inches thick. The upper part of the subsoil is dark brown gravelly clay loam about 16 inches thick, and the lower part to a depth of 60 inches is yellowish brown loam. In some areas the subsoil has more than 35 percent rock fragments.

Permeability is slow in the Poley soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Pojoaque soil is deep and well drained. It formed in alluvium and colluvium derived dominantly from shale and sandstone. Typically, the surface layer is brown very cobbly loam about 3 inches thick. The subsurface layer is brown gravelly clay loam about 4 inches thick. The underlying material to a depth of 60 inches is light yellowish brown and very pale brown cobbly clay loam and gravelly sandy clay loam. In some areas it has more than 35 percent rock fragments.

Permeability is moderate in the Pojoaque soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing and wildlife habitat.

The potential natural plant community on this unit is mainly blue grama, sideoats grama, black grama, New Mexico feathergrass, and sacahuista. The average annual production of air-dry vegetation ranges from 750 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, sideoats grama and black grama decrease in abundance and blue grama, threeawn, and sacahuista increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is limited as a site for such management practices as livestock pipelines and ponds because of the slope. Good grazing management can increase the

productivity and reproduction potential of black grama and sideoats grama.

264—Tapia sandy loam, 1 to 5 percent slopes. This deep, well drained soil is on fan terraces. It formed in mixed alluvium. Areas are irregular in shape and are 500 to 1,200 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 6,200 to 6,900 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 120 to 150 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The upper 19 inches of the subsoil is brown clay loam and sandy clay loam, the next 17 inches is very pale brown cobbly sandy loam, and the lower part to a depth of 60 inches is very pale brown cobbly sand.

Included in this unit are small areas of Penistaja, Mikim, Hagerman, and Poley soils on fan terraces; San Mateo and Sparank soils on alluvial fans and in drainageways; and, on fan terraces, soils that are similar to the Tapia soil but have more than 35 percent rock fragments. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Tapia soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, blue grama, New Mexico feathergrass, and galleta. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass decreases in abundance and blue grama increases. Blue grama generally occurs in small amounts in the potential natural plant community.

This unit is suited to such management practices as livestock pipelines, range seeding, and brush control. It is not suitable as a site for livestock ponds because of seepage. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

270—Charo loam, 0 to 5 percent slopes. This moderately deep, well drained soil is on hills and mesa tops. It formed in mixed alluvium and windblown sediments over basalt. Areas are irregular in shape and are 150 to 500 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 7,800 to 8,200 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is dark brown loam about 5 inches thick. The upper 6 inches of the subsoil is reddish brown clay loam, and the lower 17 inches is reddish brown clay and clay loam. Basalt is at a depth of about 28 inches. In some areas the surface layer is clay loam. In other areas the soil has as much as 15 percent rock fragments.

Included in this unit are small areas of Cebolleta and Borrego soils on hills and mesa tops, Rock outcrop on hillsides, and Trag soils in swales. Included areas make up about 20 percent of the total acreage.

Permeability is slow in the Charo soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wildlife habitat.

The potential natural plant community on this unit is mainly mountain muhly, Arizona fescue, muttongrass, and prairie junegrass. The average annual production of air-dry vegetation ranges from 1,050 pounds per acre in favorable years to 650 pounds in unfavorable years. If the plant community deteriorates, mountain muhly and prairie junegrass decrease in abundance and needleandthread and blue grama increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as range seeding and livestock pipelines. It is not suitable as a site for livestock ponds because of the depth to bedrock.

272—Cebolleta-Borrego-Rock outcrop complex, 1 to 15 percent slopes. This map unit is on hills and mesas. Areas are irregular in shape and are 500 to 1,000 acres in size. The native vegetation is mainly grasses and trees. Elevation is 7,500 to 8,200 feet. The average annual precipitation is about 18 to 22 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 35 percent Cebolleta cobbly loam, 1 to 15 percent slopes, very stony; 30 percent Borrego gravelly loam, 1 to 15 percent slopes; and 20 percent Rock outcrop. The Cebolleta soil is on mesa tops and hills, the Borrego soil is on mesas and hilltops, and the Rock outcrop is on hills. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Charo soils on hillsides and mesa tops and Trag soils in swales. Also

included, on hilltops, are soils that are similar to the Borrego soil but have more rock fragments in the subsoil. Included areas make up about 15 percent of the total acreage.

The Cebolleta soil is moderately deep and well drained. It formed in alluvium and windblown sediments derived dominantly from basalt and andesite. Typically, the surface layer is brown cobbly loam about 2 inches thick. The next layer is brown very cobbly clay loam about 6 inches thick. The subsoil is strong brown and brown very cobbly clay about 17 inches thick. Basalt is at a depth of about 25 inches.

Permeability is slow in the Cebolleta soil. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Borrego soil is shallow and well drained. It formed in alluvium and windblown sediments derived dominantly from basalt and andesite. Typically, the surface layer is brown gravelly loam about 4 inches thick. Below this is brown gravelly clay about 14 inches thick. Basalt is at a depth of about 18 inches.

Permeability is very slow in the Borrego soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on hills and mesa tops.

This unit is used for livestock grazing and wood products.

In some areas pinyon, juniper, and scattered ponderosa pine are at the lower elevations. The site index for ponderosa pine ranges from 54 to 64. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber on this unit are seedling mortality, the hazard of windthrow, equipment limitations, and the stones on the surface. The stones can interfere with felling, yarding, and other activities involving the use of equipment. The seedling mortality rate is moderate because of the depth to bedrock, the clayey texture, and the available water capacity. Trees are subject to windthrow because of the limited rooting depth.

The understory vegetation on this unit is mainly Arizona fescue, Gambel oak, blue grama, muttongrass, western wheatgrass, and bottlebrush squirreltail.

276—Trag loam, 1 to 8 percent slopes. This deep, well drained soil is on valley sides. It formed in mixed alluvium. Areas are irregular in shape and are 50 to 100 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 7,800 to 8,900 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 40 to 46 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is brown loam about 3 inches thick. The subsoil is about 21 inches of reddish brown sandy clay loam and clay loam. The substratum to a depth of 60 inches is brown and light brown sandy clay loam.

Included in this unit are small areas of McGaffey soils in swales and Charo and Cebolleta soils on hills. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Trag soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community is mainly mountain muhly, Arizona fescue, muttongrass, and prairie junegrass. The average annual production of air-dry vegetation ranges from 1,050 pounds per acre in favorable years to 650 pounds in unfavorable years. If the plant community deteriorates, mountain muhly and prairie junegrass decrease in abundance and Poa and blue grama increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as range seeding, ponds, and livestock pipelines.

278—Microy-Rock outcrop complex, 5 to 30 percent slopes. This map unit is on hills. Areas are circular or irregular in shape and are 100 to 300 acres in size. The native vegetation is mainly grasses and trees. Elevation is 8,000 to 8,900 feet. The average annual precipitation is about 18 to 22 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 100 days.

This unit is 55 percent Microy cobbly loam, 5 to 30 percent slopes, and 25 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Borrego, Cebolleta, and Raton soils on hills. Included areas make up about 20 percent of the total acreage.

The Microy soil is moderately deep and well drained. It formed in mixed alluvium. Typically, the surface layer

is brown cobbly loam about 3 inches thick. The subsoil is dark reddish gray and reddish brown cobbly clay about 25 inches thick. The substratum is reddish brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 36 inches. In some areas the surface layer is loam.

Permeability is slow in the Microy soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on hills.

This unit is used for wood products and livestock grazing.

The Microy soil is suited to the production of ponderosa pine. The site index for ponderosa pine averages 50. Based on a site index of 50, the potential production of merchantable timber is 2,500 cubic feet, or 9,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of erosion, equipment limitations, plant competition, and a slow growth rate. When timber is harvested, minimizing the risk of erosion is essential. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Spoil from excavations is subject to rill and gully erosion and to sloughing. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Conventional methods of harvesting timber generally can be used, but their use may be limited when the soil is wet. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Brushy plants, such as Gambel oak, limit the natural regeneration of ponderosa pine. Thinning the stand can help to accelerate the growth of desirable trees.

The understory vegetation on this unit is Arizona fescue, mountain muhly, western wheatgrass, and Gambel oak.

282—Cebolleta cobbly loam, 2 to 10 percent slopes, very stony. This moderately deep, well drained soil is on hills. It formed in alluvium and windblown sediments derived dominantly from basalt and andesite. Areas are irregular in shape and are 100 to 1,500 acres in size. The native vegetation is mainly trees, grasses, and shrubs. Elevation is 7,900 to 9,100 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 80 to 100 days.

Typically, the surface layer is dark grayish brown cobbly loam about 4 inches thick. The next layer is dark grayish brown very cobbly loam about 6 inches thick. The subsoil is reddish brown very cobbly clay about 15 inches thick. Basalt is at a depth of about 25 inches.

Included in this unit are small areas of soils that are similar to the Cebolleta soil but have a light colored surface layer. These soils are on hills. Also included are Borrego soils on hilltops, Charo soils on hills, and Rock outcrop on ridges and hills. Included areas make up about 20 percent of the total acreage.

Permeability is slow in the Cebolleta soil. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

This unit is used for livestock grazing and commercial wood products.

This unit is moderately suited to the production of ponderosa pine at elevations above 8,000 feet and poorly suited at elevations below 8,000 feet. The site index for ponderosa pine ranges from 53 to 62 above 8,000 feet and from 43 to 47 below 8,000 feet. Based on a site index of 50, the potential production of merchantable timber is 2,500 cubic feet, or 9,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 38 cubic feet, or 130 board feet (International rule ⅛-inch kerf), per acre.

The main concerns in producing and harvesting ponderosa pine are the stones on the surface, plant competition, and a slow growth rate. The stones can interfere with felling, yarding, and other activities involving the use of equipment. Unless the site is adequately prepared, competition from undesirable plants can prevent or delay the natural or artificial regeneration of trees. Understory grasses and brushy plants limit the natural regeneration of ponderosa pine at elevations below 8,000 feet. Thinning the stand can help to accelerate the growth of desirable trees. When timber is harvested, minimizing the risk of erosion is essential. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality.

The understory vegetation on this unit is mainly Arizona fescue, mountain muhly, and prairie junegrass at elevations above 8,000 feet and blue grama, little bluestem, and mountainmahogany at elevations below 8,000 feet.

284—Cebolleta-Rock outcrop complex, 15 to 50 percent slopes. This map unit is on mountains. Areas are irregular in shape and are 100 to 1,000 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 7,700 to 9,400 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 80 to 100 days.

This unit is 65 percent Cebolleta very cobbly loam, 15 to 50 percent slopes, very stony, and 20 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of soils that are similar to the Cebolleta soil but have a light colored surface layer. These soils are on mountainsides. Also included are small areas of Borrego soils on mountainsides and benches. Included areas make up about 15 percent of the total acreage.

The Cebolleta soil is moderately deep and well drained. It formed in alluvium and colluvium derived dominantly from basalt and andesite. Typically, the surface layer is dark grayish brown very cobbly loam about 5 inches thick. The subsurface layer is grayish brown very cobbly loam about 5 inches thick. The subsoil is brown very cobbly clay about 14 inches thick. Basalt is at a depth of about 24 inches. In some areas the slope is less than 15 percent.

Permeability is slow in the Cebolleta soil. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt and andesite on mountainsides and benches.

This unit is used for livestock grazing and commercial wood products.

The Cebolleta soil is suited to the production of ponderosa pine and Douglas fir. The site index for ponderosa pine ranges from 52 to 64. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting ponderosa pine and Douglas fir are the slope and the stones on the surface. Conventional methods of harvesting timber can be used in the less sloping areas, but their use is limited in the steeper areas. Properly designing logging roads, skid trails, and landings helps to overcome the slope. Erosion-control structures and seeding are needed to protect the roads against erosion. The stones can interfere with felling, yarding, and other activities involving the use of equipment. Such plants as Gambel oak, alligator juniper, and pinyon delay natural regeneration but do not prevent the eventual development of a fully stocked, normal stand of trees.

The understory vegetation on this unit is mainly Arizona fescue, mountain muhly, yarrow, and mountainmahogany.

286—Cebolleta-Raton complex, 1 to 5 percent slopes. This map unit is on hills and mesa tops. Areas are irregular in shape and are 500 to 1,000 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 8,400 to 8,800 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 80 to 100 days.

This unit is 60 percent Cebolleta very cobbly loam, 1 to 5 percent slopes, very stony, and 25 percent Raton cobbly loam, 1 to 5 percent slopes, very stony. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Charo soils and Rock outcrop on hills and mesa tops, Microy soils on hills, and Trag soils along drainageways. Included areas make up about 15 percent of the total acreage.

The Cebolleta soil is moderately deep and well drained. It formed in alluvium and windblown sediments derived dominantly from basalt. Typically, the surface layer is dark brown very cobbly loam about 3 inches thick. The subsurface layer is dark brown very cobbly clay loam about 6 inches thick. The subsoil is brown and reddish brown very cobbly clay about 19 inches thick. Basalt is at a depth of about 28 inches.

Permeability is slow in the Cebolleta soil. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Raton soil is shallow and well drained. It formed in alluvium and windblown sediments derived dominantly from igneous rock. Typically, the surface layer is dark yellowish brown cobbly loam about 3 inches thick. The subsurface layer is brown very cobbly clay loam about 3 inches thick. The subsoil is brown very cobbly clay about 4 inches thick. Basalt is at a depth of about 10 inches.

Permeability is slow in the Raton soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water

erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing and commercial wood products.

This unit is suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 59 to 61. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

Conventional methods of harvesting timber can be used. Carefully managing reforestation can minimize competition from undesirable understory plants. Brushy plants, such as Gambel oak, limit the natural regeneration of ponderosa pine.

The main concerns in producing and harvesting timber on the Cebolleta soil are seedling mortality and the hazard of windthrow. The seedling mortality rate is moderate because of the very low available water capacity. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong.

The main concerns in producing and harvesting of timber on the Raton soil are equipment limitations, seedling mortality, and the hazard of windthrow. Rock outcrop restricts the movement of equipment, and sharp, angular cobbles and stones cause abnormal wear of rubber-tired equipment. The seedling mortality rate is moderate because of the very low available water capacity and the restricted rooting depth. Trees are subject to windthrow because of the restricted rooting depth.

The understory vegetation on this unit is Arizona fescue, blue grama, western wheatgrass, and Gambel oak.

290—Paguate-Hackroy complex, 1 to 5 percent slopes. This map unit is on basalt-capped mesa tops and plateaus. Areas are irregular in shape and are 100 to 1,300 acres in size. The native vegetation is mainly grasses, forbs, and trees. Elevation is 7,000 to 8,000 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 52 degrees F, and the average frost-free period is 110 to 130 days.

This unit is 50 percent Paguate loam, 1 to 5 percent slopes, and 35 percent Hackroy cobbly loam, 1 to 5 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Cabezon soils on mesas and ridges; on mesas and plateaus, soils that are similar to the Hackroy and Paguate soils but have more rock fragments in the subsoil; Millpaw soils in upland drainageways and depressions; and Rock outcrop on the edges of mesas and on ridges. Included areas make up about 15 percent of the total acreage.

The Paguate soil is moderately deep and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the surface layer is dark brown loam about 3 inches thick. The upper 16 inches of the subsoil is reddish brown clay loam and clay, and the lower 14 inches is pink gravelly clay loam. Basalt is at a depth of about 33 inches.

Permeability is slow in the Paguate soil. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Hackroy soil is shallow and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the surface layer is brown cobbly loam about 3 inches thick. The upper part of the subsoil is reddish brown clay loam about 8 inches thick, and the lower part is reddish brown clay about 3 inches thick. Basalt is at a depth of about 14 inches.

Permeability is slow in the Hackroy soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used for livestock grazing, wildlife habitat, and limited wood products.

The potential natural plant community on the Paguate soil is mainly blue grama, spike muhly, western wheatgrass, fourwing saltbush, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and spike muhly decrease in abundance and blue grama, ring muhly, sand dropseed, pinyon, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The Paguate soil is suited to such management practices as livestock pipelines, fencing, and range seeding. It is not suitable as a site for livestock ponds because of the depth to bedrock. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and spike muhly.

The potential natural plant community on the Hackroy soil is mainly blue grama, sideoats grama, black grama, little bluestem, and western wheatgrass. The average annual production of air-dry vegetation ranges from

1,100 pounds per acre in favorable years to 425 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, black grama, and western wheatgrass decrease in abundance and blue grama, threeawn, and pinyon increase. The increasers generally occur in small amounts in the potential natural plant community.

The suitability of the Hackroy soil for such management practices as livestock pipelines and range seeding is limited because of the depth to bedrock and the available water capacity. Good grazing management can increase the productivity and reproduction potential of western wheatgrass, spike muhly, sideoats grama, and black grama.

291—Paguate cobbly clay loam, 1 to 5 percent slopes. This moderately deep, well drained soil is on basalt-capped mesa tops and plateaus. It formed in mixed alluvium and windblown sediments. Areas are irregular in shape and are 100 to 2,500 acres in size. The native vegetation is mainly trees, grasses, and forbs. Elevation is 7,000 to 8,000 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 130 days.

Typically, the surface layer is dark yellowish brown cobbly clay loam about 5 inches thick. The upper part of the subsoil is strong brown and brown clay about 21 inches thick, and the lower part is reddish yellow clay loam about 12 inches thick. Basalt is at a depth of about 38 inches. In some areas the surface layer is clay loam.

Included in this unit are small areas of Cabezon soils on mesa tops, hills, and ridges; Millpaw soils in swales; and Rock outcrop on ridges, hills, and the edges of mesas. Also included are some areas near the boundary of Catron County where temperatures are slightly cooler and some areas near the boundary of Socorro County where the surface layer is darker. Included areas make up about 20 percent of the total acreage.

Permeability is slow in the Paguate soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on this unit ranges from 30 to 50. Based on a site index of 40, the soil can produce 6 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

Grasses, forbs, and shrubs limit the natural regeneration of woody species. Properly preparing the site can control the competing vegetation.

The understory vegetation on this unit is western wheatgrass, bluegrass, bottlebrush squirreltail, oak, and pinyon ricegrass. The production of understory plants can be increased by reducing the density of the canopy.

294—Parkay-Rock outcrop complex, 15 to 45 percent slopes. This map unit is on mountains, ridges, hills, and escarpments. Areas are irregular in shape and are 200 to 1,100 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 8,200 to 10,300 feet. The average annual precipitation is about 22 to 26 inches, the average annual air temperature is 36 to 42 degrees F, and the average frost-free period is 60 to 80 days.

This unit is 60 percent Parkay stony loam, 15 to 45 percent slopes, extremely stony, and 25 percent Rock outcrop. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Trag soils on ridges, mountains, and hills. Also included, on side slopes and ridges, are soils that are similar to the Parkay soil but are moderately deep over shale. Included areas make up about 15 percent of the total acreage.

The Parkay soil is deep and well drained. It formed in colluvium and alluvium derived dominantly from basalt and andesite. Typically, the surface layer is dark grayish brown stony loam about 2 inches thick. The subsurface layer is dark grayish brown very gravelly sandy clay loam about 6 inches thick. The subsoil is brown very cobbly sandy clay loam about 15 inches thick. The substratum to a depth of 60 inches is brown and light brown very cobbly sandy clay loam. In some areas the slope is less than 15 percent.

Permeability is moderate in the Parkay soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt and andesite on escarpments, mountains, hills, and ridges.

This unit is used for wood products and livestock grazing.

The Parkay soil is suited to the production of Douglas fir and Engelmann spruce. At the lower elevations, it is suited to the production of ponderosa pine. The site index for Douglas fir ranges from 70 to 85. The site index for Engelmann spruce ranges from 69 to 85 where slopes are 15 to 35 percent and from 76 to 96 where slopes are 35 to 45 percent. The site index

for ponderosa pine ranges from 56 to 76 in less sloping areas. Douglas fir and Engelmann spruce can be grown as Christmas trees.

Based on a site index of 75 for Douglas fir, the potential production of merchantable timber is 4,945 cubic feet, or 26,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 62 cubic feet, or 271 board feet (International rule, ⅛-inch kerf), per acre.

Based on a site index of 80 for Engelmann spruce, the potential production of merchantable timber is 4,360 cubic feet, or 21,800 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 76 cubic feet per acre.

The main concerns in producing and harvesting Engelmann spruce and Douglas fir are the hazard of erosion in the steeper areas, equipment limitations, and plant competition. When timber is harvested, minimizing the risk of erosion is essential. Conventional methods of harvesting can be used in the less sloping areas, but their use is restricted in the steeper areas. Areas that have slopes of more than 35 percent are not suited to conventional methods of harvesting. Stones on the surface can interfere with felling, yarding, and other activities involving the use of equipment, and Rock outcrop can restrict the movement of equipment. Special design of logging roads, skid trails, and landings is needed in the steeper areas. Erosion-control structures and seeding can protect the roads against erosion. Spoil from excavations is subject to rill and gully erosion and to sloughing. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Aspen may limit the natural regeneration of Engelmann spruce and Douglas fir.

The understory vegetation on this unit is Arizona fescue, pyrola, violet, Fendler meadowrue, currant, and gooseberry. It is very sparse because of the dense canopy.

300—Saladon clay loam, 0 to 5 percent slopes. This deep, poorly drained soil is in valleys and drainageways. It formed in mixed alluvium. Areas are long and narrow and are 20 to 100 acres in size. The native vegetation is mainly grasses and sedges. Elevation is 7,900 to 8,300 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is dark brown clay loam about 4 inches thick. The underlying material to a depth of 60 inches is black, yellowish brown, grayish brown, and very dark gray sandy clay and clay.

Included in this unit are small areas of McGaffey soils in valleys, soils that are similar to the Saladon soil but are well drained and are on valley sides, Moreno soils on valley sides, and soils that are similar to the Saladon soil but are less clayey. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Saladon soil. Available water capacity is high. A high water table limits the effective rooting depth to 15 to 35 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight. A seasonal high water table fluctuates between depths of 18 to 36 inches. This soil is subject to rare flooding.

This unit is used for livestock grazing. The potential natural plant community is mainly tufted hairgrass, western wheatgrass, sedges, rushes, and bluegrass. The average annual production of air-dry vegetation ranges from 3,000 pounds per acre in favorable years to 2,500 pounds in unfavorable years. If the plant community deteriorates, tufted hairgrass and wheatgrass decrease in abundance and bluegrass and sedges increase. The increasers generally occur in small amounts in the potential natural plant community. Deterioration of the vegetation on this unit often results in the formation of gullies that drain the site and hinder production. After gullies have drained the site, a combination of grazing management and engineering practices may be required to return the site to its productive potential.

This unit is suited to such management practices as range seeding and livestock ponds.

310—Mirabal very gravelly loam, 2 to 15 percent slopes. This moderately deep, well drained soil is on hills. It formed in mixed alluvium and windblown sediments. Areas are irregular in shape and are 100 to 1,200 acres in size. The native vegetation is mainly trees and a sparse understory of grasses. Elevation is 8,100 to 8,800 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 85 to 105 days.

Typically, the surface layer is brown very gravelly loam about 3 inches thick. The upper part of the underlying material is light brown very gravelly loam about 11 inches thick, and the lower part is pink very cobbly sandy clay loam about 7 inches thick. Granite is at a depth of about 21 inches.

Included in this unit are small areas of soils that are similar to the Mirabal soil but are shallow over bedrock. These soils are on hills. Also included are small areas

of Moreno soils on fan terraces and in valleys and Rock outcrop on hilltops. Included areas make up about 15 percent of the total acreage.

Permeability is moderate in the Mirabal soil. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wood products and livestock grazing.

This unit is suited to the production of ponderosa pine. The steeper, north-facing slopes also are suited to the production of Douglas fir for timber. The Douglas fir also can be grown as a Christmas tree species. The site index for ponderosa pine ranges from 50 to 67. The site index for Douglas fir is 62. Based on a site index of 60 for both species, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of water erosion, seedling mortality, and the hazard of windthrow. When timber is harvested, minimizing the risk of erosion is essential. Erosion-control structures and seeding can protect logging roads against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality. Because of the very low available water capacity, the restricted rooting depth, and a high evaporation rate, the seedling mortality rate is low on the north-and east-facing slopes and moderate on the south- and west-facing slopes. During some periods of heavy rainfall or snowmelt, the soil is saturated and thus trees are subject to windthrow.

The understory vegetation on this unit is scattered Arizona fescue, mountain muhly, and bottlebrush squirreltail.

315—Abersito, cobbly-Abersito-Rock outcrop association, 5 to 30 percent slopes. This map unit is on hills and mesas. Areas are irregular in shape and are 50 to 450 acres in size. The native vegetation is mainly trees and a sparse understory of grasses. Elevation is 8,300 to 8,800 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 85 to 105 days.

This unit is 35 percent Abersito very cobbly sandy clay loam, 15 to 30 percent slopes, very stony; 30 percent Abersito gravelly loam, 5 to 10 percent slopes; and 20 percent Rock outcrop. The cobbly Abersito soil is on hills and the sides of mesas, the other Abersito soil is on hills and mesa tops, and the Rock outcrop is on escarpments, ridges, and ledges.

Included in this unit are small areas of shallow soils on hills and mesas, deep soils on hillsides, and Cinnadale soils on mesa tops. Also included, on mesas and hills, are soils that are similar to the Abersito soil but are less clayey in the subsoil. Included areas make up about 15 percent of the total acreage.

The cobbly Abersito soil is moderately deep and well drained. It formed in mixed alluvial and colluvial material. Typically, a thin mat of partially decomposed pine needles and oak leaves is on the surface. The surface layer is dark brown very cobbly sandy clay loam about 3 inches thick. The subsurface layer is light brown very cobbly fine sandy loam about 6 inches thick. The subsoil is yellowish red very cobbly clay about 15 inches thick. Sandstone bedrock is at a depth of about 24 inches.

The other Abersito soil is moderately deep and well drained. It formed in mixed alluvial and colluvial material. Typically, a thin mat of partially decomposed pine needles and oak leaves is on the surface. The surface layer is brown gravelly loam about 5 inches thick. The subsoil is brown and strong brown very cobbly clay about 19 inches thick. Sandstone is at a depth of about 24 inches.

Permeability is slow in the Abersito soils. Available water capacity is very low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of sandstone on escarpments and ridges.

This unit is used for wood products and livestock grazing.

The Abersito soils are suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 64 to 68. Based on a site index of 65, the potential production of merchantable timber is 4,025 cubic feet, or 8,300 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 50 cubic feet, or 203 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of water erosion, the slope, seedling mortality, plant competition, and the hazard of windthrow. When timber is harvested, minimizing the risk of erosion is essential. Conventional methods of harvesting can be used in the less sloping areas, but their use is restricted in the steeper areas. Special design of logging roads, skid trails, and landings is

needed in the steeper areas. Erosion-control structures and seeding can protect the roads against erosion. Proper design of road drainage systems and care in the placement of culverts also help to control erosion. Spoil from excavations is subject to rill and gully erosion and to sloughing. Stones on the surface can interfere with felling, yarding, and other activities involving the use of equipment.

Overall, the seedling mortality rate is moderate. The rate, however, is slightly lower on the north- and east-facing slopes than on the south- and west-facing slopes. Carefully managing reforestation can minimize competition from undesirable understory plants. Unless the site is adequately prepared, plant competition can prevent or delay the natural or artificial regeneration of trees. Brushy plants, such as Gambel oak, limit the natural regeneration of ponderosa pine. During some periods of heavy rainfall or snowmelt, the soils are saturated and thus trees are subject to windthrow.

The understory vegetation on this unit is Arizona fescue, mountain muhly, little bluestem, and Gambel oak.

This unit is limited as a site for such management practices as livestock pipelines and fencing because of the large stones, the depth to bedrock, and the Rock outcrop.

320—Cinnadale gravelly very fine sandy loam, 1 to 15 percent slopes. This shallow, well drained soil is on ridges and hills. It formed in alluvium and windblown sediments derived dominantly from sandstone and siltstone. Areas are irregular in shape and are 200 to 1,500 acres in size. The native vegetation is mainly trees and an understory of grasses (fig. 6). Elevation is 7,800 to 8,400 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is light reddish brown gravelly very fine sandy loam about 4 inches thick. The subsoil is light reddish brown very channery loam about 8 inches thick. Sandstone is at a depth of about 12 inches. In some areas the bedrock is weathered in the upper few inches.

Included in this unit are small areas of Rock outcrop, small areas of soils that are similar to the Cinnadale soil but are moderately deep, and small areas of Stout soils. All of these included areas are on hills and ridges. Also included are small areas of Moreno and Moreno Variant soils on hills. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Cinnadale soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for wood products and livestock grazing.

The Cinnadale soil is suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 61 to 68. Based on a site index of 65, the potential production of merchantable timber is 4,025 cubic feet, or 8,300 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 50 cubic feet, or 203 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of water erosion, seedling mortality, and the hazard of windthrow. When timber is harvested, minimizing the risk of erosion is essential. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality.

Because of the very low available water capacity, the shallow rooting depth, and a high evaporation rate, the seedling mortality rate is moderate. During some periods of heavy rainfall or snowmelt, the soil is saturated and thus trees are subject to windthrow.

The understory vegetation on this unit is Arizona fescue, mountain muhly, prairie junegrass, bottlebrush squirreltail, and Fendler ceanothus.

325—Moreno Variant loam, 2 to 10 percent slopes. This deep, well drained soil is on fan terraces and toe slopes. It formed in mixed alluvium. Areas are irregular in shape and are 25 to 150 acres in size. The native vegetation is mainly grasses and trees. Elevation is 8,000 to 8,300 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 85 to 105 days.

Typically, the surface layer is dark brown loam about 7 inches thick. The subsurface layer is brown and strong brown very fine sandy loam about 15 inches thick. The subsoil to a depth of 60 inches is red clay loam and sandy clay loam.

Included in this unit are small areas of Moreno soils on fan terraces, Saladon soils along narrow drainageways, Cinnadale soils on hills and ridges, and soils that are similar to the Moreno Variant soil but are moderately deep and are on fan terraces and ridges. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Moreno Variant soil. Available water capacity is high. The

Figure 6.—Ponderosa pine in an area of Cinnadale gravelly very fine sandy loam, 1 to 15 percent slopes.

effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

This unit is used for livestock grazing and wood products.

This unit is suited to the production of ponderosa pine. The site index ranges from 85 to 90. Based on a site index of 85, the potential production of merchantable timber is 6,055 cubic feet, or 35,750 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 77 cubic feet, or 357 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of erosion and plant competition. When timber is harvested, minimizing the risk of erosion is essential. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality. Carefully managing reforestation can minimize competition from undesirable understory plants. Grasses, forbs, and shrubs limit the natural regeneration of ponderosa pine. Properly preparing the site can control competing vegetation.

The understory vegetation on this unit is Arizona fescue, mountain muhly, and western wheatgrass.

330—Moreno loam, 1 to 10 percent slopes. This deep, well drained soil is on fan terraces. It formed in mixed alluvium. Areas are irregular in shape and are 150 to 800 acres in size. The native vegetation is mainly ponderosa pine and grasses. Elevation is 7,800 to 8,200 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 110 days.

Typically, a thin mat of pine needles is on the surface. The surface layer is reddish brown loam about 11 inches thick. The upper 3 inches of the subsoil is yellowish red loam, the next 21 inches is red clay loam and reddish brown clay, and the lower part to a depth of 60 inches is red very gravelly clay loam.

Included in this unit are small areas of Yankee soils on valley bottoms and Moreno Variant soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Moreno soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wood products and livestock grazing.

This unit is suited to the production of ponderosa pine. The site index ranges from 70 to 90. Based on a site index of 80, the potential production of merchantable timber is 5,410 cubic feet, or 31,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 69 cubic feet, or 313 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of erosion and plant competition. When timber is harvested, minimizing the risk of erosion is essential. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality. Carefully managing reforestation can minimize competition from undesirable understory plants. Grasses, forbs, and shrubs limit the natural regeneration of ponderosa pine. Properly preparing the site can control competing vegetation.

The understory vegetation on this unit is Arizona fescue, mountain muhly, and western wheatgrass.

340—Yankee silty clay loam, 0 to 3 percent slopes. This deep, well drained soil is on the bottom of mountain valleys. It formed in mixed alluvium. Areas are irregular in shape and are 50 to 800 acres in size. The native vegetation is mainly grasses. Elevation is 7,700 to 8,300 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is dark reddish brown silty clay loam about 3 inches thick. The subsoil to a depth of 60 inches is dark reddish brown, dark reddish gray, and reddish brown silty clay.

Included in this unit are small areas of McGaffey and Moreno soils on valley sides. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Yankee soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. The soil has cracks that extend from the surface to a depth of about 20 inches.

This unit is used for livestock grazing. The potential natural plant community is mainly tufted hairgrass, western wheatgrass, and bluegrass. The average annual production of air-dry vegetation ranges from 3,000 pounds per acre in favorable years to 2,500 pounds in unfavorable years. If the plant community deteriorates, tufted hairgrass and wheatgrass decrease in abundance and bluegrass increases. The increasers generally occur in small amounts in the potential natural plant community.

Deterioration of the vegetation on this unit often results in the formation of gullies that drain the site and hinder the production of vegetation. After gullies have drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential. The unit is suited to such management practices as range seeding and livestock ponds.

350—Rock outcrop-Stout complex, 3 to 15 percent slopes. This map unit is on ridges and hills. Areas are irregular in shape. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 7,800 to 8,500 feet. The average annual precipitation is about 20 to 24 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 60 percent Rock outcrop and 25 percent Stout sandy loam, 3 to 15 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Cinnadale soils on hills and ridges and Mirabal soils on ridges. Also included, on hills, are soils that are similar to the Stout soil but are moderately deep. Included areas make up about 15 percent of the total acreage.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone on hills and ridges.

The Stout soil is very shallow or shallow and is well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface is covered with partially decomposed pine needles. The surface layer is brown sandy loam about 3 inches thick. The underlying material is brown sandy loam about 11 inches thick. Sandstone is at a depth of about 14 inches.

Permeability is moderately rapid in the Stout soil. Available water capacity is very low. The effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

This unit is used for wood products and livestock grazing.

The Stout soil is suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 45 to 54. Based on a site index of 50, the potential production of merchantable timber is 2,500 cubic feet, or 9,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 38 cubic feet, or 130 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting ponderosa pine are the hazard of erosion, seedling mortality, plant competition, and the hazard of windthrow. When timber is harvested, minimizing the risk of erosion is essential. Soil blowing can be controlled and damage to seedlings minimized by maintaining enough plant residue on the surface. The seedling mortality rate is high because of the very low available water capacity. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. During some periods of heavy rainfall or snowmelt, the soil is saturated and thus trees are subject to windthrow. Conventional methods of harvesting timber can be used, but the Rock outcrop can interfere with cross-slope movement.

The understory vegetation on this unit is mountain muhly, bottlebrush squirreltail, little bluestem, and Gambel oak.

406—Poley-Rock outcrop complex, 2 to 25 percent slopes. This map unit is on hills, ridges, benches, and the escarpments of basalt mesas. Areas are irregular in shape and are 100 to 8,000 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 5,800 to 7,100 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 45 percent Poley very cobbly loam, 2 to 25 percent slopes, very stony, and 40 percent Rock outcrop. The Poley soil is on benches, ridges, and hills, and the Rock outcrop is on ridges and escarpments. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in areas near the boundary of Socorro County may have a less well developed subsoil.

Included in this unit are small areas of Rana soils on benches and hills, Penistaja soils on hills, and fine textured, shallow and moderately deep soils that are underlain by shale and are on benches and hills. Included areas make up about 15 percent of the total acreage.

The Poley soil is deep and well drained. It formed in colluvium and alluvium derived dominantly from shale. Typically, the surface layer is reddish brown very cobbly loam about 3 inches thick. The upper part of the subsoil is reddish brown and yellowish red clay about 19 inches thick, and the lower part to a depth of 60 inches is light reddish brown and pink clay and clay loam.

Permeability is slow in the Poley soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on ridges, benches, and escarpments.

This unit is used mainly for livestock grazing. In areas near Grants, it is used for urban development.

The potential natural plant community on the Poley soil is mainly blue grama, sideoats grama, New Mexico feathergrass, black grama, alkali sacaton, and sacahuista. The average annual production of air-dry vegetation ranges from 750 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, black grama, alkali sacaton, and sideoats grama decrease in abundance and blue grama, threeawn, and sacahuista increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is limited as a site for such management practices as livestock pipelines and range seeding because of the Rock outcrop and the low precipitation. Good grazing management can increase the productivity and reproduction potential of black grama and sideoats grama.

This unit is suited to urban development. The main limitations are the slope, the clayey texture, the stones on the surface, and a high shrink-swell potential. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Properly designing buildings and roads can reduce the damaging effects of shrinking and swelling and help overcome the slope and the stones on the surface.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. Extra care is needed during planting to ensure that the soil is firmly packed around the roots. Cultivation or applications of herbicide can help to remove competing vegetation. Drip irrigation can help to establish windbreaks.

407—Viuda-Rock outcrop complex, 1 to 10 percent slopes. This map unit is on ridges, hillsides, and benches on Cerro Verde. Areas are oval and are 2,000 to 4,000 acres in size. The native vegetation is mainly grasses, shrubs, and scattered juniper. Elevation is 6,500 to 7,000 feet. The average annual precipitation is 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 65 percent Viuda very cobbly silty clay loam, 1 to 10 percent slopes, very stony, and 15 percent Rock outcrop. The Viuda soil is on ridges, hillsides, and benches, and the Rock outcrop is on ridges and breaks and along drainageways. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of soils that are similar to the Viuda soil but are less well developed or are moderately deep. These soils are on ridges and hills. Also included are the cobbly Flaco and Berto soils on ridges and hillsides. Included areas make up about 20 percent of the total acreage.

The Viuda soil is shallow and well drained. It formed in windblown sediments and colluvium derived dominantly from basalt. Typically, the surface layer is brown very cobbly silty clay loam about 3 inches thick. The subsoil is brown clay about 10 inches thick. Basalt is at a depth of about 13 inches.

Permeability is slow in the Viuda soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on ridges, breaks, and benches.

This unit is used for livestock grazing. The potential natural plant community on the Viuda soil is mainly blue grama, sideoats grama, black grama, little bluestem, and wolftail. The average annual production of air-dry vegetation ranges from 1,100 pounds per acre in favorable years to 425 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, black grama, and little bluestem decrease in abundance and blue grama and wolftail increase. The increasers generally occur in small amounts in the potential natural plant community.

The suitability of the Viuda soil for such management practices as livestock pipelines and range seeding is limited because of the depth to bedrock and the low precipitation. Good grazing management can increase the productivity and reproduction potential of sideoats grama, black grama, and little bluestem.

419—Navajo silty clay loam, 1 to 5 percent slopes. This deep, well drained soil is on alluvial fans, in large drainageways, and on flood plains. It formed in alluvium derived dominantly from shale. Areas are irregular in shape and are 30 to 2,000 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,400 to 6,000 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

Typically, the surface layer is reddish brown silty clay loam about 3 inches thick. The underlying material to a depth of 60 inches is reddish brown silty clay and clay. Areas near the boundary of Bernalillo County are warmer. In places the surface layer is clay or sandy clay loam.

Included in this unit are small areas of Suwanee soils on alluvial fans and flood plains and Grieta soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is very slow in the Navajo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer. Cracks are common in the upper 30 inches. The soil is slightly saline.

This unit is used for livestock grazing. The potential natural plant community is mainly giant sacaton, alkali sacaton, vine mesquite, and shadscale. The average annual production of air-dry vegetation ranges from 4,000 pounds per acre in favorable years to 800 pounds in unfavorable years. If the plant community deteriorates, giant sacaton and vine mesquite decrease in abundance and galleta, burrograss, mat muhly, and annual grasses and forbs increase. The increasers generally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of giant sacaton, alkali sacaton, and vine mesquite. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved enough growth to withstand grazing pressure.

This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. Deterioration of the plant community often results in the formation of gullies that drain the site and hinder the production of vegetation.

This unit is not suitable for such management practices as range seeding because of the low precipitation.

420—Navajo-Suwanee complex, 1 to 5 percent slopes. This map unit is on flood plains and alluvial fans and in large drainageways. Areas are irregular in shape and are 75 to 2,000 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,400 to 6,000 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

This unit is 45 percent Navajo clay loam, 1 to 5 percent slopes, and 40 percent Suwanee silty clay loam, 1 to 5 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. Areas near the boundary of Bernalillo County are warmer.

Included in this unit are small areas of soils that are similar to the Suwanee soil but are more silty. These soils are on flood plains, mainly near the boundary of Socorro County and the boundary of the soil survey of the eastern part of Valencia County. Also included are areas of riverwash at the mouth of drainageways and in arroyos; Grieta soils on fan terraces; and Sheppard and Shiprock soils in windblown areas, mainly near the boundary of the soil survey of the eastern part of Valencia County. Included areas make up about 15 percent of the total acreage.

The Navajo soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is reddish brown clay loam about 4 inches thick. The underlying material to a depth of 60 inches is reddish brown clay. In some areas the soil has less clay below a depth of 40 inches.

Permeability is very slow in the Navajo soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. This soil is occasionally flooded for very brief periods in summer. Cracks are common in the upper 30 inches. The soil is slightly saline.

The Suwanee soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is reddish brown silty clay loam about 3 inches thick. The underlying material to a depth of 60 inches is dominantly brown and reddish brown silt loam and silty clay loam ranging from 18 to 35 percent in content of clay, but it includes strata of silty clay to loamy fine sand.

Permeability is moderately slow in the Suwanee soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate. This soil is occasionally flooded for very brief periods in summer.

This unit is used for livestock grazing. The potential natural plant community is mainly giant sacaton, alkali sacaton, vine mesquite, and shadscale. The average annual production of air-dry vegetation ranges from 4,000 pounds per acre in favorable years to 800 pounds in unfavorable years. If the plant community deteriorates, giant sacaton and vine mesquite decrease in abundance and galleta, burrograss, mat muhly, and annual forbs and grasses increase. The increasers generally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of giant sacaton, alkali sacaton, and vine mesquite. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved enough growth to withstand grazing pressure.

This unit receives runoff from the adjacent areas. As a result, it is potentially more productive. Deterioration of the plant community often results in the formation of gullies that drain the site and hinder the production of vegetation. After gullies have drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

This unit is not suitable for such management practices as range seeding because of the low precipitation. The Suwanee soil is limited as a site for livestock ponds because of seepage, but the Navajo soil is suitable as a site for these ponds. Both soils are suited to such management practices as livestock pipelines and fencing.

424—Mespun-Palma association, 1 to 12 percent slopes. This map unit is on stable sand dunes, in interdune areas, and on ridges. Areas are irregular in shape and are 300 to 1,100 acres in size. The native vegetation is mainly grasses and scattered trees and shrubs. Elevation is 5,900 to 7,100 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 45 percent Mespun fine sand, 3 to 12 percent slopes, and 40 percent Palma loamy fine sand, 1 to 7 percent slopes. The Mespun soil is on the upper part of sand dunes and on ridges, and the Palma soil is in interdune areas and on the lower part of stable sand dunes. In areas near the boundary of the soil survey of the eastern part of Valencia County, the soils have a higher content of calcium carbonate and rock fragments.

Included in this unit are small areas of Penistaja and Hagerman soils on fan terraces and between dunes, mainly near the boundary of Bernalillo County; Rock

outcrop on ridges; Zia and Mikim soils on fans; and Aparejo soils on alluvial fans. Included areas make up about 15 percent of the total acreage.

The Mespun soil is deep and excessively drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is yellowish brown fine sand about 2 inches thick. The underlying material to a depth of 60 inches is reddish yellow loamy fine sand and fine sand.

Permeability is rapid in the Mespun soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

The Palma soil is deep and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is light brown loamy fine sand about 4 inches thick. The upper part of the subsoil is brown fine sandy loam about 17 inches thick, and the lower part to a depth of 60 inches is reddish yellow sandy loam.

Permeability is moderately rapid in the Palma soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for livestock grazing and limited wood products.

The potential natural plant community on the Mespun soil is mainly blue grama, Indian ricegrass, sand dropseed, western wheatgrass, and sand sagebrush. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, Indian ricegrass and western wheatgrass decrease in abundance and blue grama and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Palma soil is mainly blue grama, western wheatgrass, Indian ricegrass, and winterfat. The average annual production of air-dry vegetation ranges from 850 pounds per acre in favorable years to 325 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, Indian ricegrass, needleandthread, and winterfat decrease in abundance and threeawn, galleta, muhly, and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community.

Woody species, such as pinyon and oneseed juniper, may invade on both soils.

This unit is not suitable as a site for livestock ponds because of seepage. Good grazing management can increase the productivity and reproduction potential of Indian ricegrass, western wheatgrass, and winterfat.

Properly managing livestock grazing can protect the unit against excessive soil blowing. Maintaining enough plant residue on the surface can control soil blowing and minimize damage to seedlings.

426—Sheppard-Shiprock association, 1 to 12 percent slopes. This map unit is on old stable dunes, in interdune areas, and on fans. Areas are elongated and are 50 to 1,000 acres in size. The native vegetation is mainly shrubs and grasses. Elevation is 5,400 to 6,000 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

This unit is 45 percent Sheppard loamy fine sand, 3 to 12 percent slopes, and 35 percent Shiprock sandy loam, 1 to 8 percent slopes. The Sheppard soil is on the upper parts of dunes and on fans, and the Shiprock soil is on the lower parts of dunes, in interdune areas, and on fans.

Included in this unit are small areas of Grieta soils between dunes and on fans, Suwanee and Navajo soils along drainageways, and riverwash in drainageways. Included areas make up about 20 percent of the total acreage.

The Sheppard soil is deep and somewhat excessively drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is reddish yellow loamy fine sand about 4 inches thick. The underlying material to a depth of 60 inches is reddish yellowish loamy fine sand and loamy sand.

Permeability is rapid in the Sheppard soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

The Shiprock soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is reddish yellow sandy loam about 3 inches thick. The upper part of the subsoil is reddish yellow and reddish brown fine sandy loam about 15 inches thick, and the lower part to a depth of 60 inches is reddish yellow fine sandy loam.

Permeability is moderately rapid in the Shiprock soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community on the Sheppard soil is mainly black grama, New Mexico feathergrass, Indian ricegrass, and bush muhly. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 300 pounds in unfavorable years. If the plant community deteriorates,

black grama and Indian ricegrass decrease in abundance and sandhill muhly, annuals, and cacti increase. The increasers generally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Shiprock soil is mainly black grama, New Mexico feathergrass, Indian ricegrass, and dropseed. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, black grama and Indian ricegrass decrease in abundance and ring muhly, sandhill muhly, annuals, and cacti increase. The increasers generally occur in small amounts in the potential natural plant community.

Properly managing livestock grazing can protect the unit against soil blowing. Maintaining enough plant residue on the surface can control soil blowing and minimize damage to seedlings.

This unit is not suitable for livestock ponds or range seeding because of seepage and droughtiness. It is suited to such management practices as livestock pipelines and fencing.

432—Winona-Rock outcrop complex, 3 to 20 percent slopes. This map unit is on benches, hills, ridges, and escarpments. Areas are irregular in shape and are 100 to 2,500 acres in size. The native vegetation is mainly grasses, shrubs, and scattered juniper. Elevation is 6,000 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 55 percent Winona very gravelly loam, 3 to 20 percent slopes, and 30 percent Rock outcrop. The Winona soil is on ridges, hills, and benches, and the Rock outcrop is on escarpments, hills, and ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Harvey soils on hilltops and in depressions, mainly near the boundary of Socorro County, and small areas of Penistaja soils on hills. Included areas make up about 15 percent of the total acreage.

The Winona soil is very shallow or shallow and is well drained. It formed in alluvium and windblown sediments derived dominantly from limestone. Typically, the surface layer is brown very gravelly loam about 3 inches thick. The subsoil is pale brown and very pale brown very cobbly loam about 7 inches thick. Limestone is at a depth of about 10 inches. In some areas the slope is more than 20 percent.

Permeability is moderate in the Winona soil. Available water capacity is very low. The effective rooting depth is 5 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed limestone, some of which is very slightly weathered.

This unit is used for livestock grazing. The potential natural plant community on the Winona soil is mainly blue grama, New Mexico feathergrass, sideoats grama, western wheatgrass, little bluestem, and winterfat. The average annual production of air-dry vegetation ranges from 850 pounds per acre in favorable years to 300 pounds in unfavorable years. If the plant community deteriorates, New Mexico feathergrass, sideoats grama, western wheatgrass, and winterfat decrease in abundance and blue grama, bottlebrush squirreltail, and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community.

The Winona soil is not suitable for such management practices as livestock pipelines and range seedling because of the depth to bedrock and the very low available water capacity. Good grazing management can increase the productivity and reproduction potential of New Mexico feathergrass, sideoats grama, and little bluestem.

434—Rizozo-Rock outcrop association, 3 to 55 percent slopes. This map unit is on hills, mesas, escarpments, ridges, and ledges. Areas are irregular in shape and are 100 to 1,100 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 6,000 to 6,700 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 45 percent Rizozo sandy loam, 3 to 55 percent slopes, and 40 percent Rock outcrop. The Rizozo soil is on hills, mesa tops, and ridges, and the Rock outcrop is on hills, ridges, ledges, and escarpments.

Included in this unit are small areas of Penistaja and Oelop soils in depressions and drainageways, Suwanee soils along drainageways, Bond soils on mesa tops and hills, and riverwash along drainageways. Included areas make up about 15 percent of the total acreage.

The Rizozo soil is very shallow or shallow and is well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is reddish brown sandy loam about 2 inches thick. The underlying material is reddish brown sandy loam about 6 inches

thick. Below this is weathered sandstone about 2 inches thick. Unweathered sandstone is at a depth of about 10 inches.

Permeability is moderate in the Rizozo soil. Available water capacity is very low. The effective rooting depth is 4 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone on hills, ridges, ledges, and escarpments.

This unit is used for livestock grazing. The potential natural plant community on the Rizozo soil is mainly sideoats grama, blue grama, little bluestem, and oneseed juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, sideoats grama and little bluestem decrease in abundance and blue grama and threeawn increase. The increasers generally occur in small amounts in the potential natural plant community.

The Rizozo soil is not suitable for such management practices as livestock pipelines and range seeding because of the depth to bedrock and the low precipitation. Good grazing management can increase the productivity and reproduction potential of sideoats grama and little bluestem.

446—Harvey-Oelop association, 0 to 5 percent slopes. This map unit is on fan terraces and mesas. Areas are irregular in shape and are 100 to 1,900 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,000 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 55 percent Harvey loam, 1 to 5 percent slopes, and 30 percent Oelop loam, 0 to 2 percent slopes. The Harvey soil is on mesa tops and fan terraces, and the Oelop soil is in valleys and in drainageways on mesas. In areas near the boundary of the soil survey of the eastern part of Valencia County, the soils have a less well developed subsoil.

Included in this unit are small areas of Penistaja and Hagerman soils on mesas, Winona soils on the tops and sides of mesas, and soils that are similar to the Harvey soil but are very gravelly in the subsoil, are moderately deep, and are on the sides of mesas, mainly near the boundary of Socorro County. Included areas make up about 15 percent of the total acreage.

The Harvey soil is deep and well drained. It formed in alluvium and windblown sediments derived dominantly from limestone. Typically, the surface layer is brown loam about 2 inches thick. The upper part of the subsoil is reddish yellow and light brown clay loam about 18 inches thick, and the lower part to a depth of 60 inches is pink loam.

Permeability is moderate in the Harvey soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Oelop soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is dark yellowish brown loam about 3 inches thick. The upper part of the subsoil is dark yellowish brown clay loam about 13 inches thick, and the lower part to a depth of 60 inches is dark yellowish brown clay loam and loam.

Permeability is moderately slow in the Oelop soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used for livestock grazing. The potential natural plant community on the Harvey soil is mainly black grama, sideoats grama, western wheatgrass, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, black grama, western wheatgrass, sideoats grama, and winterfat decrease in abundance and blue grama, broom snakeweed, and cacti increase. The increasers generally occur in small amounts in the potential natural plant community.

Properly managing livestock grazing can protect the Harvey soil against soil blowing and water erosion. Loss of the surface layer results in a severe decrease in productivity and in the potential of the soil to produce plants suitable for grazing. If the plant cover is disturbed, special treatment is needed to control gullying and sheet erosion. Good grazing management can increase the productivity and reproduction potential of western wheatgrass, black grama, and winterfat. This soil is suitable as a site for livestock ponds.

The potential natural plant community on the Oelop soil is mainly western wheatgrass, vine mesquite, alkali sacaton, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 2,000 pounds per acre in favorable years to 900 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, vine mesquite, and fourwing saltbush decrease in abundance and blue grama, galleta, mat muhly, and walkingstick cholla increase. The increasers generally occur in small amounts in the potential natural plant community.

Properly managing livestock grazing can protect the Oelop soil against water erosion. Deterioration of the

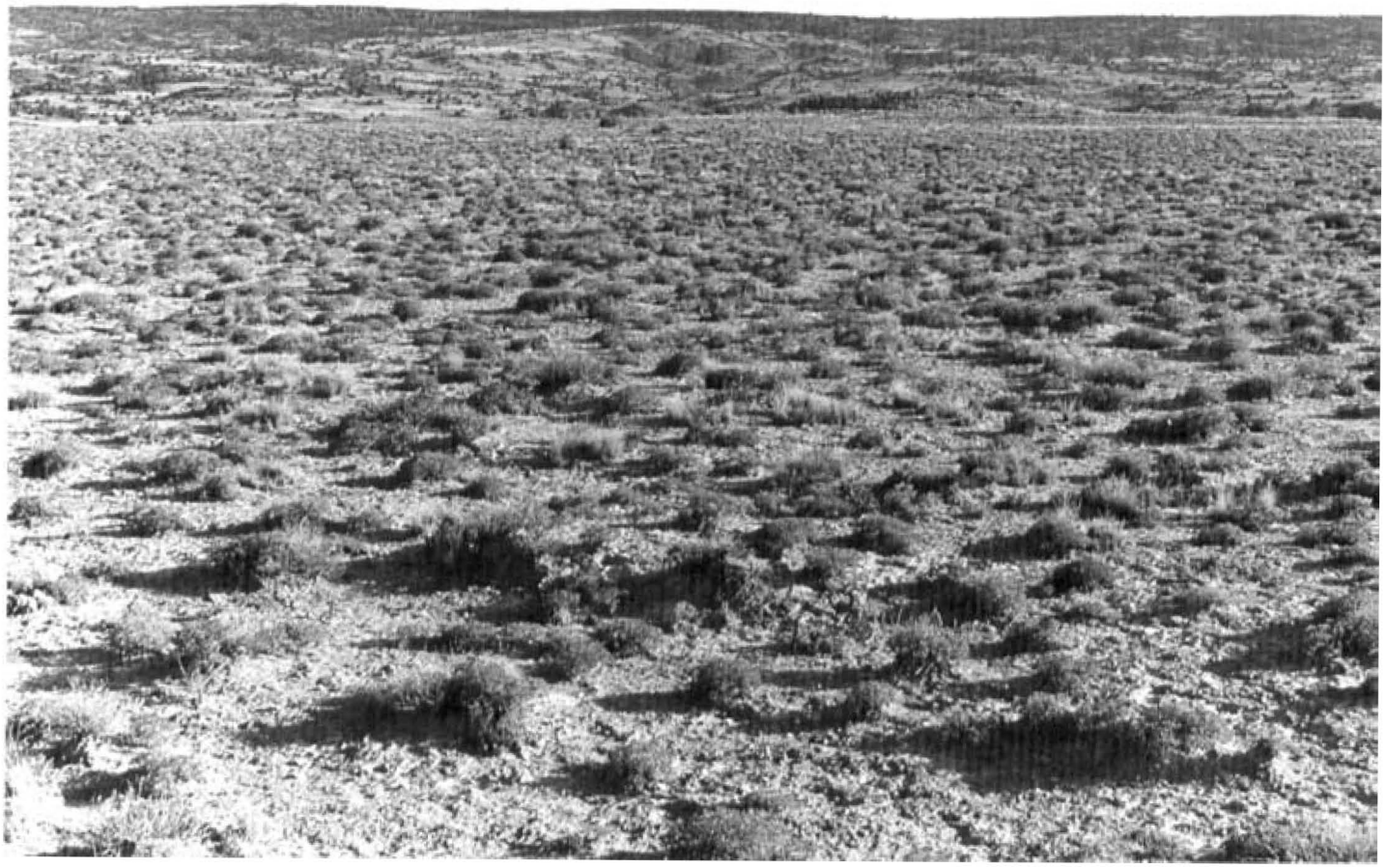

Figure 7.—Typical area of Saido loam, 1 to 12 percent slopes. This is a gypsiferous soil.

plant community often results in the formation of rills and gullies that drain the soil and hinder the production of vegetation. Because of seepage and piping, this soil is not suitable as a site for earthen structures and livestock ponds. Good grazing management can increase the productivity and reproduction potential of western wheatgrass, vine mesquite, and alkali sacaton.

476—Saido loam, 1 to 12 percent slopes. This deep, well drained soil is on fans and knolls. It formed in alluvium derived dominantly from gypsum (fig. 7). Areas are oval or elongated and are 50 to 800 acres in size. The native vegetation is mainly shrubs and forbs. Elevation is 5,500 to 6,400 feet. The average annual precipitation is about 8 to 12 inches, the average annual air temperature is 51 to 53 degrees F, and the average frost-free period is 130 to 150 days.

Typically, the surface layer is reddish brown loam about 2 inches thick. The upper part of the subsoil is white, gypsiferous loam about 9 inches thick, and the lower part to a depth of 60 inches is very pale brown and white loam. In some areas the surface layer is eroded. In areas near the boundary of Socorro County, the soils have a higher content of calcium carbonate and rock fragments.

Included in this unit are small areas of Navajo and Suwanee soils on alluvial fans and flood plains, Netoma soils on fan terraces and valley sides, Sheppard soils on dunes, and soils that are similar to the Netoma soil but are more silty, are shallow or moderately deep over gypsum, and are on plains. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Saido soil. Available water capacity also is moderate. The effective rooting

depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. The soil has more than 40 percent gypsum below a depth of 2 inches.

This unit is used for livestock grazing. The potential natural plant community is mainly alkali sacaton, black grama, blue grama, gyp grama, fourwing saltbush, and winterfat. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 350 pounds in unfavorable years. If the plant community deteriorates, black grama and alkali sacaton decrease in abundance and gyp muhly and gray coldenia increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is not suitable as a site for livestock ponds because of the content of gypsum and a potential for piping. Good grazing management can increase the productivity and reproduction potential of black grama and bush muhly.

485—Rock outcrop-Mion complex, 15 to 65 percent slopes. This map unit is on hills, escarpments, and benches. Areas are irregular in shape and are 75 to 2,000 acres in size. The native vegetation is mainly grasses, shrubs, and scattered trees. Elevation is 6,000 to 6,700 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 120 to 160 days.

This unit is 60 percent Rock outcrop and 35 percent Mion stony loam, 15 to 65 percent slopes, extremely stony. The Rock outcrop is on escarpments and benches, and the Mion soil is on hills and benches. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Hagerman and Bond soils and Badland on hills, mainly near the boundary of Socorro County; Penistaja and Harvey soils on the lower hill slopes; Flaco and Berto soils on hills and in the lower areas underlain by basalt; on hills, soils that are similar to the Mion soil but are moderately deep over shale; and Skyvillage soils on ridges, mainly near the boundary of Bernalillo County. Included areas make up about 5 percent of the total acreage.

The Rock outcrop consists barren or nearly barren areas of exposed sandstone, basalt, limestone, or gypsum on steep escarpments and benches.

The Mion soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from shale and sandstone. Typically, the surface layer is light olive brown stony loam about 3 inches thick. The underlying material is about 10 inches of grayish brown silty clay and silty clay loam. Shale is at a depth of about 13 inches.

Permeability is very slow in the Mion soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is very rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

This unit is used for livestock grazing. The potential natural plant community on the Mion soil is mainly blue grama, sideoats grama, New Mexico feathergrass, black grama, sacahuista, and oneseed juniper. The average annual production of air-dry vegetation ranges from 750 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, black grama and New Mexico feathergrass decrease in abundance and blue grama and threeawn increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is limited as a site for such management practices as livestock pipelines and mechanical brush control because of the depth to bedrock and the slope. Good grazing management can increase the productivity and reproduction potential of black grama and New Mexico feathergrass.

487—Mion-Badland complex, 20 to 65 percent slopes. This map unit is on hills, escarpments, benches, and ridges. Areas are elongated and are 100 to 2,500 acres in size. The native vegetation is mainly grasses, shrubs, and scattered trees. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 50 to 54 degrees F, and the average frost-free period is 120 to 160 days.

This unit is 50 percent Mion loam, 20 to 65 percent slopes, and 30 percent Badland. The Mion soil is on benches, hills, and ridges, and the Badland is on hills and escarpments. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of sandstone, limestone, and gypsum outcrops on benches and escarpments; Winona soils on hills; Skyvillage soils on benches and hills; and soils that are similar to the Mion soil but are moderately deep over shale. Included areas make up about 20 percent of the total acreage.

The Mion soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from shale. Typically, the surface layer is brown loam about 1 inch thick. The underlying material is about 15 inches of brown and grayish brown clay and silty clay. Shale is at a depth of about 16 inches. In areas near the boundary of Bernalillo County, the soil has less clay. In places it has more sand or gravel.

Permeability is very slow in the Mion soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

The Badland occurs as areas of exposed shale. It supports essentially no vegetation. It commonly is dissected.

This unit is used on a limited basis for livestock grazing. The potential natural plant community is mainly blue grama, sideoats grama, New Mexico feathergrass, black grama, sacahuista, and oneseed juniper. The average annual production of air-dry vegetation ranges from 750 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, black grama and New Mexico feathergrass decrease in abundance and blue grama and threeawn increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is limited as a site for such management practices as livestock pipelines and mechanical brush control because of the depth to rock and the slope. Good grazing management can increase the productivity and reproduction potential of black grama and New Mexico feathergrass.

500—Timhus-Bandera association, 20 to 50 percent slopes. This map unit is on the sides of cinder cones. Areas are oval and are 150 to 400 acres in size. The native vegetation is mainly pinyon, juniper, and ponderosa pine. Elevation is 7,400 to 8,100 feet. The average annual precipitation is about 14 to 20 inches, the average annual air temperature is 40 to 49 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 45 percent Timhus extremely gravelly loam, 20 to 50 percent slopes, and 40 percent Bandera very gravelly loam, 20 to 45 percent slopes. The Timhus soil is on the south-facing side slopes of the cinder cones, and the Bandera soil is on the north-facing side slopes of the cinder cones.

Included in this unit are small areas of Microy soils on the north-facing side slopes of the cinder cones and Cantina and Cabezon soils on the lower parts of hills. Included areas make up about 15 percent of the total acreage.

The Timhus soil is deep and somewhat excessively drained. It formed in colluvial material and windblown volcanic sediments. Typically, the surface layer is yellowish brown extremely gravelly loam about 5 inches thick. The upper part of the subsoil is yellowish brown and light yellowish brown very gravelly loam about 15 inches thick, and the lower part is light yellowish brown extremely gravelly loam about 9 inches thick. Cinders are at a depth of about 29 inches. The depth to cinders ranges from 29 to 60 inches. In some areas the slope is less than 20 percent.

Permeability is moderate in the Timhus soil. Available water capacity is very low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

The Bandera soil is deep and somewhat excessively drained. It formed in colluvial material and windblown volcanic sediments. Typically, the surface layer is dark brown very gravelly loam about 3 inches thick. The subsurface layer is dark brown gravelly loam about 5 inches thick. The underlying material is dark yellowish brown very gravelly loam about 8 inches thick. Cinders are at a depth of about 16 inches. The depth to cinders ranges from 16 to 60 inches.

Permeability is moderate in the Bandera soil. Available water capacity is very low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

This unit is used for wood products and livestock grazing.

The site index for pinyon and juniper on the Timhus soil ranges from 25 to 40. Based on a site index of 33, this soil can produce 4 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is mainly blue grama, bottlebrush squirreltail, mountain muhly, and fourwing saltbush. The production of understory can be increased by reducing the density of the canopy. The slope limits access by livestock.

The Bandera soil is suited to the production of ponderosa pine. The site index averages 63 in areas that have slopes of 20 to 35 percent and is 54 to 58 in areas that have slopes of more than 35 percent. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting ponderosa pine are the hazard of erosion and equipment limitations in the steeper areas, seedling mortality, and plant competition. When timber is harvested, minimizing the risk of erosion is essential. Conventional methods of harvesting can be used in the less sloping areas, but their use is restricted in the steeper areas. Areas that have slopes of more than 35 percent are not suited to conventional harvesting methods. Special design of logging roads, skid trails,

and landings is needed in the steeper areas. Erosion-control structures and seeding can protect the roads against erosion. The seedling mortality rate is moderate because of the low available water capacity.

The understory vegetation on this unit is Arizona fescue, mountain muhly, prairie junegrass, and Gambel oak.

505—Flugle-Goesling loamy fine sands, 1 to 8 percent slopes. This map unit is on fan terraces, hills, mesas, and ridges. Areas are irregular in shape and are 75 to 1,500 acres in size. The native vegetation is mainly grasses, shrubs, and a few scattered trees. Elevation is 6,000 to 6,800 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 53 degrees F, and the average frost-free period is 115 to 135 days.

This unit is 55 percent Flugle loamy fine sand, 1 to 8 percent slopes, and 25 percent Goesling loamy fine sand, 1 to 8 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. In areas near the boundary of Catron County, the soils are moderately deep and slightly drier.

Included in this unit are small areas of Catman and Silkie soils in swales and valleys and Celacy, Atarque, and Quintana soils and Rock outcrop on hills and ridges. Included areas make up about 20 percent of the total acreage.

The Flugle soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is brown loamy fine sand about 5 inches thick. The upper part of the subsoil is strong brown and brown sandy clay loam about 22 inches thick, the next part is light brown sandy clay loam about 14 inches thick, and the lower part to a depth of 60 inches is pink sandy loam.

Permeability is moderate in the Flugle soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Goesling soil is deep and well drained. It formed in wind-modified alluvium derived dominantly from sandstone. Typically, the surface layer is light brown loamy fine sand about 5 inches thick. The upper part of the subsoil is brown and light brown sandy clay loam about 13 inches thick. The lower part to a depth of 60 inches is light yellowish brown, very pale brown, and white sandy loam and loam. It has a high content of calcium carbonate in some part.

Permeability is moderately slow in the Goesling soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, New Mexico feathergrass, galleta, blue grama, and winterfat. The average annual production of air-dry vegetation ranges from 1,100 pounds per acre in favorable years to 600 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and New Mexico feathergrass decrease in abundance and blue grama and rabbitbrush increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as range seeding, fencing, and livestock pipelines. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

514—Raton-Rock outcrop complex, 1 to 10 percent slopes. This map unit is in swales on old lava flows, in depressions, and on ridges. Areas are irregular in shape and are 200 to 800 acres in size. The native vegetation is mainly ponderosa pine and an understory of grasses. Elevation is 7,200 to 8,000 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 55 percent Raton very cobbly loam, 1 to 10 percent slopes, extremely stony, and 25 percent Rock outcrop. The Raton soil is in swales on old lava flows, in depressions, and on ridgetops, and the Rock outcrop is on ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Charo soils in swales; on ridgetops, soils are that are similar to the Raton soil but are loamy; and, in depressions and swales, soils that are similar to the Raton soil but have a lighter colored surface layer. Included areas make up about 20 percent of the total acreage.

The Raton soil is very shallow or shallow and is well drained. It formed in windblown sediments and alluvium over basalt. Typically, the surface layer is dark reddish brown very cobbly loam about 5 inches thick. The subsoil is reddish brown very cobbly clay about 8 inches thick. Basalt is at a depth of about 13 inches. In most places the soil is covered by layer of pine needles and litter about 1 inch thick.

Permeability is slow in the Raton soil. Available water capacity is very low. The effective rooting depth is 6 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren

areas of exposed basalt on the sides of ridges.

This unit is used for wood products and livestock grazing.

The Raton soil is poorly suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 41 to 44. Based on a site index of 40, the potential production of merchantable timber is 1,480 cubic feet, or 3,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 30 cubic feet, or 84 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are equipment limitations, seedling mortality, the hazard of windthrow, a slow growth rate, and a low stocking rate. The Rock outcrop restricts the movement of equipment, and sharp, angular cobbles and stones cause abnormal wear of rubber-tired equipment. The seedling mortality rate is high because of the very low available water capacity, the restricted rooting depth, and a high evaporation rate. Trees are subject to windthrow because of the limited rooting depth. A below-normal stocking rate limits yields.

The understory vegetation on this unit is blue grama, little bluestem, sideoats grama, mountain muhly, skunkbush sumac, and Apacheplume. The canopy cover, which ranges from 12 to 22 percent, allows for good production of grasses and forbs.

The average annual production of air-dry understory vegetation ranges from 1,300 pounds per acre in favorable years to 800 pounds in unfavorable years. If the plant community deteriorates, Arizona fescue, little bluestem, and sideoats grama decrease in abundance and threeawn, ring muhly, and broom snakeweed increase. The increasers generally occur in small amounts in the plant community.

This unit is not suitable for such management practices as fencing, livestock ponds, and livestock pipelines because of the depth to bedrock and the Rock outcrop. Constructing trails or walkways can allow livestock to graze in areas where access is limited.

515—Rock outcrop-Vessilla-Mion complex, 3 to 55 percent slopes. This map unit is on escarpments, ridges, and hills. Areas are irregularly shaped and are 120 to 2,000 acres in size. The native vegetation is mainly trees and shrubs. Elevation is 6,500 to 7,400 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 47 to 53 degrees F, and the average frost-free period is 115 to 130 days.

This unit is 45 percent Rock outcrop, 20 percent Vessilla sandy loam, 3 to 55 percent slopes, and 20 percent Mion loam, 3 to 55 percent slopes. The Rock outcrop is on steep escarpments and ridges, the Vessilla soil is on the north-facing slopes of hills and ridges, and the Mion soil is on the south-facing slopes of hills and ridges. In areas near the boundary of Catron County, the soils are more highly developed and have a darker surface layer.

Included in this unit are small areas of Nogal, Celacy, and Galestina soils on hills; soils that are similar to the Mion and Vessilla soils but are moderately deep and are on hills and side slopes; Catman and Silkie soils in valleys; Hickman soils in valleys and on alluvial fans; and Flugle soils on hillsides. Included areas make up about 15 percent of the total acreage.

The Rock outcrop consists of barren or nearly barren areas of sandstone or shale.

The Vessilla soil is shallow or very shallow and is well drained. It formed in eolian and colluvial material derived dominantly from sandstone. Typically, the surface layer is reddish yellow sandy loam about 3 inches thick. The underlying material is light brown sandy loam about 12 inches thick. Sandstone is at a depth of about 15 inches. In some areas the soil is underlain by shale.

Permeability is moderately rapid in the Vessilla soil. Available water capacity is very low. The effective rooting depth is 6 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

The Mion soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from shale. Typically, the surface layer is brown loam about 2 inches thick. The underlying material is about 9 inches of yellowish brown silty clay and clay. Shale is at a depth of about 11 inches.

Permeability is very slow in the Mion soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

This unit is used for livestock grazing and limited wood products.

The site index for pinyon and juniper is 20 in areas of the Mion soil and 58 in areas of the Vessilla soil. The Mion soil can produce about 2 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot, and the Vessilla soil can produce about 8 cords.

The suitability of this unit for the production of pinyon and juniper is limited because of the slope, the hazard of windthrow, plant competition, and the hazard of erosion. The use of equipment is limited by the Rock outcrop and the slope. Trees are subject to windthrow because of the limited rooting depth. Carefully managing reforestation can minimize competition from

undesirable understory plants. Brushy plants, such as oak, limit the natural regeneration of pinyon and juniper.

Good management is needed to protect the soils against excessive water erosion. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality.

The understory vegetation on this unit is blue grama, Indian ricegrass, western wheatgrass, hairy grama, and forbs. Reducing the density of the canopy can increase the production of understory plants.

518—Borrego-Charo-Rock outcrop complex, 1 to 10 percent slopes. This map unit is on basalt ridges and lava flows and in swales. Areas are irregular in shape and are 200 to 1,000 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 7,200 to 7,500 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 40 percent Borrego loam, 2 to 10 percent slopes, very stony; 30 percent Charo loam, 1 to 5 percent slopes; and 15 percent Rock outcrop. The Borrego soil is on basalt ridges, the Charo soil is in swales, and the Rock outcrop is on basalt ridges and lava flows.

Included in this unit are small areas of Hackroy soils on lava flows and ridges and in swales, Cebolleta soils on lava flows and in swales, and Trag soils in swales. Included areas make up about 15 percent of the total acreage.

The Borrego soil is shallow and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the surface layer is brown loam about 3 inches thick. The subsoil is strong brown clay about 8 inches thick. Basalt is at a depth of about 11 inches. In some areas a layer in which calcium carbonate has accumulated is directly above the basalt.

Permeability is very slow in the Borrego soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

The Charo soil is moderately deep and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the upper part of the surface layer is brown loam about 2 inches thick. The lower part is brown clay loam about 4 inches thick. The subsoil is brown clay about 21 inches thick. Basalt is at a depth of about 27 inches. In some areas a layer in which calcium carbonate has accumulated is directly above the basalt.

Permeability is slow in the Charo soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on lava flows and ridges.

This unit is used for livestock grazing and wood products.

The site index for ponderosa pine on the Borrego soil ranges from 52 to 58. Based on a site index of 55, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber on the Borrego soil are equipment limitations, seeding mortality, and the hazard of windthrow. Stones on the surface can interfere with felling, yarding, and other activities involving the use of equipment. The seedling mortality rate is high because of the very low available water capacity and the clayey texture. The understory vegetation is gray horsebrush, Arizona fescue, blue grama, and mountain muhly.

The potential natural plant community on the Charo soil is mainly mountain muhly, Arizona fescue, muttongrass, western wheatgrass, and prairie junegrass. The average annual production of air-dry vegetation ranges from 1,050 pounds per acre in favorable years to 650 pounds in unfavorable years. If the plant community deteriorates, mountain muhly, western wheatgrass, and prairie junegrass decrease in abundance and Stipa and blue grama increase. The increasers generally occur in small amounts in the potential natural plant community.

The Charo soil is suited to such management practices as range seeding and livestock pipelines. It is not suitable as a site for livestock ponds because of the depth to bedrock.

520—Celacy-Atarque complex, 1 to 10 percent slopes. This map unit is on mesa tops, cuestas, and hilltops. Areas are irregular in shape and are 50 to 2,500 acres in size. The native vegetation is mainly grasses and some scattered trees. Elevation is 6,600 to 7,300 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 130 days.

This unit is 55 percent Celacy sandy loam, 1 to 5

percent slopes, and 30 percent Atarque fine sandy loam, 2 to 10 percent slopes. The Celacy soil is on mesa tops and the lower dip slopes of cuestas, and the Atarque soil is on mesa tops, the upper dip slopes of cuestas, and hilltops. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Flugle and Goesling soils in valleys between hills and on mesa tops, Catman soils in depressions and drainageways, and Rock outcrop on ledges, escarpments, and hilltops. Included areas make up about 15 percent of the total acreage.

The Celacy soil is moderately deep and well drained. It formed in alluvium and eolian material derived dominantly from sandstone. Typically, the surface layer is strong brown sandy loam about 2 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 10 inches thick, and the lower part is reddish yellow sandy clay loam about 12 inches thick. Sandstone is at a depth of about 24 inches.

Permeability is moderate in the Celacy soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Atarque soil is shallow or very shallow and is well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 2 inches thick. The subsoil is brown sandy clay loam about 14 inches thick. Sandstone is at a depth of about 16 inches.

Permeability is moderate in the Atarque soil. Available water capacity is very low. The effective rooting depth is 8 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing and fuel wood production.

The potential natural plant community on the Celacy soil is mainly blue grama, western wheatgrass, pinyon, and oneseed juniper. The average annual production of air-dry vegetation ranges from 875 pounds per acre in favorable years to 300 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, Indian ricegrass, pinyon ricegrass, and prairie junegrass decrease in abundance and blue grama, threeawn, pinyon, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Atarque soil is mainly sideoats grama, New Mexico feathergrass, Indian ricegrass, blue grama, and scattered oneseed juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, New Mexico feathergrass, and Indian ricegrass decrease in abundance and blue grama, sand sagebrush, broom snakeweed, and oneseed juniper increase. The increasers generally occur in small amounts in the potential natural plant community.

The site index for pinyon and juniper on the Celacy and Atarque soils ranges from 13 to 16. Based on a site index of 15, the soils can produce about 2 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The soils are suited to such management practices as range seeding. In some areas dense stands of pinyon and juniper may become established. If properly managed, a limited wood crop can be produced in these areas. Reducing the density of the canopy can increase the production of understory grasses.

522—Bandera association, 15 to 45 percent slopes. This map unit is on cinder cones and hills. Areas are irregular in shape and are 50 to 600 acres in size. The native vegetation is mainly ponderosa pine and a sparse understory of grasses. Elevation is 7,800 to 8,300 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 50 percent Bandera gravelly loam, 30 to 45 percent slopes, and 30 percent Bandera gravelly loam, 15 to 30 percent slopes. The steeper Bandera soil is on cinder cones and the upper hillsides, and the less sloping Bandera soil is on the lower hills.

Included in this unit are small areas of Raton soils on ridges, Charo soils on hills and ridges, and Rock outcrop on hilltops and ridges. Included areas make up about 20 percent of the total acreage.

The steeper Bandera soil is deep and somewhat excessively drained. It formed in colluvium and windblown sediments derived dominantly from cinders. Typically, the surface layer is brown gravelly loam about 3 inches thick. The subsurface layer is dark brown gravelly loam about 5 inches thick. The underlying material is dark yellowish brown very gravelly loam about 10 inches thick. Cinders are at a depth of about 18 inches. A thin layer of undecomposed pine needles covers the surface in some areas.

Permeability is moderate in the steeper Bandera soil. Available water capacity is very low. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The less sloping Bandera soil is deep and somewhat

excessively drained. It formed in colluvium and windblown sediments derived dominantly from cinders. Typically, the surface layer is brown gravelly loam about 4 inches thick. The subsurface layer is brown gravelly loam about 5 inches thick. The underlying material is yellowish brown very gravelly loam about 7 inches thick. Unconsolidated cinders are at a depth of about 16 inches.

Permeability is moderate in the less sloping Bandera soil. Available water capacity is very low. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing and wood products.

This unit is suited to the production of ponderosa pine. The site index for ponderosa pine averages 63 in the less sloping areas and is 54 to 58 in the steeper areas. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting ponderosa pine are the hazard of erosion and equipment limitations in the steeper areas, seedling mortality, and plant competition. Conventional methods of harvesting can be used in the less sloping areas, but their use is limited in the steeper areas. Areas that have slopes of more than 30 percent are not suited to conventional methods of harvesting. Special design of logging roads, skid trails, and landings is needed in the steeper areas. Erosion-control structures and seeding can protect the roads against erosion. The seedling mortality rate is moderate because of the large number of pebbles. Brushy plants, such as Gambel oak, and grasses, such as Arizona fescue and mountain muhly, limit the natural regeneration of ponderosa pine, but they do not prevent the eventual development of a fully stocked, normal stand of trees.

The understory vegetation on this unit is Arizona fescue, mountain muhly, prairie junegrass, Fendler ceanothus, and Gambel oak.

523—Charo-Raton complex, 1 to 10 percent slopes. This map unit is on basalt plains and basalt ridges and in depressions. Areas are irregular in shape and are 200 to 1,200 acres in size. The native vegetation is mainly ponderosa pine, grasses, and shrubs. Elevation is 7,500 to 8,000 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 42 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 45 percent Charo cobbly loam, 1 to 5 percent slopes, and 40 percent Raton very cobbly loam, 2 to 10 percent slopes, very stony. The Charo soil is in swales on basalt plains, and the Raton soil is on basalt ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Rock outcrop on lava ridges, soils that are similar to the Raton soil but have less than 35 percent rock fragments in the subsoil and are on lava ridges, and soils that are similar to the Charo soil but are deep to basalt and are in pockets. Included areas make up about 15 percent of the total acreage.

The Charo soil is moderately deep and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the surface layer is brown cobbly loam about 2 inches thick. The next layer is brown clay loam about 6 inches thick. The subsoil is brown and strong brown clay about 20 inches thick. Basalt is at a depth of about 28 inches.

Permeability is slow in the Charo soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

The Raton soil is shallow and well drained. It formed in alluvium and windblown sediments over basalt. Typically, the surface layer is dark grayish brown very cobbly loam about 2 inches thick. The subsurface layer also is dark grayish brown very cobbly loam. It is about 5 inches thick. The subsoil is brown and strong brown very cobbly clay about 11 inches thick. Basalt is at a depth of about 18 inches. In some areas a layer of pine needle litter about 1 inch thick is on the surface.

Permeability is slow in the Raton soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wood products and livestock grazing.

This unit is suited to the production of ponderosa pine. The site index for ponderosa pine is 54 to 59 on the Raton soil and averages 66 on the Charo soil. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber on the Raton soil are equipment limitations,

seedling mortality, and the hazard of windthrow. Stones on the surface can interfere with felling, yarding, and other activities involving the use of equipment. The seedling mortality rate is moderate because of the very low available water capacity and the high content of clay. Trees are subject to windthrow because of the limited rooting depth.

The main concerns in producing and harvesting timber on the Charo soil are equipment limitations and plant competition. Conventional methods of harvesting timber generally can be used, but their use may be limited when the soil is wet. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Brushy plants, such as Gambel oak and Fendler ceanothus, limit the natural regeneration of ponderosa pine. Trees commonly are subject to windthrow during periods when the soil is excessively wet and winds are strong.

The understory vegetation on this unit is Gambel oak, Fendler ceanothus, gray horsebrush, Arizona fescue, mountain muhly, and blue grama.

525—Catman-Silkie association, 1 to 10 percent slopes. This map unit is in valleys and on fans. Areas are irregular in shape and are 100 to 2,000 acres in size. The native vegetation is mainly grasses, forbs, and shrubs. Elevation is 6,600 to 7,500 feet. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 45 percent Catman clay loam, 1 to 5 percent slopes, and 40 percent Silkie clay loam, 3 to 10 percent slopes. The Catman soil is on valley bottoms, alluvial fans, and the lower valley sides, and the Silkie soil is on the upper valley sides.

Included in this unit are small areas of Hickman soils on valley sides and fans, Flugle and Goesling soils on valley sides, and sandstone and shale outcrops on the upper valley sides. Included areas make up about 15 percent of the total acreage.

The Catman soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is light olive brown clay loam about 3 inches thick. The underlying material to a depth of 60 inches is light olive brown clay. In some areas cracks are in the upper 20 inches when the soil is dry.

Permeability is very slow in the Catman soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. This soil is slightly saline. It is occasionally flooded for long periods in summer.

The Silkie soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is light yellowish brown clay loam about 4 inches thick. The subsoil to a depth of 60 inches is light olive brown clay.

Permeability is very slow in the Silkie soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community on the Catman soil is mainly western wheatgrass, vine mesquite, spike muhly, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 1,250 pounds in unfavorable years. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. If the plant community deteriorates, western wheatgrass, spike muhly, and winterfat decrease in abundance and blue grama, annual grasses and forbs, rabbitbrush, and broom snakeweed increase. The increasers generally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Silkie soil is mainly alkali sacaton, spike muhly, western wheatgrass, bottlebrush squirreltail, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 300 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, spike muhly, and alkali sacaton decrease in abundance and blue grama, cacti, broom snakeweed, and rabbitbrush increase. The increasers generally occur in small amounts in the potential natural plant community.

Deterioration of the plant community on this unit often results in the formation of very deep, vertical-walled gullies that drain the site and hinder the production of vegetation. After the gullies have drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

This unit is suited to such management practices as livestock ponds, fencing, and livestock pipelines.

535—Millpaw loam, 0 to 5 percent slopes. This deep, well drained soil is in swales and valleys. It formed in mixed alluvium. Areas are irregular in shape and are 100 to 1,500 acres in size. The native vegetation is mainly grasses. Elevation is 7,000 to 7,800 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is brown loam about 3

inches thick. The upper 26 inches of the subsoil is dark brown clay loam and clay, and the lower part to a depth of 60 inches is brown and brownish yellow sandy clay loam. In areas near the boundary of Catron County, temperatures are slightly cooler and the soil has a thinner surface layer and a higher content of calcium carbonate.

Included in this unit are small areas of Catman soils on valley bottoms and in depressions, Montecito soils on valley sides and bottoms, and Flugle, Galestina, and Pinitos soils on valley sides. Included areas make up about 15 percent of the total acreage.

Permeability is slow in the Millpaw soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing and some dryland farming.

The potential natural plant community on this unit is mainly western wheatgrass, New Mexico feathergrass, galleta, blue grama, and winterfat. The average annual production of air-dry vegetation ranges from 1,100 pounds per acre in favorable years to 600 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and New Mexico feathergrass decrease in abundance and blue grama and rabbitbrush increase. The increasers generally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as range seeding, fencing, livestock ponds, and livestock pipelines. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

If this unit is used for nonirrigated crops, the main limitation is the low precipitation.

536—McGaffey loam, 1 to 5 percent slopes. This deep, well drained soil is on fan terraces and valley floors. It formed in mixed alluvium. Areas are irregular in shape and are 100 to 600 acres in size. The native vegetation is mainly grasses and trees. Elevation is 7,500 to 8,500 feet. The average annual precipitation is about 18 to 22 inches, the average annual air temperature is 40 to 44 degrees F, and the average frost-free period is 90 to 105 days.

Typically, the surface layer is reddish brown loam about 3 inches thick. The subsoil is about 30 inches of reddish brown loam and clay loam. The substratum to a depth of 60 inches is reddish brown and reddish yellow loam and clay loam.

Included in this unit are small areas of Charo soils on mesas, Moreno soils on fan terraces, and Raton soils on lava ridges. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the McGaffey soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

This unit is used for livestock grazing (fig. 8) and wood products.

This unit is well suited to the production of ponderosa pine. The site index ranges from 83 to 93. Based on a site index of 90, the potential production of merchantable timber is 6,700 cubic feet, or 40,300 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 85 cubic feet, or 403 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of erosion and plant competition. When timber is harvested, minimizing the risk of water erosion is essential. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality. Grasses, forbs, and shrubs limit the natural regeneration of ponderosa pine. Properly preparing the site can control competing vegetation.

The understory vegetation on this unit is Arizona fescue, mountain muhly, and western wheatgrass.

537—Millpaw-Loarc complex, 0 to 10 percent slopes. This map unit is on fan terraces, in swales, and on mesa tops and hills. Areas are irregular in shape and are 100 to 1,500 acres in size. The native vegetation is mainly pinyon and oneseed juniper and an understory of grasses. Elevation is 7,200 to 7,800 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 50 percent Millpaw loam, 0 to 5 percent slopes, and 35 percent Loarc fine sandy loam, 0 to 10 percent slopes. The Millpaw soil is in swales and on mesa tops, and the Loarc soil is on mesa tops, fan terraces, and hills. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. In areas near the boundary of Catron County, temperatures are slightly cooler and the soils have a thinner surface layer and a higher content of calcium carbonate.

Included in this unit are small areas of Pinitos and

Figure 8.—An area of McGaffey loam, 1 to 5 percent slopes, used for livestock grazing.

Ribera soils on fan terraces and mesa tops, Galestina soils on fan terraces and hills, Catman soils in depressions, and Cabezon soils on hills. Included areas make up about 15 percent of the total acreage.

The Millpaw soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown loam about 2 inches thick. The upper part of the subsoil is brown and strong brown sandy clay about 35 inches thick, and the lower part to a depth of 60 inches is strong brown sandy clay and sandy clay loam.

Permeability is slow in the Millpaw soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Loarc soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown fine sandy loam about 4 inches thick. The upper part of the subsoil is brown and dark yellowish brown sandy clay loam about 27 inches thick, and the lower part to a depth of 60 inches is yellowish brown sandy clay loam.

Permeability is moderate in the Loarc soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on this unit ranges from 40 to 52. Based on a site index of 46, the

unit can produce about 7 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is blue grama, bottlebrush squirreltail, pinyon ricegrass, and rabbitbrush.

540—Montecito fine sandy loam, 1 to 15 percent slopes. This deep, well drained soil is on mesas and ridges. It formed in mixed alluvium and windblown sediments. Areas are irregular in shape and are 200 to 2,000 acres in size. The native vegetation is mainly pinyon, juniper, and grasses. Elevation is 6,800 to 7,300 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 100 to 120 days.

Typically, the surface layer is brown fine sandy loam about 5 inches thick. The upper part of the subsoil is brown and strong brown clay about 25 inches thick, and the lower part to a depth of 60 inches is pink gravelly clay loam. In some areas on Santa Rita Mesa, near Fence Lake, the soil has indurated caliche at a depth of less than 40 inches.

Included in this unit are small areas of Millpaw soils in depressions, Pinitos and Ribera soils on mesas and ridges, and Loarc soils on mesas. Included areas make up about 25 percent of the total acreage.

Permeability is moderately slow in the Montecito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for wood products and livestock grazing.

The site index for pinyon and juniper on this unit ranges from 25 to 35. Based on a site index of 30, the unit can produce about 3 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is blue grama, muttongrass, western wheatgrass, spineless horsebrush, and fringed sagebrush.

550—Nogal-Galestina sandy loams, 1 to 10 percent slopes. This map unit is on mesa tops and hills. Areas are irregular in shape and are 100 to 2,500 acres in size. The native vegetation is mainly grasses, pinyon, and scattered juniper. Elevation is 6,800 to 7,500 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 45 percent Nogal sandy loam, 1 to 10 percent slopes, and 35 percent Galestina sandy loam, 1 to 8 percent slopes. Both soils are on mesa tops and hills. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in areas near the boundary of Catron County have a higher content of calcium carbonate and are drier in the subsoil. Those in areas near the boundary of Socorro County have a less well developed subsoil.

Included in this unit are small areas of Rock outcrop on hills, ridges, and escarpments; Silkie soils on valley sides; shallow, fine textured soils on hills; and Pinitos and Ribera soils on mesa tops. Included areas make up about 20 percent of the total acreage.

The Nogal soil is moderately deep and well drained. It formed in alluvium derived dominantly from interbedded sandstone and shale. Typically, the surface layer is brown sandy loam about 1 inch thick. The upper 18 inches of the subsoil is brown clay loam and clay, and the lower 12 inches is strong brown clay. Hard, interbedded sandstone and shale are at a depth of about 31 inches.

Permeability is slow in the Nogal soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Galestina soil is deep and well drained. It formed in alluvium derived dominantly from sandstone and shale. Typically, the surface layer is yellowish brown sandy loam about 2 inches thick. The subsurface layer is yellowish brown loam about 5 inches thick. The upper part of the subsoil is yellowish brown clay about 24 inches thick, and the lower part is yellowish brown and light yellowish brown clay about 15 inches thick. Shale is at a depth of about 46 inches.

Permeability is slow in the Galestina soil. Available water capacity is moderate. The effective rooting depth is 40 to 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on the Nogal soil ranges from 21 to 50. Based on a site index of 35, the soil can produce about 6 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The suitability for the production of pinyon and juniper is limited because of the medium runoff and the low available water capacity.

The understory vegetation on the Nogal soil is western wheatgrass, blue grama, prairie junegrass,

Gambel oak, and forbs. Reducing the density of the canopy can increase the production of understory plants.

The potential natural plant community on the Galestina soil is mainly western wheatgrass, New Mexico feathergrass, sideoats grama, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, New Mexico feathergrass, sideoats grama, and winterfat decrease in abundance and blue grama, galleta, and cactus increase. The increasers generally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of cool-season grasses. If the plant cover is disturbed, special treatment is needed to control gullying and sheet erosion.

555—Pinitos-Ribera sandy loams, 1 to 10 percent slopes. This map unit is on mesa tops and gently rolling hills. Areas are irregular in shape and are 150 to 2,000 acres in size. The native vegetation is mainly grasses, pinyon, and scattered juniper and ponderosa pine. Elevation is 6,800 to 7,500 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 50 percent Pinitos sandy loam and 30 percent Ribera sandy loam. Both soils are on mesa tops and hills. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in areas near the boundary of Catron County have a higher content of clay in the subsoil. Those in areas near the boundary of Socorro County are less well developed and are shallower.

Included in this unit are small areas of Galestina and Nogal soils between hills and in depressions; Rock outcrop on hilltops, ridges, ledges, and escarpments; soils that are similar to the Ribera soil but are shallow and are on hilltops and ridgetops; and Catman soils along drainageways. Included areas make up about 20 percent of the total acreage.

The Pinitos soil is deep and well drained. It formed in wind-modified alluvium derived dominantly from sandstone. Typically, the surface layer is light brown sandy loam about 2 inches thick. The upper part of the subsoil is brown and light brown sandy clay loam about 22 inches thick, and the lower part to a depth of 60 inches is light brown sandy loam.

Permeability is moderate in the Pinitos soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Ribera soil is moderately deep and well drained. It formed in wind-modified alluvium derived dominantly from sandstone. Typically, the surface layer is brown sandy loam about 3 inches thick. The upper 13 inches of the subsoil is brown and yellowish brown sandy clay loam, and the lower 23 inches is yellowish brown and brown sandy clay loam and clay loam. Sandstone is at a depth of about 39 inches.

Permeability is moderate in the Ribera soil. Available water capacity also is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on this unit ranges from 40 to 50. Based on a site index of 45, the unit can produce about 7 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is western wheatgrass, blue grama, big sagebrush, bottlebrush squirreltail, and pinyon ricegrass. Reducing the density of the canopy can increase the production of understory plants.

560—Flugle-Teco association, 1 to 8 percent slopes. This map unit is on mesas and ridges and in swales. Areas are irregular in shape and are 500 to 6,000 acres in size. The native vegetation is mainly grasses and trees. Elevation is 6,600 to 7,000 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 135 days.

This unit is 50 percent Flugle loamy fine sand, 3 to 8 percent slopes, and 30 percent Teco sandy loam, 1 to 4 percent slopes. The Flugle soil is on ridges and mesas, and the Teco soil is on ridges and mesas and in swales. The soils in areas near the boundary of Apache County, Arizona, have a lower content of clay in the subsoil. Those in areas near the boundary of Catron County are moderately deep over bedrock.

Included in this unit are small areas of Hickman and Catman soils along drainageways and in swales; on ridges and hills, soils that are similar to the Flugle soil but have less than 18 percent clay; and Goesling and Quintana soils on ridges. Included areas make up about 20 percent of the total acreage.

The Flugle soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is brown loamy fine sand about 3 inches thick.

The subsurface layer is brown fine sandy loam about 2 inches thick. The upper 16 inches of the subsoil is reddish brown clay loam and sandy clay, the upper part of the subsoil is dark brown sandy clay loam about 14 inches thick, the next part is light brown and brown sandy clay loam about 18 inches thick, and the lower part to a depth of 60 inches is sandy loam.

Permeability is moderate in the Flugle soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Teco soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper 16 inches of the subsoil is reddish brown clay loam and sandy clay, the next 25 inches is light reddish brown sandy clay loam, and the lower part to a depth of 60 inches is light reddish brown sandy loam.

Permeability is moderately slow in the Teco soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on the Flugle soil ranges from 30 to 50. Based on a site index of 40, the soil can produce about 6 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. Properly managing the soil helps to control soil blowing.

The understory vegetation on the Flugle soil is pinyon ricegrass, Indian ricegrass, blue grama, and bottlebrush squirreltail. Reducing the density of the canopy can increase the production of understory plants.

The potential natural plant community on the Teco soil is mainly western wheatgrass, alkali sacaton, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds in unfavorable years. The soil is suited to such management practices as livestock pipelines, range seeding, and brush control. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and alkali sacaton.

561—Flugle-Quintana complex, 2 to 15 percent slopes. This map unit is on ridges and hills and in dissected valleys. Areas are elongated and are 150 to 1,200 acres in size. The native vegetation is mainly grasses and trees. Elevation is 6,400 to 6,900 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 130 days.

This unit is 45 percent Flugle sandy loam, 2 to 8 percent slopes, and 35 percent Quintana fine sandy loam, 5 to 15 percent slopes. The Flugle soil is on hills and ridges, and the Quintana soil is on ridges and in dissected valleys. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. The soils in areas near the boundary of Apache County, Arizona, have a higher content of calcium carbonate. Those in areas near the boundary of Catron County are moderately deep and fine textured and have a higher content of calcium carbonate.

Included in this unit are small areas of Goesling soils on mesas and Teco soils on mesa tops and in swales. Also included are Atarque soils on ridges and in gullied areas. Included areas make up about 20 percent of the total acreage.

The Flugle soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper 17 inches of the subsoil is brown and reddish brown sandy clay loam, the next 28 inches is light brown sandy clay loam and clay loam, and the lower part to a depth of 60 inches is light brown sandy loam.

Permeability is moderate in the Flugle soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Quintana soil is deep and well drained. It formed in mixed alluvium reworked by the wind. Typically, the surface layer is light brown fine sandy loam about 2 inches thick. The upper 9 inches of the subsoil is brown fine sandy loam, the next 35 inches is pink loam and sandy clay loam, and the lower part to a depth of 60 inches is pink sandy loam. In some areas the slope is more than 15 percent.

Permeability is moderate in the Quintana soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is severe. The hazard of soil blowing is slight.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on this unit ranges from 30 to 50. Based on a site index of 40, the unit can produce 6 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. Good management is needed to protect the unit against excessive soil blowing and water erosion.

The understory vegetation on this unit is pinyon ricegrass, Indian ricegrass, blue grama, and bottlebrush

squirreltail. Reducing the density of the canopy can increase the production of understory plants.

565—Quintana sandy loam, 5 to 15 percent slopes, gullied. This deep, well drained soil is on dissected ridges and terrace escarpments. It formed in wind-modified, mixed alluvium. Areas are irregular in shape and are 200 to 1,500 acres in size. The native vegetation is mainly trees and grasses. Elevation is 6,400 to 6,900 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 130 days.

Typically, the surface layer is brown sandy loam about 4 inches thick. The upper part of the subsoil is strong brown and light brown sandy clay loam about 17 inches thick, and the lower part to a depth of 60 inches is pink and light brown sandy loam.

Included in this unit are small areas of Goesling and Flugle soils on mesas and side slopes, Teco soils in swales and valleys, and gullied land. Included areas make up about 20 percent of the total acreage.

Permeability is moderate in the Quintana soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing is slight.

This unit is used for limited livestock grazing and fuel wood production.

The site index for pinyon and juniper on this unit ranges from 32 to 38. Based on a site index of 35, the unit can produce 4 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is antelope bitterbrush and Indian ricegrass.

570—Torreon-Rock outcrop-Cabezon complex, 15 to 45 percent slopes. This map unit is on hills, ridges, and escarpments. Areas are irregular in shape and are 100 to 1,250 acres in size. The native vegetation is mainly grasses, shrubs, and trees. Elevation is 6,400 to 7,800 feet. The average annual precipitation is about 12 to 16 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 100 to 135 days.

This unit is 40 percent Torreon very cobbly loam, 15 to 35 percent slopes, extremely stony; 25 percent Rock outcrop; and 15 percent Cabezon very cobbly loam, 15 to 45 percent slopes. The Torreon and Cabezon soils are on hills and ridges, and the Rock outcrop is on escarpments, hills, and ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. Areas near the boundary of Catron County are cooler.

Included in this unit are small areas of Atarque soils on mesa breaks; Flugle, Celacy, Ribera, and Pinitos soils on hills and ridges; and Catman and Hickman soils along narrow drainageways. Included areas make up about 20 percent of the total acreage.

The Torreon soil is deep and well drained. It formed in mixed colluvium and alluvium. Typically, the surface layer is brown very cobbly loam about 2 inches thick. The upper 23 inches of the subsoil is brown and reddish brown clay loam and clay, and the lower 35 inches is pinkish white silty clay loam. In some areas the soil is moderately deep or has less clay or more gravel.

Permeability is slow in the Torreon soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on escarpments, ledges, and ridges.

The Cabezon soil is shallow and well drained. It formed in windblown sediments and alluvium. Typically, the surface layer is brown very cobbly loam about 3 inches thick. The subsoil is brown and dark brown clay loam about 10 inches thick. Basalt is at a depth of about 13 inches.

Permeability is slow in the Cabezon soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing, wildlife habitat, and wood products.

The site index for pinyon and juniper on the Torreon and Cabezon soils ranges from 38 to 55. Based on a site index of 46, the soils can produce 6 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is blue grama, bottlebrush squirreltail, and pinyon ricegrass. Reducing the density of the canopy can increase the production of understory plants. The main limitations affecting the use of this unit for livestock grazing are stones on the surface and the slope.

575—Teco-Atarque association, 1 to 8 percent slopes. This map unit is on old basalt-capped mesas. The soils formed in mixed alluvium reworked by the wind. Areas are elongated and are 200 to 2,000 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 6,600 to 7,000 feet. The

average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 135 days.

This unit is 60 percent Teco fine sandy loam, 1 to 4 percent slopes, and 25 percent Atarque fine sandy loam, 1 to 8 percent slopes. The Teco soil is in swales and in low areas on basalt-capped mesas, and the Atarque soil is on knolls in high areas on basalt-capped mesas. The soils in areas near the boundary of Apache County, Arizona, have less clay in the subsoil.

Included in this unit are small areas of Flugle and Goesling soils on mesas, Rock outcrop on knolls, soils that are similar to the Atarque soil but are fine textured and are on knolls, and soils that are similar to the Teco soil but are moderately deep and are on mesas and the lower parts of knolls. Included areas make up about 15 percent of the total acreage.

The Teco soil is deep and well drained. It formed in alluvium and eolian material derived dominantly from sandstone and shale. Typically, the surface layer and subsurface layer are light brown fine sandy loam. The surface layer is about 4 inches thick, and the subsurface layer is about 2 inches thick. The upper 18 inches of the subsoil is reddish brown and brown clay loam, the next 17 inches is light brown and pink clay loam and sandy clay loam, and the lower part to a depth of 60 inches is reddish yellow gravelly sandy loam.

Permeability is moderately slow in the Teco soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing also is slight.

The Atarque soil is shallow or very shallow and is well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is brown fine sandy loam about 3 inches thick. The subsoil is brown and light brown clay loam about 16 inches thick. Basalt is at a depth of about 19 inches.

Permeability is moderate in the Atarque soil. Available water capacity is very low. The effective rooting depth is 8 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

This unit is used for livestock grazing. The potential natural plant community on the Teco soil is mainly alkali sacaton, western wheatgrass, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, alkali sacaton, and winterfat decrease in abundance and muhly, dropseed, and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community.

The Teco soil is suited to such management practices as livestock pipelines and range seeding. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and alkali sacaton. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive.

The potential natural plant community on the Atarque soil is mainly blue grama, sideoats grama, black grama, little bluestem, and wolftail. The average annual production of air-dry vegetation ranges from 1,100 pounds per acre in favorable years to 425 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, black grama, and little bluestem decrease in abundance and blue grama and wolftail increase. The increasers normally occur in small amounts in the potential natural plant community.

The Atarque soil is not suitable as a site for as livestock pipelines and livestock ponds because of the depth to bedrock. Good grazing management can increase the productivity and reproduction potential of sideoats grama, black grama, and little bluestem.

576—Teco sandy loam, 2 to 5 percent slopes. This deep, well drained soil is on valley sides and hills. It formed in mixed alluvium. Areas are irregular in shape and are 100 to 600 acres in size. The native vegetation is mainly grasses. Elevation is 6,800 to 7,500 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 115 to 135 days.

Typically, the surface layer is light brown sandy loam about 3 inches thick. The upper part of the subsoil is reddish brown sandy clay about 25 inches thick, and the lower part to a depth of 60 inches is reddish yellow sandy clay.

Included in this unit are small areas of Atarque soils on hilltops, Catman and Venadito soils on valley bottoms, Silkie soils on fans, and Flugle soils on hillsides. Included areas make up about 20 percent of the total acreage.

Permeability is moderately slow in the Teco soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community is mainly alkali sacaton, western wheatgrass, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds

in unfavorable years. If the plant community deteriorates, western wheatgrass, alkali sacaton, and winterfat decrease in abundance and muhly, dropseed, and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as livestock ponds, livestock pipelines, and range seeding. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and alkali sacaton. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive.

577—Cabezon-Montecito-Rock outcrop association, 1 to 10 percent slopes. This map unit is on hills, ridges, and valley bottoms. Areas are irregular in shape and are 1,000 to 6,000 acres in size. The native vegetation is mainly grasses, shrubs, juniper, and pinyon. Elevation is 7,100 to 7,500 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 52 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 35 percent Cabezon very cobbly loam, 2 to 10 percent slopes, very stony; 30 percent Montecito clay loam, 1 to 5 percent slopes; and 20 percent Rock outcrop. The Cabezon soil is on lava hills and ridges, the Montecito soil is on the lower hillsides and in valleys between lava ridges, and the Rock outcrop is on hills and ridges.

Included in this unit are small areas of Millpaw soils on bottoms, Cantina soils on the lower hillsides and in valleys between lava ridges, and soils that are similar to the Montecito soil but are moderately deep and are on hillsides. Included areas make up about 15 percent of the total acreage.

The Cabezon soil is shallow and well drained. It formed in alluvium and windblown sediments. Typically, the surface layer is brown very cobbly loam about 2 inches thick. The subsoil is brown clay about 16 inches thick. Basalt is at a depth of about 18 inches.

Permeability is slow in the Cabezon soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Montecito soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is dark brown clay loam about 3 inches thick. The upper part of the subsoil is yellowish brown clay about 21 inches thick, and the lower part to a depth of 60 inches is light yellowish brown sandy clay.

Permeability is moderately slow in the Montecito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on hills and ridges.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on the Cabezon soil ranges from 34 to 52. Based on a site index of 43, the soil can produce 5 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. The main limitations are the depth to bedrock and the low available water capacity.

The understory vegetation on the Cabezon soil is blue grama, bottlebrush squirreltail, and muttongrass. Reducing the density of the canopy can increase the production of understory plants.

The potential natural plant community on the Montecito is mainly western wheatgrass, alkali sacaton, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds in unfavorable years.

The Montecito soil is suited to such management practices as livestock ponds, livestock pipelines, range seeding, and brush control. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. Good grazing management can increase the productivity and reproduction potential of western wheatgrass and alkali sacaton.

The main limitations affecting the use of this unit for livestock grazing are the Rock outcrop and the depth to bedrock and stones on the surface in areas of the Cabezon soil.

579—Cabezon-Cantina complex, 1 to 7 percent slopes. This map unit is on hills and in valleys between basalt ridges. Areas are irregular in shape and are 1,000 to 3,000 acres in size. The native vegetation is mainly trees and an understory of grasses. Elevation is 7,100 to 7,500 feet. The average annual precipitation is about 14 to 16 inches, the average annual air temperature is 47 to 51 degrees F, and the average frost-free period is 100 to 120 days.

This unit is 45 percent Cabezon very cobbly sandy loam, 1 to 7 percent slopes, very stony, and 40 percent Cantina sandy loam, 1 to 3 percent slopes. The Cabezon soil is on hills, and the Cantina soil is on the lower hills and in valleys between basalt ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of soils that are similar to the Cantina soil but are moderately deep, Millpaw and Montecito soils in valleys between lava

ridges, and Rock outcrop on basalt hills and ridges. Included areas make up about 15 percent of the total acreage.

The Cabezon soil is shallow and well drained. It formed in alluvium and windblown sediments. Typically, the surface layer is brown very cobbly sandy loam about 2 inches thick. The subsoil is dark yellowish brown sandy clay about 12 inches thick. Basalt is at a depth of about 14 inches.

Permeability is slow in the Cabezon soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Cantina soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is brown sandy loam about 2 inches thick. The upper part of the subsoil is brown sandy clay loam about 7 inches thick, the next part is brown sandy clay about 22 inches thick, and the lower part is strong brown sandy clay loam about 23 inches thick. Basalt is at a depth of about 54 inches.

Permeability is slow in the Cantina soil. Available water capacity is high. The effective rooting depth is 40 to 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is moderate.

This unit is used for livestock grazing and wood products.

The site index for pinyon and juniper on the Cabezon soil ranges from 34 to 52. Based on a site index of 43, the soil can produce 5 cords of wood per acre from trees that average 5 inches in diameter at a height of 1 foot. The main limitations affecting the use of this soil for wood products are the depth to bedrock and the low available water capacity.

The site index for pinyon and juniper on the Cantina soil ranges from 39 to 70. Based on a site index of 55, the soil can produce 7 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot.

The understory vegetation on this unit is blue grama, bottlebrush squirreltail, and muttongrass.

581—Laporte-Vessilla complex, 3 to 15 percent slopes. This map unit is on hilltops and ridges. Areas are irregular in shape and are 500 to 1,500 acres in size. The native vegetation is mainly trees and grasses. Elevation is 7,000 to 7,500 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 110 to 125 days.

This unit is 45 percent Laporte gravelly loam, 3 to 15 percent slopes, and 35 percent Vessilla sandy loam, 3 to 15 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Mion soils on hills, Rock outcrop on hills and ridges, and Ribera soils on ridges. Included areas make up about 20 percent of the total acreage.

The Laporte soil is shallow and well drained. It formed in alluvium and windblown sediments derived dominantly from limestone. Typically, the surface layer is very dark grayish brown gravelly loam about 1 inch thick. The upper part of the underlying material is dark grayish brown gravelly loam about 14 inches thick, and the lower part is brown gravelly loam about 3 inches thick. Limestone is at a depth of about 18 inches.

Permeability is moderate in the Laporte soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Vessilla soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is dark brown sandy loam about 6 inches thick. The underlying material is light brown sandy loam about 12 inches thick. Sandstone is at a depth of about 18 inches.

Permeability is moderately rapid in the Vessilla soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for fuel wood production and livestock grazing.

The site index for pinyon and juniper on this unit generally ranges from 40 to 50. Based on a site index of 45, the unit can produce 7 cords of wood per acre in a stand of trees that average 5 inches in diameter at a height of 1 foot. In the vicinity of Oso Ridge Lookout, the site index for pinyon and juniper is higher on the Laporte soil. The overstory in this area consists of scattered ponderosa pine, Rocky Mountain juniper, alligator juniper, oneseed juniper, pinyon, and Gambel oak.

The understory vegetation on this unit is little bluestem, New Mexico feathergrass, blue grama, and sideoats grama. Reducing the density of the canopy can increase the production of understory plants.

582—Kenray fine sand, 3 to 15 percent slopes. This deep, excessively drained soil is on dunes, hills, and mesas. It formed in eolian material derived dominantly from sandstone. Areas are irregular in shape and are 200 to 1,300 acres in size. The native vegetation is mainly ponderosa pine, shrubs, and

grasses. Elevation is 7,300 to 8,000 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 43 to 45 degrees F, and the average frost-free period is 90 to 110 days.

Typically, the surface layer is brown fine sand about 15 inches thick. The underlying material to a depth of 60 inches is light yellowish brown and brownish yellow loamy sand.

Included in this unit are small areas of Pinitos and Ribera soils on hillsides at the lower elevations, soils that are similar to the Kenray soil but are moderately deep or shallow and are on hills, Techado soils on hills, and Valnor soils on mesas. Included areas make up about 20 percent of the total acreage.

Permeability is rapid in the Kenray soil. Available water capacity is low. The effective rooting depth is 60 inches. Runoff is slow, and the hazard of water erosion is slight. The hazard of soil blowing is severe.

This unit is used for limited wood products and livestock grazing.

This unit is suited to the production of ponderosa pine. The site index for ponderosa pine ranges from 50 to 65. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of soil blowing, equipment limitations, seedling mortality, and plant competition. The sandy texture of the surface layer can interfere with felling, yarding, and other activities involving the use of equipment. When timber is harvested, minimizing the risk of erosion is essential. Special design of logging roads, skid trails, and landings is needed. Erosion-control structures and seeding can protect the roads, trails, and landings against erosion. Because of the low available water capacity, the seedling mortality rate is moderate on the north- and east-facing slopes and severe on the south- and west-facing slopes. Carefully managing reforestation can minimize competition from undesirable understory plants. Unless the site is adequately prepared, plant competition can prevent or delay the natural or artificial regeneration of trees. In the Zuni Mountains, Gambel oak and various grasses limit the natural regeneration of ponderosa pine. At the lower elevations, pinyon, oneseed juniper, skunkbush sumac, and oaks limit natural regeneration. Properly preparing the site can control competing vegetation. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality.

The understory vegetation on this unit is blue grama, Arizona fescue, mountain muhly, and Gambel oak.

585—Moncha silt loam, 2 to 10 percent slopes. This deep, well drained soil is in valleys, on fan terraces, and on mesa tops. It formed in alluvium derived from siltstone and shale. Areas are irregular in shape and are 100 to 1,000 acres in size. The native vegetation is mainly grasses and a few scattered trees. Elevation is 6,800 to 7,300 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 48 to 52 degrees F, and the average frost-free period is 115 to 130 days.

Typically, the surface layer is light red silt loam about 2 inches thick. The subsoil is red silty clay loam about 19 inches thick. The substratum to a depth of 60 inches also is red silty clay loam.

Included in this unit are small areas of Venadito soils in depressions and along drainageways, Teco soils in depressions, and Flugle and Goesling soils on fan terraces. Included areas make up about 15 percent of the total acreage.

Permeability is moderately slow in the Moncha soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community on the Moncha soil is mainly alkali sacaton, spike muhly, western wheatgrass, bottlebrush squirreltail, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 300 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, spike muhly, and alkali sacaton decrease in abundance and blue grama, cacti, broom snakeweed, and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive.

Deterioration of the plant community often results in the formation of deep, vertical-walled gullies that drain the site and hinder the production of vegetation. After the gullies have drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

This soil is suited to such management practices as fencing and livestock pipelines.

586—Venadito-Teco association, 0 to 10 percent slopes. This map unit is on valley bottoms and sides and on hills. Areas are irregular in shape and are 75 to 1,300 acres in size. The native vegetation is mainly

grasses and a few scattered trees. Elevation is 6,500 to 7,500 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 40 to 53 degrees F, and the average frost-free period is 115 to 135 days.

This unit is 60 percent Venadito clay loam, 0 to 5 percent slopes, and 25 percent Teco clay loam, 2 to 10 percent slopes. The Venadito soil is on valley bottoms and the lower valley sides, and the Teco soil is on valley sides and hills.

Included in this unit are small areas of Flugle soils on fan terraces, Quintana soils on hills, and Aparejo, Catman, and Hickman soils along drainageways. Included areas make up about 15 percent of the total acreage.

The Venadito soil is deep and well drained. It formed in alluvium derived dominantly from shale. Typically, the surface layer is reddish brown clay loam about 3 inches thick. The underlying material to a depth of 60 inches is reddish brown clay.

Permeability is very slow in the Venadito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight. This soil has prominent slickensides and cracks that extend to a depth of about 35 inches. It is occasionally flooded for very brief periods in summer.

The Teco soil is deep and well drained. It formed in alluvium derived dominantly from shale and sandstone. Typically, the surface layer is reddish brown clay loam about 3 inches thick. The upper 25 inches of the subsoil is reddish brown clay and clay loam, and the lower part to a depth of 60 inches is light reddish brown clay loam.

Permeability is moderately slow in the Teco soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community on the Venadito soil is mainly western wheatgrass, vine mesquite, alkali sacaton, blue grama, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 900 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and vine mesquite decrease in abundance and blue grama increases. Blue grama normally occurs in small amounts in the potential natural plant community.

The potential natural plant community on the Teco soil is mainly alkali sacaton, western wheatgrass, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 600 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, alkali sacaton, and winterfat decrease in abundance and muhly, dropseed, and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community.

The Venadito soil is suitable as a site for livestock ponds. The Teco soil is suited to such management practices as livestock ponds, livestock pipelines, and range seeding.

Good grazing management on this unit can increase the productivity and reproduction potential of western wheatgrass.

591—Valnor-Techado association, 2 to 25 percent slopes. This map unit is on hills, plateaus, and mesas. Areas are irregular in shape and are 100 to 4,500 acres in size. The native vegetation is mainly pine trees and an understory of grasses. Elevation is 7,500 to 8,200 feet. The average annual precipitation is about 16 to 20 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 45 percent Valnor clay loam, 2 to 7 percent slopes, and 40 percent Techado channery clay loam, 5 to 25 percent slopes. The Valnor soil is on mesa tops, hilltops, and plateaus, and the Techado soil is on hillsides and hilltops.

Included in this unit are small areas of soils that are similar to the Valnor soil but have shale below a depth of 40 inches and are on mesa tops, soils that are similar to the Valnor and Techado soils but have less clay in the subsoil and are on hills and mesas, Rock outcrop on hills and mesas, and Catman soils along narrow drainageways. Included areas make up about 15 percent of the total acreage.

The Valnor soil is moderately deep and well drained. It formed in alluvium derived dominantly from shale and sandstone. Typically, the surface layer is yellowish brown clay loam about 2 inches thick. The upper part of the subsoil is dark yellowish brown and yellowish brown clay about 16 inches thick, and the lower part is light yellowish brown clay about 20 inches thick. Soft shale is at a depth of about 38 inches.

Permeability is slow in the Valnor soil. Available water capacity is moderate. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Techado soil is shallow and well drained. It formed in alluvium derived from shale and sandstone. Typically, the surface layer is light olive brown channery clay loam about 3 inches thick. The underlying material is light olive brown clay about 13 inches thick. Soft shale is at a depth of about 16 inches. In areas near

the boundary of Catron County, the underlying material has less clay.

Permeability is slow in the Techado soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing and wood products.

This unit is suited to limited production of ponderosa pine. The site index for ponderosa pine ranges from 43 to 47. Based on a site index of 45, the potential production of merchantable timber is 1,990 cubic feet, or 6,200 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 34 cubic feet, or 107 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting wood products are the hazard of erosion, plant competition, a slow growth rate, seedling mortality, and equipment limitations. Also, the Techado soil is subject to windthrow during periods when the soil is excessively wet and winds are strong. When timber is harvested, minimizing the risk of erosion is essential. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Spoil from excavations is subject to rill and gully erosion and to sloughing. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Brushy plants, such as Gambel oak and juniper, limit the natural regeneration of ponderosa pine. Thinning the stand can accelerate the growth of desirable trees. The seedling mortality rate is moderate because of the clayey texture. Conventional methods of harvesting timber generally can be used, but their use may be limited when the soils are wet.

The understory vegetation on the Valnor soil is Arizona fescue, mountain muhly, western wheatgrass, and Gambel oak, and that on the Techado soil is blue grama, spike muhly, gray horsebrush, and Gambel oak.

610—Grieta-Shiprock association, 1 to 10 percent slopes. This map unit is on hills, ridges, fan terraces, and stable dunes. Areas are irregular in shape and are 50 to 1,250 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 5,400 to 6,100 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

This unit is 65 percent Grieta sandy loam, 1 to 7 percent slopes, and 20 percent Shiprock sandy loam, 3 to 10 percent slopes. The Grieta soil is on hilltops, on fan terraces, and in interdune areas, and the Shiprock soil is on stable dunes, ridges, and hills.

Included in this unit are small areas of Sheppard soils on stable dunes, Kiki soils on hills, and Suwanee and Navajo soils on flood plains. Included areas make up about 15 percent of the total acreage.

The Grieta soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is strong brown sandy loam about 3 inches thick. The subsurface layer also is strong brown sandy loam. It is about 5 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 20 inches thick. The lower part to a depth of 60 inches is pink and pinkish white sandy loam. It has a high content of calcium carbonate.

Permeability is moderate in the Grieta soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Shiprock soil is deep and well drained. It formed in wind-modified, mixed alluvium. Typically, the surface layer is reddish yellow sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 10 inches thick. The upper part of the subsoil is brown sandy loam about 12 inches thick, and the lower part to a depth of 60 inches is reddish yellow sandy loam.

Permeability is moderately rapid in the Shiprock soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community on the Grieta soil is mainly bush muhly, black grama, galleta, and winterfat. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, bush muhly, black grama, galleta, and winterfat decrease in abundance and blue grama, broom snakeweed, and annuals increase. The increasers normally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Shiprock soil is mainly black grama, Indian ricegrass, and dropseed. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, black grama and Indian ricegrass decrease in abundance and ring muhly, threeawn, annuals, and cacti increase. The increasers

normally occur in small amounts in the potential natural plant community.

Good management is needed to protect the soils against excessive soil blowing. Soil blowing can be controlled and damage to seedlings minimized by maintaining enough plant residue on the surface.

This unit is not suitable as a site for livestock ponds and range seeding because of seepage and droughtiness. It is suited to such management practices as livestock pipelines, fencing, deferred grazing, and rotation grazing.

611—Grieta-Kiki sandy loams, 3 to 15 percent slopes. This map unit is on knolls, ridges, and hills. Areas are irregular in shape and are 50 to 700 acres in size. The native vegetation is mainly grasses and forbs. Elevation is 5,500 to 6,000 feet. The average annual precipitation is about 7 to 10 inches, the average annual air temperature is 51 to 55 degrees F, and the average frost-free period is 140 to 165 days.

This unit is 50 percent Grieta sandy loam, 3 to 10 percent slopes, and 35 percent Kiki sandy loam, 3 to 15 percent slopes. The Grieta soil is on the lower parts of hills, and the Kiki soil is on knolls and ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of shallow, loamy soils on hilltops and hills, Rock outcrop on hilltops, Suwanee and Navajo soils on flood plains, and Shiprock soils on hills. Included areas make up about 15 percent of the total acreage.

The Grieta soil is deep and well drained. It formed in mixed alluvium reworked by the wind. Typically, the surface layer is yellowish red sandy loam about 3 inches thick. The upper part of the subsoil is yellowish red sandy clay loam about 10 inches thick, and the lower part to a depth of 60 inches is reddish yellow, yellowish red, and reddish brown sandy clay loam.

Permeability is moderate in the Grieta soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Kiki soil is moderately deep and well drained. It formed in eolian material and mixed alluvium. Typically, the surface layer and subsurface layer are strong brown sandy loam. They are each about 3 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 8 inches thick, and the lower part is strong brown sandy clay loam about 10 inches thick. Basalt is at a depth of about 24 inches.

Permeability is moderate in the Kiki soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing and urban development.

The potential natural plant community on the Grieta soil is mainly black grama, galleta, bush muhly, and winterfat. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, black grama and winterfat decrease in abundance and broom snakeweed, forbs, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Kiki soil is mainly black grama, Indian ricegrass, and dropseed. The average annual production of air-dry vegetation ranges from 900 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, black grama and Indian ricegrass decrease in abundance and ring muhly, sandhill muhly, annuals, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

Good management is needed to protect the soils against excessive soil blowing. Soil blowing can be controlled and damage to seedlings minimized by maintaining enough plant residue on the surface.

This unit is not suitable as a site for livestock ponds and range seeding because of seepage and droughtiness.

The trees and shrubs selected for windbreaks and environmental plantings should be those that are tolerant of droughtiness. Unless the seedlings on the Kiki soil are irrigated, the mortality rate is moderate because of the moisture stress caused by the low available water capacity. Unless the young seedlings are protected during high winds, they can be damaged by sand blasting or covered with drifting sand. Soil blowing can be controlled by maintaining strips of native vegetation between the rows of trees and shrubs. Undesirable grasses and weeds can be controlled by applying herbicides and by rototilling or hand hoeing.

The soils in this unit are suited to urban development. The main management concerns are the hazard of soil blowing, the high content of calcium carbonate in the Grieta soil, and the depth to bedrock in the Kiki soil. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees.

615—Trag-Techado-Rock outcrop complex, 3 to 55 percent slopes. This map unit is on mountainsides, ridges, benches, and escarpments. Areas are irregular in shape and are 200 to 3,000 acres in size. The native vegetation is mainly trees, shrubs, and grasses. Elevation is 7,200 to 8,900 feet. The average annual precipitation is about 16 to 22 inches, the average annual air temperature is 40 to 45 degrees F, and the average frost-free period is 90 to 110 days.

This unit is 35 percent Trag cobbly loam, 3 to 30 percent slopes; 30 percent Techado cobbly clay loam, 5 to 55 percent slopes; and 20 percent Rock outcrop. The Trag soil is on benches and mountainsides, the Techado soil is on mountainsides and ridges, and the Rock outcrop is on ridges and escarpments.

Included in this unit are small areas of Parkay soils on mountainsides and benches; on benches and mountainsides, soils that are similar to the Trag soil but have an accumulation of calcium carbonate; on benches and ridges, soils that are similar to the Techado soil but are underlain by basalt and have an accumulation of calcium carbonate; and, on benches, mountainsides, and ridges, soils that are similar to the Techado and Trag soils but are moderately deep. Included areas make up about 15 percent of the total acreage.

The Trag soil is deep and well drained. It formed in mixed alluvium and colluvium. Typically, the surface layer is dark grayish brown cobbly loam about 2 inches thick. The subsoil is yellowish brown and brown cobbly sandy clay loam about 33 inches thick. The substratum to a depth of 60 inches is light brown cobbly sandy loam. In some areas bedrock is at a depth of 40 to 60 inches.

Permeability is moderate in the Trag soil. Available water capacity also is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

The Techado soil is shallow and well drained. It formed in alluvium and colluvium derived dominantly from shale and sandstone. Typically, the surface layer is light yellowish brown cobbly clay loam about 2 inches thick. The underlying material is about 17 inches of dark yellowish brown clay loam and sandy clay. Soft shale is at a depth of about 19 inches.

Permeability is slow in the Techado soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing is moderate.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone, andesite, or basalt on escarpments, benches, and mountainsides.

This unit is used for wood products and livestock grazing.

This unit is suited to the production of ponderosa pine. The site index ranges from 61 to 66 on the Trag soil and averages 56 on the Techado soil. Based on a site index of 60, the potential production of merchantable timber is 3,570 cubic feet, or 14,600 board feet (International rule, ⅛-inch kerf), per acre in an even-aged, fully stocked stand of trees 100 years old. The culmination of mean annual increment is 46 cubic feet, or 177 board feet (International rule, ⅛-inch kerf), per acre.

The main concerns in producing and harvesting timber are the hazard of water erosion and plant competition. Equipment limitations and the hazard of windthrow also are concerns on the Techado soil. When timber is harvested, minimizing the risk of erosion is essential. Proper design of road drainage systems and care in the placement of culverts help to control erosion. Spoil from excavations is subject to rill and gully erosion and to sloughing. Constructing water bars and seeding cut and filled areas can protect logging roads and landings against erosion. Leaving an undisturbed buffer or filter strip along watercourses minimizes sedimentation and thus helps to maintain water quality.

Carefully managing reforestation can minimize competition from undesirable understory plants. Plant competition delays natural regeneration but does not prevent the eventual development of a fully stocked, normal stand of trees. Grasses, forbs, and shrubs limit the natural regeneration of ponderosa pine. Properly preparing the site can control the competing vegetation.

Conventional methods of harvesting can be used in the areas that have slopes of less than 35 percent slopes, but their use is limited in the steeper areas. Harvesting activities are hindered when the soil is wet. Special design of logging roads, skid trails, and landings is needed in the steeper areas. Erosion-control structures and seeding can protect the roads against erosion. Trees on the Techado soil are subject to windthrow because of the limited rooting depth.

The understory vegetation on this unit is Arizona fescue, mountain muhly, and Gambel oak.

618—Netoma sandy loam, 2 to 12 percent slopes. This deep, well drained soil is on fan terraces and hills. It formed in alluvium derived dominantly from gypsiferous material. Areas are irregular in shape and are 50 to 800 acres in size. The native vegetation is mainly grasses and scattered trees. Elevation is 5,800 to 6,500 feet. The average annual precipitation is about

10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

Typically, the surface layer is strong brown sandy loam about 4 inches thick. The upper part of the subsoil is strong brown sandy loam about 8 inches thick, and the lower part to a depth of 60 inches is light brown and reddish yellow, gypsiferous sandy loam. In areas near the boundary of Bernalillo County, the soils have a higher content of clay and shale crops out.

Included in this unit are small areas of Grieta, Kiki, Shiprock, and Penistaja soils on fan terraces; soils that are similar to the Netoma soil but are gravelly or have more clay in the subsoil and are on fan terraces and hillsides; soils that are similar to the Netoma soil but soft bedrock at a depth of less than 40 inches and are on hills, mainly near the boundary of Socorro County; and Harvey soils on hills, mainly near the boundary of Socorro County. Included areas make up about 15 percent of the total acreage.

Permeability is moderately rapid in the Netoma soil. Available water capacity is moderate. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe. This soil is slightly saline.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, blue grama, Indian ricegrass, and spike dropseed. The average annual production of air-dry vegetation ranges from 850 pounds per acre in favorable years to 325 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass and Indian ricegrass decrease in abundance and blue grama and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community.

This unit is suited to such management practices as livestock pipelines, brush control, and seeding. It is not suitable as a site for livestock ponds because of seepage, piping, and the content of gypsum. Good grazing management can increase the productivity and reproduction potential of western wheatgrass.

619—Venadito clay loam, 1 to 5 percent slopes. This deep, well drained soil is on alluvial fans and flood plains and in valleys. It formed in alluvium derived dominantly from shale. Areas are irregular in shape and are 50 to 2,000 acres in size. The native vegetation is mainly grasses and shrubs. Elevation is 6,200 to 7,500 feet. The average annual precipitation is about 10 to 13 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

Typically, the surface layer is reddish brown clay loam about 4 inches thick. The underlying material to a depth of 60 inches is reddish brown clay.

Included in this unit are small areas of Aparejo soils on alluvial fans and flood plains and in valleys and Penistaja soils on fan terraces and valley sides. Included areas make up about 10 percent of the total acreage.

Permeability is very slow in the Venadito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate. Cracks that extend to a depth of about 30 inches are common. This soil is occasionally flooded for very brief periods in summer.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, vine mesquite, alkali sacaton, spike muhly, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 1,250 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, spike muhly, and winterfat decrease in abundance and blue grama, threeawn, annual grasses and forbs, and rabbitbrush increase. The increasers normally occur in small amounts in the potential natural plant community. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, vine mesquite, alkali sacaton, and spike muhly. Grazing should be delayed until the soil is firm and the more desirable forage plants have achieved enough growth to withstand grazing pressure. Deterioration of the vegetation on this unit often results in the formation of gullies that drain the site and hinder the production of vegetation. After deep gullies have artificially drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

620—Aparejo-Venadito complex, 1 to 5 percent slopes. This map unit is on flood plains and in large drainageways. Areas are irregular in shape and are 150 to 1,300 acres in size. The native vegetation is mainly grasses and scattered shrubs. Elevation is 6,200 to 7,500 feet. The average annual precipitation is about 12 to 14 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 50 percent Aparejo silt loam, 1 to 5 percent slopes, and 35 percent Venadito silty clay loam, 1 to 5 percent slopes. The Aparejo soil is on flood plains and the bottom of drainageways, and the Venadito soil is on flood plains and in drainageways. The components of this unit occur as areas so

intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Flugle and Penistaja soils on small hills and fan terraces, Catman and Hickman soils on flood plains, and riverwash in arroyos. Included areas make up about 15 percent of the total acreage.

The Aparejo soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is yellowish red silt loam about 2 inches thick. The upper part of the underlying material is yellowish red silty clay loam about 16 inches thick. The lower part to a depth of 60 inches is dominantly yellowish red silt loam, but it commonly has strata of sandy loam, clay loam, or clay less than 0.5 inch thick.

Permeability is moderately slow in the Aparejo soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate. This soil is occasionally flooded for very brief periods in summer.

The Venadito soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is reddish brown silty clay loam about 3 inches thick. The upper part of the underlying material is reddish brown clay about 24 inches thick, and the lower part to a depth of 60 inches is yellowish red clay.

Permeability is very slow in the Venadito soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate. This soil is occasionally flooded for very brief periods in summer. Cracks extend to a depth of about 30 inches.

This unit is used for livestock grazing. The potential natural plant community is mainly western wheatgrass, vine mesquite, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 3,200 pounds per acre in favorable years to 1,250 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, alkali sacaton, Indian ricegrass, and winterfat decrease in abundance and blue grama, galleta, rabbitbrush, and broom snakeweed increase. The unit receives runoff from the adjacent areas. As a result, it is potentially more productive.

Deterioration of the plant community on this unit often results in the formation of deep gullies that drain the site and hinder the production of vegetation. After deep gullies have artificially drained the site, a combination of grazing management and engineering practices may be needed to return the site to its productive potential.

The suitability of the Aparejo soil for livestock ponds is limited because of seepage. The Venadito soil is suitable as a site for these ponds. Good grazing management can increase the productivity and reproduction potential of western wheatgrass, alkali sacaton, and winterfat. The unit is suited to such management practices as deferred grazing, rotation grazing, livestock pipelines, and fencing.

625—Hagerman-Bond association, 1 to 10 percent slopes. This map unit is on mesa tops, cuestas, hills, and ridges. Areas are irregular in shape and are 50 to 1,500 acres in size. The native vegetation is mainly grasses and some scattered trees. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 55 percent Hagerman fine sandy loam, 1 to 5 percent slopes, and 30 percent Bond sandy loam, 2 to 10 percent slopes. The Hagerman soil is on mesa tops, on the lower dip slopes of cuestas, and on hills and ridges, and the Bond soil is on mesa tops, on the upper dip slopes of cuestas, and on hilltops and ridges. In areas near the boundary of Socorro County, the soils have a less well developed subsoil and there is more Rock outcrop.

Included in this unit are small areas of Skyvillage soils on hills and ridgetops, mainly near the boundary of Bernalillo County; Penistaja soils on the lower side slopes; Rock outcrop on hilltops, ledges, ridges, and escarpments; and Mikim and Mion soils at the base of escarpments. Included areas make up about 15 percent of the total acreage.

The Hagerman soil is moderately deep and well drained. It formed in eolian and alluvial material derived dominantly from sandstone. Typically, the surface layer is brown fine sandy loam about 3 inches thick. The subsurface layer is dark brown fine sandy loam about 3 inches thick. The upper part of the subsoil is brown sandy clay loam about 17 inches thick, and the lower part is strong brown and light brown sandy loam about 11 inches thick. Sandstone is at a depth of about 34 inches.

Permeability is moderate in the Hagerman soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Bond soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is brown sandy loam about 5 inches thick. The subsoil is dark brown sandy clay loam about 10 inches thick. The substratum is strong

brown sandy clay loam about 3 inches thick. Hard sandstone is at a depth of about 18 inches.

Permeability is moderate in the Bond soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing and urban development.

The potential natural plant community on the Hagerman soil is mainly blue grama, western wheatgrass, sideoats grama, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, sideoats grama, and New Mexico feathergrass decrease in abundance and blue grama, galleta, ring muhly, and broom snakeweed increase. Pinyon and oneseed juniper may invade.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, sideoats grama, and spike muhly. The Hagerman soil is suited to such management practices as livestock pipelines, fencing, and range seeding.

The potential natural plant community on the Bond soil is mainly sideoats grama, Indian ricegrass, blue grama, and scattered oneseed juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, Indian ricegrass, and little bluestem decrease in abundance and juniper, broom snakeweed, sand sagebrush, and blue grama increase. The increasers normally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of sideoats grama, little bluestem, and Indian ricegrass. The Bond soil is suited to such management practices as deferred grazing and rotation grazing. It is limited as a site for such management practices as livestock pipelines, fencing, and range seeding because of the depth to bedrock and droughtiness.

Properly managing livestock grazing can protect this unit against soil blowing. Soil blowing can be controlled and damage to seedlings minimized by maintaining enough plant residue on the surface. In some areas dense stands of pinyon and oneseed juniper may become established. If the stand in these areas is properly managed, a limited wood crop can be produced. The unit is not suitable as a site for livestock ponds because of the texture of the soils and the depth to bedrock.

If the soils in this unit are used for urban development, the main management concerns are the hazard of soil blowing, the depth to bedrock, and the slope in some areas. In summer, irrigation is needed in areas used for lawn grasses, shrubs, vines, shade trees, or ornamental trees. Properly designing buildings and roads can help to control soil blowing and overcome the slope and the depth to bedrock.

630—Bond-Rizozo-Rock outcrop complex, 2 to 20 percent slopes. This map unit is on ridges, escarpments, and hills. Areas are irregular in shape and are 70 to 1,000 acres in size. The native vegetation is mainly grasses and some scattered trees. Elevation is 6,000 to 6,700 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 35 percent Bond sandy loam, 2 to 20 percent slopes; 25 percent Rizozo loam, 5 to 20 percent slopes; and 25 percent Rock outcrop. The Bond soil is on hills and ridgetops. The Rizozo soil is on hills and ridges. The Rock outcrop is on escarpments, hills, and ridges. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Hagerman soils on fan terraces and Rana soils at the base of escarpments. Included areas make up about 15 percent of the total acreage.

The Bond soil is shallow and well drained. It formed in eolian material derived dominantly from sandstone. Typically, the surface layer is yellowish red sandy loam about 2 inches thick. The subsoil is yellowish red clay loam about 5 inches thick. The substratum is red loam about 12 inches thick. Sandstone is at a depth of about 19 inches. In some areas the surface layer is channery or very channery.

Permeability is moderate in the Bond soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rizozo soil is shallow or very shallow and is well drained. It formed in eolian material derived dominantly from fine grained sandstone. Typically, the surface layer is reddish brown loam about 2 inches thick. The underlying material also is reddish brown loam. It is about 12 inches thick. Sandstone is at a depth of about 14 inches. In some areas the surface layer is channery or very channery.

Permeability is moderate in the Rizozo soil. Available water capacity is very low. The effective rooting depth is

5 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed sandstone on hills, ridges, and escarpments.

This unit is used for livestock grazing. The potential natural plant community is mainly New Mexico feathergrass, Indian ricegrass, blue grama, sideoats grama, and juniper. The average annual production of air-dry vegetation ranges from 700 pounds per acre in favorable years to 275 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, New Mexico feathergrass, and Indian ricegrass decrease in abundance and blue grama, oneseed juniper, and broom snakeweed increase. The increasers normally occur in small amounts in the potential natural plant community.

This unit is limited as a site for such management practices as livestock pipelines and range seeding because of the depth to bedrock and the very low available water capacity. It is suited to such practices as deferred grazing and rotation grazing. Good grazing management can increase the productivity and reproduction potential of sideoats grama, New Mexico feathergrass, and winterfat.

640—Flaco-Berto loams, 0 to 5 percent slopes. This map unit is on basalt-capped mesa tops. Areas are irregular in shape and are 150 to 3,000 acres in size. The native vegetation is mainly grasses and a few trees and shrubs. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 55 percent Flaco loam, 0 to 5 percent slopes, and 30 percent Berto loam, 1 to 5 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used. In areas near the boundary of the soil survey of the eastern part of Valencia County, temperatures are higher and the soils are less well developed and have a higher content of rock fragments.

Included in this unit are small areas of Harvey soils on mesa tops, soils that are similar to the Flaco and Berto soils but have more than 35 percent clay in the subsoil, Oelop soils along drainageways, and Rock outcrop on knolls and hills. Included areas make up about 15 percent of the total acreage.

The Flaco soil is moderately deep and well drained. It formed in mixed alluvium and windblown sediments. Typically, the surface layer is yellowish brown loam about 2 inches thick. The upper 9 inches of the subsoil is yellowish brown loam and clay loam, and the lower 18 inches is yellowish brown and light yellowish brown clay loam and loam. Basalt is at a depth of about 29 inches. In some areas the surface layer is cobbly or stony.

Permeability is moderately slow in the Flaco soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Berto soil is shallow and well drained. It formed in mixed alluvium and windblown sediments over basalt. Typically, the surface layer is brown loam about 2 inches thick. The upper 10 inches of the subsoil also is brown loam. The lower 6 inches is pink cobbly loam and loam. Basalt is at a depth of about 18 inches. In some areas the surface layer is cobbly or stony.

Permeability is moderate in the Berto soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

This unit is used for livestock grazing. The potential natural plant community on the Flaco soil is mainly western wheatgrass, New Mexico feathergrass, black grama, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, black grama, and winterfat decrease in abundance and blue grama, threeawn, broom snakeweed, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

The Flaco soil is suitable as a site for livestock pipelines. It is not suitable as a site for livestock ponds because of the depth to bedrock.

The potential natural plant community on the Berto soil is mainly western wheatgrass, sideoats grama, black grama, alkali sacaton, and winterfat. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, sideoats grama, black grama, winterfat, and western wheatgrass decrease in abundance and blue grama, broom snakeweed, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

The Berto soil is not suitable for livestock pipelines, livestock ponds, or range seeding because of the depth to bedrock and the low available water capacity.

The included Oelop soils in this unit receive runoff from the adjacent areas. As a result, they are potentially more productive. Areas of these soils provide about 20 percent of the available forage on the unit.

641—Berto-Flaco cobbly loams, 1 to 10 percent slopes. This map unit is on basalt-capped mesa tops. Areas are irregular in shape and are 100 to 2,500 acres in size. The native vegetation is mainly grasses and some scattered trees and shrubs. Elevation is 6,000 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 55 percent Berto cobbly loam, 1 to 10 percent slopes, and 30 percent Flaco cobbly loam, 1 to 10 percent slopes. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Harvey soils on mesa tops, soils that are similar to the Flaco and Berto soils but have more than 35 percent clay in the subsoil, and Rock outcrop on hills and mesa tops. Included areas make up about 15 percent of the total acreage.

The Berto soil is shallow and well drained. It formed in mixed alluvium and windblown sediments. Typically, the surface layer is brown cobbly loam about 2 inches thick. The upper part of the subsoil is brown clay loam about 6 inches thick, and the lower part is brown cobbly clay loam about 8 inches thick. Basalt is at a depth of about 16 inches. In some areas the surface layer is not cobbly.

Permeability is moderate in the Berto soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Flaco soil is moderately deep and well drained. It formed in mixed alluvium and windblown sediments. Typically, the surface layer is brown cobbly loam about 2 inches thick. The upper 7 inches of the subsoil is brown clay loam, and the lower 17 inches is yellowish brown and very pale brown clay loam and cobbly loam. Basalt is at a depth of about 26 inches. In some areas the surface layer is not cobbly.

Permeability is moderately slow in the Flaco soil. Available water capacity is low. The effective rooting depth is 20 to 40 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is slight.

This unit is used for livestock grazing. The potential natural plant community on the Berto soil is mainly blue grama, black grama, winterfat, little bluestem, alkali sacaton, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 800 pounds per acre in favorable years to 400 pounds in unfavorable years. If the plant community deteriorates, alkali sacaton and winterfat decrease in abundance and blue grama, broom snakeweed, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Flaco soil is mainly western wheatgrass, New Mexico feathergrass, black grama, and winterfat. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass, black grama, and winterfat decrease in abundance and blue grama, threeawn, broom snakeweed, and cacti increase. The increasers normally occur in small amounts in the potential natural plant community.

The suitability of this unit for such management practices as livestock pipelines and fencing is limited because of the content of rock fragments and the depth to bedrock. The unit is not suitable for livestock ponds or range seeding because of the depth to bedrock and the low available water capacity.

645—Penistaja-Oelop association, 0 to 5 percent slopes. This map unit is on fan terraces and in swales. Areas are irregular in shape and are 450 to 2,000 acres in size. The native vegetation is mainly grasses. Elevation is 6,000 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 60 percent Penistaja sandy loam, 0 to 5 percent slopes, and 25 percent Oelop loam, 0 to 3 percent slopes. The Penistaja soil is on fan terraces, and the Oelop soil is in swales.

Included in this unit are small areas of Palma soils on hills, Aparejo and Venadito soils along drainageways and on alluvial fans, and Mikim and Zia soils on fan terraces. Included areas make up about 15 percent of the total acreage.

The Penistaja soil is deep and well drained. It formed in mixed alluvium reworked by the wind. Typically, the surface layer is brown sandy loam about 3 inches thick. The upper part of the subsoil is strong brown sandy clay loam about 15 inches thick, and the lower part to a depth of 60 inches is light brown and strong brown sandy loam.

Permeability is moderate in the Penistaja soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Oelop soil is deep and well drained. It formed in mixed alluvium. Typically, the surface layer is yellowish brown loam about 3 inches thick. The upper part of the subsoil is brown clay loam about 13 inches thick, and

the lower part to a depth of 60 inches is yellowish brown clay loam and loam.

Permeability is moderately slow in the Oelop soil. Available water capacity is very high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

This unit is used for livestock grazing. The potential natural plant community on the Penistaja soil is mainly blue grama, western wheatgrass, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 950 pounds per acre in favorable years to 375 pounds in unfavorable years. If the plant community deteriorates, western wheatgrass decreases in abundance and blue grama, ring muhly, and sand dropseed increase. The increasers normally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of western wheatgrass, spike muhly, and sideoats grama. Properly managing livestock grazing can protect the Penistaja soil against soil blowing. Soil blowing can be controlled and damage to seedlings minimized by maintaining enough plant residue on the surface. The soil is suited to such management practices as fencing, range seeding, and livestock pipelines. It is not suitable as a site for livestock ponds because of seepage.

The potential natural plant community on the Oelop soil is mainly western wheatgrass, vine mesquite, and alkali sacaton. This soil receives runoff from the adjacent areas. As a result, it is potentially more productive. The average annual production of air-dry vegetation ranges from 1,350 pounds per acre in favorable years to 600 pounds in unfavorable years. If the plant community deteriorates, alkali sacaton, vine mesquite, and western wheatgrass decrease in abundance and blue grama, galleta, tumble windmillgrass, and mat muhly increase. The increasers normally occur in small amounts in the potential natural plant community.

Properly managing livestock grazing can protect the Oelop soil against water erosion. The soil is suitable as a site for erosion-control structures and livestock ponds.

650—Winona-Tanbark-Rock outcrop association, 15 to 60 percent slopes. This map unit is on mesa breaks, hills, ridges, and escarpments. Areas are irregular in shape and are 50 to 2,500 acres in size. The native vegetation is mainly grasses, shrubs, and scattered trees. Elevation is 5,800 to 6,800 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 45 percent Winona very gravelly loam, 15 to 45 percent slopes; 30 percent Tanbark loam, 25 to 60 percent slopes; and 15 percent Rock outcrop. The Winona soil is on mesa breaks and hills, the Tanbark soil is on ridges and hills, and the Rock outcrop is on escarpments, mesa breaks, hills, and ridgetops.

Included in this unit are small areas of Harvey soils on mesa breaks, mainly near the boundary of Socorro County; on hills and mesa breaks, soils that are similar to the Winona soil but are moderately deep; Suwanee and Aparejo soils in drainageways; and Hagerman soils on hills. Included areas make up about 10 percent of the total acreage.

The Winona soil is shallow and well drained. It formed in alluvium and windblown sediments derived dominantly from limestone. Typically, the surface layer is yellowish brown very gravelly loam about 3 inches thick. The subsoil is brown very cobbly loam about 12 inches thick. Limestone is at a depth of about 15 inches.

Permeability is moderate in the Winona soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing is severe.

The Tanbark soil is shallow and well drained. It formed in alluvial and eolian material derived dominantly from gypsum. Typically, the surface layer is very pale brown loam about 2 inches thick. The upper part of the underlying material is very pale brown, gypsiferous silt loam about 10 inches thick, and the lower part is white, gypsiferous sandy loam about 5 inches thick. Gypsum is at a depth of about 17 inches.

Permeability is moderate in the Tanbark soil. Available water capacity is very low. The effective rooting depth is 10 to 20 inches. Runoff is rapid, and the hazard of water erosion is severe. The hazard of soil blowing also is severe.

The Rock outcrop consists of barren or nearly barren areas of exposed limestone on escarpments, ridges, and mesa breaks.

This unit is used for livestock grazing. The potential natural plant community on the Winona soil is mainly New Mexico muhly, New Mexico feathergrass, black grama, blue grama, sideoats grama, winterfat, and scattered juniper. The average annual production of air-dry vegetation ranges from 1,200 pounds per acre in favorable years to 700 pounds in unfavorable years. If the plant community deteriorates, New Mexico feathergrass, sideoats grama, and black grama decrease in abundance and sacahuista, blue grama, and oneseed juniper increase. The increasers normally occur in small amounts in the potential natural plant community.

The potential natural plant community on the Tanbark soil is mainly gyp dropseed, alkali sacaton, galleta, hairy coldenia, and black grama. The average annual production of air-dry vegetation ranges from 475 pounds per acre in favorable years to 200 pounds in unfavorable years. If the plant community deteriorates, galleta, black grama, and sideoats grama decrease in abundance and gyp dropseed, threeawn, ring muhly, and hairy coldenia increase. The increasers normally occur in small amounts in the potential natural plant community.

The slope limits access by livestock. Constructing trails or walkways can allow the livestock to graze in areas where access is limited.

This unit is not suitable for livestock ponds, livestock pipelines, or range seeding because of the depth to bedrock, the slope, and the low available water capacity.

660—Rana-Rock outcrop complex, 2 to 25 percent slopes. This map unit is on mesa breaks, ridges, ledges, and escarpments. Areas are irregular in shape and are 900 to 7,000 acres in size. The native vegetation is mainly grasses and scattered trees and shrubs. Elevation is 5,800 to 7,000 feet. The average annual precipitation is about 10 to 12 inches, the average annual air temperature is 49 to 53 degrees F, and the average frost-free period is 120 to 140 days.

This unit is 45 percent Rana very cobbly clay, 2 to 25 percent slopes, very stony, and 40 percent Rock outcrop. The Rana soil is on benches and hills on mesa breaks, and the Rock outcrop is on ridges, ledges, and escarpments. The components of this unit occur as areas so intricately intermingled that mapping them separately was not practical at the scale used.

Included in this unit are small areas of Poley soils on ridges and mesa breaks; Torreon soils on hillsides on mesa breaks; on benches and hills on mesa breaks, soils that are similar to the Rana soil but are less than 40 inches deep over shale; and outcrops of sedimentary rock on ridges, ledges, and escarpments. Included areas make up about 15 percent of the total acreage.

The Rana soil is deep and well drained. It formed in alluvium and colluvium derived dominantly from red-bed shale. Typically, the surface layer is red very cobbly clay about 3 inches thick. The upper part of the underlying material is red clay about 31 inches thick, and the lower part to a depth of 60 inches is reddish brown clay.

Permeability is very slow in the Rana soil. Available water capacity is high. The effective rooting depth is 60 inches. Runoff is medium, and the hazard of water erosion is moderate. The hazard of soil blowing also is moderate.

The Rock outcrop consists of barren or nearly barren areas of exposed basalt on ridges and escarpments.

This unit is used for livestock grazing. The potential natural plant community on the Rana soil is mainly alkali sacaton, galleta, sideoats grama, black grama, and fourwing saltbush. The average annual production of air-dry vegetation ranges from 660 pounds per acre in favorable years to 250 pounds in unfavorable years. If the plant community deteriorates, alkali sacaton, sideoats grama, and black grama decrease in abundance and galleta, silver bluestem, and broom snakeweed increase. The increasers normally occur in small amounts in the potential natural plant community.

Good grazing management can increase the productivity and reproduction potential of alkali sacaton, sideoats grama, and black grama. The Rana soil is suited to such management practices as livestock ponds, livestock pipelines, and fencing.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded

during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 1,047 acres in the survey area would meet the soil requirements for prime farmland if an adequate and dependable supply of irrigation water were available. Most of the irrigated farmland in the area is subject to excessive soil blowing and therefore is not considered prime farmland.

The map units in the survey area that are considered prime farmland where irrigated are Clovis sandy clay loam, 1 to 3 percent slopes (unit 21) and Hickman sandy clay loam, 1 to 3 percent slopes (unit 75). The extent of the two map units is shown in table 2. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

By Kenneth R. Walker, district conservationist, Soil Conservation Service.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 4,500 acres in the survey area is irrigated cropland, most of which is in small tracts adjacent to dwellings. The supply of irrigation water is limited in most areas. Most of the small number of irrigation reservoirs in the survey area have a limited storage capacity. About 1,500 acres of nonirrigated cropland is in the Fence Lake area. The growing season in the survey area ranges from 100 to 160 days, depending on the elevation.

The primary crops in Bluewater Valley are alfalfa and small grain. A small acreage is used for potatoes, pinto beans, sweet corn, or millet. About 240 acres is used as irrigated pasture. The irrigation water in this area is provided by Bluewater Lake and by wells. Water from wells is used only when the allocation of water from the lake is less than 3 acre-feet per acre. The cropland in this valley is occasionally flooded for brief periods when snow melts in the spring.

Most of the nonirrigated cropland in the survey area is used for small grain that is grazed, but a small amount of dryland alfalfa is grown in the Fence Lake area. Enough acreage is excluded from grazing each year to allow for the harvest of seed for the next year's planting.

In the Bibo-Seboyeta, Laguna, and San Mateo communities, the main crops are truck crops, chiles, beans, and blue corn. Also, small orchards are in a few areas. The irrigation water in these areas is provided by small reservoirs constructed across two of the larger side arroyos and by the Rio San Jose.

All of the cropland in the Acoma area is used for garden crops, alfalfa, truck crops, or orchard crops,

mainly for home consumption. Some of the soils in this area have a high content of sodium and are highly saline.

In the Ramah Valley area, the main crop is small grain. A small acreage in this area is used as irrigated pasture. Irrigation water is provided by the Ramah Reservoir.

The main objectives in cropland management are proper irrigation, maintenance of good soil tilth and fertility, and control of water erosion and soil blowing. Measures that reduce salinity or sodicity and improve drainage also are needed in some areas. Salinity and sodicity can be reduced by leaching or by applying soil amendments.

Using a suitable cropping system helps to maintain good soil tilth, structure, aeration, and fertility. A single crop can be grown for many years on some soils with little adverse effect on yields. Other soils deteriorate rapidly if low-residue crops are grown unless large amounts of organic matter are added annually. Rotating crops helps to control insects, disease, and weeds.

Applying adequate amounts of irrigation water in a timely manner and avoiding overirrigation are essential for high yields. The irrigation system should be adapted to the soil and the crops grown. Overirrigation leaches nutrients from the root zone, results in excessive wetness of the lower part of the soil, and reduces aeration in the root zone.

Good management practices, such as planting improved varieties of crops, timely planting and harvesting, and applying fertilizer according to the needs of the crops, can increase yields of annual crops, hay crops, and pasture plants. Control of weeds, insects, and disease also helps to increase yields.

Good pasture management includes such practices as applying adequate fertilizer, clipping after grazing to remove excess forage and weeds, and rotation grazing.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 3. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

For yields of irrigated crops, it is assumed that the irrigation system is adapted to the soils and to the crops grown, that good-quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 3 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(11)*. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit that includes irrigated land is shown in table 3. The classification of the other map units in the survey area is available at the local office of the Soil Conservation Service.

Rangeland

Mike Delancy, range conservationist, Soil Conservation Service, helped prepare this section.

Rangeland consists of areas that support a potential natural plant community of dominantly grasses, grasslike plants, forbs, and shrubs suitable for grazing or browsing. In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

In the section "Detailed Soil Map Units," the relationship between soils and vegetation is expressed in terms of the potential natural plant community on the soils in the map units. In the following paragraphs, potential natural plant community and some of the other terms used in the map unit descriptions are defined.

The potential natural plant community is an association of plants that are best adapted to a unique combination of environmental factors. Even on similar soils, the proportion and production of these plants vary naturally from place to place and year to year. The dominant plant or plants are used to characterize a plant community because of their relative stability in areas that have not been disturbed or have not deteriorated. The grasses, forbs, and shrubs that characterize the potential natural plant community on each major soil are listed by common name in the map units.

Similar plant communities are grouped into range sites. A range site is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table also are important. Information about the range sites in this survey area is available at the local offices of the Soil Conservation Service.

The average annual production is given in the map unit descriptions. It is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture. The total amount of vegetation that can be used for forage in a given area depends on the kinds of grazing animals, the grazing season, and uses of the

area for purposes other than grazing.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as those in the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

About 60 percent of the survey area supports a plant community of dominantly grasses, forbs, and shrubs that are suitable for grazing or browsing. Nearly all of the wooded areas produce grazable understory. About 25 percent of the survey area receives enough snowfall to prevent winter grazing. Cow-calf enterprises are dominant, but some livestock producers maintain yearling enterprises.

Good grazing management includes practices that increase the extent of the ground cover, accumulate litter, and improve the vigor and reproduction potential of the more desirable grasses and shrubs. Continuous, year-round grazing or grazing every year during the growing season, usually from April through October, results in a deteriorated plant community that generally has a reduced value as forage.

Proper grazing use and deferred grazing, which varies the season of use during successive years, are needed to maintain a healthy, balanced plant community and to provide high-quality forage throughout the year. Resting pastures in summer encourages the growth and reproduction of warm-season grasses, such as sideoats grama, black grama, blue grama, and little bluestem. Resting pastures in spring encourages the growth of cool-season grasses, such as western wheatgrass and New Mexico feathergrass. Resting pastures in fall and winter encourages the growth of shrubs, such as mountainmahogany.

Flexibility in the number of grazing animals and in the frequency and intensity of grazing is essential if any grazing program is to be successful. Effective livestock distribution can be achieved through the use of fences, livestock water developments, salting facilities, and planned grazing systems.

Woodland Management and Productivity

Richard J. Reioux, forester, Soil Conservation Service, helped prepare this section.

A total of 1,078,592 acres in the survey area, or about 40 percent of the acreage, is woodland. Ponderosa pine, Douglas fir, and Engelmann spruce are the major commercial timber species in the area. They cover about 323,578 acres, or about 30 percent of the woodland in the area. The remaining 755,014 acres supports mainly pinyon and juniper *(9)*.

Logging in the Mount Taylor area and the Zuni Mountains began in the 1890's. These areas were logged extensively from the 1900's to the 1940's. In the Zuni Mountains, a narrow-gauge railroad was used to transport logs to the sawmills. From the late 1930's through World War II, areas that had appreciable amounts of ponderosa pine were cut over for the production of railroad ties.

The many periods of heavy cutting and the subsequent farming, overgrazing, and control of fires have resulted in the present forest conditions. Some wooded areas are understocked. The residual trees in these areas are of poor quality for timber. Many second-growth stands are overstocked and require thinning before optimum growth and yields can be achieved.

The dominant timber species in the survey area is ponderosa pine. Scattered Douglas fir and southwestern white pine are throughout the stands. The Zuni Mountains and the Mount Taylor area support no white fir (*Abies concolor*), which is common on most of the other woodland in the survey area. Ponderosa pine grows best at elevations above 8,000 feet, but it also grows at elevations as low as 7,300 feet. Douglas fir grows best on the north-facing slopes between elevations of 7,800 and 8,300 feet. Most of the Engelmann spruce and Douglas fir in the survey area is on Mount Taylor. Small areas of Douglas fir are on the cooler, north-facing slopes in the Zuni Mountains. The main species at elevations above 8,800 feet are Engelmann spruce and corkbar fir. Narrow bands of blue spruce are along some of the drainageways at the higher elevations.

Of the soils in the survey area, Moreno Variant, McGaffey, Moreno, Parkay, and Abersito soils have the highest potential for timber production. Timber can also be produced on Cebolleta, Cinnadale, and Charo soils.

Pinyon and oneseed juniper are common at elevations of 7,100 to 7,800 feet, but they also grow on

the south-facing slopes at elevations as high as 8,100 feet. Rocky Mountain juniper and alligator juniper are included in the overstory at the higher elevations. Although pinyon and juniper are not considered commercial species, they are used extensively for fuel wood, fenceposts, Christmas trees, and ornamental plantings. Pinyon also provides edible nuts.

Most of the understory in the areas of pinyon and juniper is used for livestock grazing. Thinning of trees and other practices are needed to obtain maximum forage production in many areas. The soils that support the best stands of pinyon and juniper are those of the Pintos, Ribera, Cantina, and Vessilla series. Other soils that support these trees are those of the Flugle, Nogal, and Cabezon series.

Good woodland management includes protection against fire, insects, and disease; thinning and pruning to improve tree growth and quality; reforestation; cutting to improve the stocking level; and proper watershed management.

Fire prevention or control is provided by the Forest Service, the New Mexico Division of Forestry, and private individuals. Proper silvicultural practices provide protection against insects, such as bark beetles, and diseases, such as dwarf mistletoe and red rot. Thinning and pruning of selected trees improves the quality of the timber and the growth potential of the site.

Reforestation can be achieved by natural regeneration and by planting. Proper site preparation may be needed to provide a good seedbed and minimize competition from shrubs and grasses.

Watershed management includes the proper location of skid trails, logging roads, and landings and the proper treatment of all areas disturbed by logging activities. Constructing water bars, cross ditching, and building out-sloping roads and then seeding grasses, forbs, and browse species help to control water erosion. Leaving a buffer strip of undisturbed soil and vegetation on both sides of watercourses also helps to control water erosion and minimizes the amount of sediment that can reach streams.

Table 4 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 4, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are

moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are depth to the water table and the available water capacity. A rating of *slight* indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of *moderate* indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of *severe* indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *productivity class*. The site index generally is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. For pinyon and juniper, however, the site index is determined by the basal area. The site index applies to fully stocked, even-aged, unmanaged stands. The site index curves for ponderosa pine were developed by Meyer *(7)*, those for Douglas fir by Edminster and Jump *(5)*, those for Engelmann spruce by Alexander *(1)*, and those for pinyon and juniper by Howell *(6)*. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *productivity class*, a number, is the yield expressed in cubic meters per hectare per year calculated at the age of culmination for a fully stocked, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Woodland Understory Vegetation

Understory vegetation consists of grasses, forbs, shrubs, and other plants. If well managed, some woodland can produce enough understory vegetation to support grazing by livestock or wildlife, or both, without damage to the trees.

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive; therefore, the production of understory plants can be increased by thinning the trees in the overstory. In the section "Detailed Soil Map Units," the common understory plants are specified for the soils in the survey area that are used as woodland.

Windbreaks and Environmental Plantings

Richard J. Reioux, forester, Soil Conservation Service, helped prepare this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 5 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 5 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens.

The trees or shrubs selected for planting in windbreaks should be those that are suited to the soils on the site. Selecting suitable species helps to ensure the survival, rapid growth, and longevity of windbreaks. The soil characteristics that greatly affect the growth rate of trees and shrubs are permeability, available water capacity, and depth to bedrock.

Grazing can be detrimental to windbreaks and environmental plantings because livestock compact the soil and remove the lower branches of the trees and shrubs. Compaction retards growth, and removal of the lower branches reduces the effectiveness and esthetic value of the windbreaks. Weeds and insects prevent maximum growth rates. Clean cultivation and applications of herbicide help to control weeds. Fallowing a year before planting helps to ensure a sufficient soil moisture supply for the establishment of seedlings. Penistaja, Clovis, Glenberg, Mespun, Grieta,

and Kiki soils are subject to soil blowing. As a result, sites for windbreaks and environmental plantings on these soils should be prepared in spring.

Shallow soils and soils that have a high water table or a high content of salts or sodium are severely limited as sites for windbreaks and environmental plantings. Plantings can be successfully established in some areas of these soils if suitable species are selected and special management is applied.

An insufficient moisture supply hinders the survival of trees in urban areas and on cropland. Drip irrigation or other methods of irrigation are needed to reduce the seedling mortality rate and ensure continued growth.

Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from the local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

The soils of the survey area are rated in table 6 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 6, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 6 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 9 and interpretations for dwellings without basements and for local roads and streets in table 8.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edwin A. Swenson, state biologist, Soil Conservation Service, helped prepare this section.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 7, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, wheatgrass, timothy, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are muhly, dropseed, buckwheat, wheatgrass, grama, tumbleweed, and mallow.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are ponderosa pine, spruce, Douglas fir, pinyon, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are mountainmahogany, Apacheplume, oak, skunkbush sumac, sand sagebrush, and fourwing saltbush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattail, saltgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, playas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include coyote, striped skunk, cottontail, and pocket gopher.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, elk, mule deer, porcupine, chickadee, squirrels, and woodpeckers.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, tiger salamander, beaver, and leopard frog.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, black-tailed jackrabbit, prairie dog, horned lark, and prairie rattlesnake.

Engineering

Bernice A. Dyer, area engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the "Glossary."

Building Site Development

Table 8 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell

potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity *(2, 3)*.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 9 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 9 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 9 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 9 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 10 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 10, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification

are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 11 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features generally are favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, and terraces and diversions.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even more than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 12 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area *(8)*. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture *(10)*. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The

estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 13 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2

millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.
2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.
3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.
5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.
6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.
8. Soils that are not subject to soil blowing because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 13, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 14 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet, receive precipitation from long-duration storms, and are not protected by a plant cover.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 14 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 14 are the depth to the seasonal high water table, the kind of water table, and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 14. Only saturated zones within a depth of about 6 feet are indicated. An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(12)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 15 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Fluvent (*Fluv*, meaning flood plain, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Ustifluvents (*Ust*, meaning ustic moisture regime, plus *fluvent*, the suborder of the Entisols characterized by an irregular decrease in carbon content).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Ustifluvents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed (calcareous), mesic Typic Ustifluvents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(10)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(12)*. Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Abersito Series

The soils in the Abersito series are classified as clayey-skeletal, mixed Mollic Eutroboralfs. These moderately deep, well drained soils formed in mixed

colluvial and alluvial sediments. They are on hills and mesas. Slope is 5 to 30 percent. Elevation is 8,300 to 8,800 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 85 to 105 days.

Typical pedon of Abersito very cobbly sandy clay loam, in an area of Abersito, cobbly-Abersito-Rock outcrop association, 5 to 30 percent slopes; about 0.5 mile southwest of Lookout Mountain; 1,100 feet east and 2,300 feet south of the northwest corner of sec. 2, T. 11 N., R. 14 W.

Oi—2 inches to 0; pine needles and oak leaves.

A—0 to 3 inches; brown (7.5YR 4/2) very cobbly sandy clay loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common fine and very fine irregular pores; about 40 percent cobbles, 10 percent gravel, and 5 percent stones; slightly acid; clear smooth boundary.

E—3 to 9 inches; light brown (7.5YR 6/4) very cobbly fine sandy loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine and few fine irregular pores; about 30 percent cobbles and 10 percent gravel; slightly acid; abrupt smooth boundary.

Bt—9 to 24 inches; yellowish red(5YR 5/6) very cobbly clay, yellowish red (5YR 4/6) moist; strong medium angular blocky structure; hard, firm, sticky and plastic; few very fine, fine, and medium roots; few very fine tubular pores; many thick clay films on faces of peds and in pores; about 35 percent cobbles and 5 percent gravel; slightly acid; abrupt smooth boundary.

2R—24 inches; sandstone.

The depth to bedrock ranges from 20 to 40 inches. The content of rock fragments in the control section ranges from 35 to 60 percent.

The A horizon is very cobbly sandy clay loam or gravelly loam. It has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. The E horizon has value of 5 or 6 (3 or 4 moist) and chroma of 4 to 6. The Bt horizon has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6.

Aparejo Series

The soils in the Aparejo series are classified as fine-loamy, mixed (calcareous), mesic Typic Ustifluvents. These deep, well drained soils formed in mixed alluvium. They are on flood plains and alluvial fans. Slope is 0 to 5 percent. Elevation is 6,200 to 7,500 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 110 to 140 days.

Typical pedon of Aparejo silt loam, in an area of Aparejo-Venadito complex, 1 to 5 percent slopes; about 3 miles northwest of Mesa Aparejo; 400 feet north and 2,165 feet east of the southwest corner of sec. 28, T. 6 N., R. 3 W.

A—0 to 2 inches; yellowish red (5YR 4/6) silt loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common medium and fine and few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

C1—2 to 18 inches; yellowish red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; massive; soft, very friable, slightly sticky and nonplastic; few medium, fine, and very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—18 to 60 inches; yellowish red (5YR 5/6) silt loam, reddish brown (5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

The soils generally are stratified with lenses of sandy or silty material less than 1 inch thick.

The A horizon is silt loam, clay loam, or clay. It has hue of 5YR or 2.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 to 6.

The C horizon is stratified silt loam, silty clay loam, clay loam, fine sandy loam, or sandy clay loam. The content of clay ranges from 18 to 35 percent, and the content of fine sand or coarser sand is more than 15 percent. This horizon has hue of 5YR or 2.5YR and value of 4 or 5 (3 or 4 moist).

Atarque Series

The soils in the Atarque series are classified as loamy, mixed, mesic Lithic Haplustalfs. These shallow and very shallow, well drained soils formed in eolian material derived mainly from sandstone. They are on mesa tops, knolls, cuestas, and hilltops. Slope is 1 to 10 percent. Elevation is 6,600 to 7,300 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F,

and the frost-free period is 115 to 135 days.

Typical pedon of Atarque fine sandy loam, in an area of Celacy-Atarque complex, 1 to 10 percent slopes; about 3.75 miles southeast of Broom Mountain; 725 feet west and 600 feet south of the northeast corner of sec. 27, T. 5 N., R. 7 W.

A—0 to 2 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few medium and fine roots; few very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—2 to 9 inches; brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few medium and fine roots; common very fine and few fine irregular pores; few moderately thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—9 to 16 inches; brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine and very fine roots; common fine and very fine irregular pores; common moderately thick clay films on faces of peds and in pores; neutral; abrupt smooth boundary.

2R—16 inches; sandstone.

The depth to bedrock is 8 to 20 inches. The soils are neutral or mildly alkaline throughout.

The A horizon has hue of 5YR or 7.5YR and value of 4 to 6 (3 to 5 moist). The Bt horizon is sandy clay loam or clay loam. It has hue of 5YR or 7.5YR and value of 4 or 5 (3 or 4 moist). The 2R horizon generally is sandstone, but in some areas it is basalt.

Bandera Series

The soils in the Bandera series are classified as loamy-skeletal over fragmental, mixed Entic Haploborolls. These deep, somewhat excessively drained soils formed in colluvium and windblown volcanic sediments. They are on cinder hills and cones. Slope is 15 to 45 percent. Elevation is 7,400 to 8,300 feet. The average annual precipitation is 16 to 20 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Bandera gravelly loam, in an area of Bandera association, 15 to 45 percent slopes; about 0.5 mile southeast of Bandera Crater; 2,200 feet east and 2,175 feet north of the southwest corner of sec. 23, T. 9 N., R. 12 W.

A1—0 to 4 inches; brown (10YR 4/3) gravelly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few coarse roots; common very fine and fine irregular pores; about 25 percent pebble-sized cinders; neutral; clear smooth boundary.

A2—4 to 9 inches; brown (10YR 5/3) gravelly loam, dark brown (10YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine and fine irregular pores; about 30 percent pebble-sized cinders; neutral; clear smooth boundary.

C—9 to 16 inches; yellowish brown (10YR 5/6) very gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine and coarse roots; common very fine and fine irregular pores; about 40 percent pebble-sized cinders; neutral; abrupt wavy boundary.

2C—16 to 60 inches; cinders.

The A horizon is very gravelly or gravelly loam. It has value of 2 or 3 moist and chroma of 2 or 3. The C horizon has value of 4 or 5 (3 or 4 moist) and chroma of 3 to 6. The 2C horizon has more than 80 percent cinders to a depth of 60 inches.

Berto Series

The soils in the Berto series are classified as loamy, mixed, mesic Lithic Ustollic Haplargids. These shallow, well drained soils formed in mixed alluvium and windblown sediments. They are on mesa tops. Slope is 1 to 10 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Berto loam, in an area of Flaco-Berto loams, 0 to 5 percent slopes; about 2,110 feet west and 2,220 feet south of the northeast corner of sec. 28, T. 7 N., R. 3 W.

A—0 to 2 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; few very fine irregular pores; about 2 percent cobbles and 2 percent gravel; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bt1—2 to 6 inches; brown (7.5YR 5/4) loam, dark brown

(7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and fine irregular and few fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 2 percent cobbles and 2 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

Bt2—6 to 11 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine and few medium roots; common very fine and fine irregular and few fine tubular pores; common thin clay films on faces of peds and in pores; about 2 percent cobbles and 2 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

Bk1—11 to 17 inches; pink (7.5YR 8/4) cobbly loam, light brown (7.5YR 6/4) moist; massive; hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; few very fine irregular pores; about 10 percent cobbles and 10 percent gravel; violently effervescent; disseminated calcium carbonate, many coarse irregular soft masses of calcium carbonate, and coatings of calcium carbonate on rock fragments; moderately alkaline; abrupt smooth boundary.

Bk2—17 to 18 inches; pink (7.5YR 8/4) loam, pink (7.5YR 7/4) moist; massive; hard, friable, slightly sticky and nonplastic; about 5 percent cobbles and 5 percent gravel; violently effervescent; disseminated calcium carbonate, many coarse irregular soft masses of calcium carbonate, and coatings of calcium carbonate on rock fragments; moderately alkaline; abrupt wavy boundary.

2R—18 inches; basalt.

The depth to bedrock is 10 to 20 inches.

The A horizon is cobbly loam or loam. It has hue of 7.5YR or 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The content of rock fragments ranges from 0 to 20 percent.

The Bt horizon is loam or clay loam. It has hue of 7.5YR or 10YR and value of 4 or 5 (3 or 4 moist). The content of rock fragments ranges from 0 to 10 percent.

The Bk horizon has hue of 7.5YR or 10YR, value of 6 to 8 (6 or 7 moist), and chroma of 4 or 5. The content of rock fragments ranges from 10 to 20 percent. The calcium carbonate equivalent is more than 15 percent.

Bond Series

The soils in the Bond series are classified as loamy, mixed, mesic Lithic Ustollic Haplargids. These shallow, well drained soils formed in eolian material derived dominantly from sandstone. They are on the upper slopes of cuestas and on the tops of hills, cuestas, mesas, and ridges. Slope is 2 to 20 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 115 to 150 days.

Typical pedon of Bond sandy loam, in an area of Bond-Penistaja-Rock outcrop complex, 2 to 15 percent slopes; about 300 feet south and 2,600 feet east of the northwest corner of sec. 8, T. 12 N., R. 10 W.

A—0 to 3 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few medium and fine roots; few very fine irregular pores; neutral; clear smooth boundary.

BA—3 to 7 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.

Bt—7 to 13 inches; reddish brown (5YR 4/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common moderately thick clay films on faces of peds and in pores; common very fine and few fine roots; common very fine and few fine tubular pores; neutral; abrupt smooth boundary.

C—13 to 16 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; few very fine roots; common very fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—16 inches; sandstone.

The depth to bedrock ranges from 10 to 20 inches. Some pedons have a Cr horizon of weathered sandstone.

The A horizon has hue of 5YR or 7.5YR, value of 4 or 5 dry or moist, and chroma of 3 or 4. The Bt horizon is sandy clay loam or clay loam. It has hue of 5YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 to 6. The C horizon is sandy loam, loam, clay loam, or

sandy clay loam. It has hue of 5YR or 7.5YR, value of 5 to 8 (5 or 6 moist), and chroma of 3 or 4 moist.

Borrego Series

The soils in the Borrego series are classified as clayey, mixed Lithic Eutroboralfs. These shallow, well drained soils formed in alluvium and windblown sediments. They are on basalt-capped mesas, ridges, and hills. Slope is 1 to 15 percent. Elevation is 7,200 to 8,200 feet. The average annual precipitation is 16 to 22 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Borrego gravelly loam, in an area of Cebolleta-Borrego-Rock outcrop complex, 1 to 15 percent slopes; about 138 feet northwest of Rancho Chupadero; long. 107 degrees 35 minutes 54 seconds W. and lat. 35 degrees 10 minutes 14 seconds N.

A—0 to 4 inches; brown (7.5YR 4/4) gravelly loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; common fine and very fine roots; about 10 percent cobbles and 20 percent gravel; slightly acid; abrupt smooth boundary.

BA—4 to 8 inches; brown (7.5YR 4/4) gravelly clay loam, dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; common fine and very fine roots; few fine irregular and tubular pores; about 5 percent cobbles and 10 percent gravel; neutral; clear smooth boundary.

Bt1—8 to 13 inches; strong brown (7.5YR 4/6) gravelly clay, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common fine and very fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; about 5 percent cobbles and 10 percent gravel; mildly alkaline; clear smooth boundary.

Bt2—13 to 18 inches; strong brown (7.5YR 4/6) gravelly clay, dark brown (7.5YR 4/4) moist; moderate medium angular blocky structure; very hard, very firm, very sticky and very plastic; common very fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; about 15 percent gravel; slightly effervescent; mildly alkaline; abrupt smooth boundary.

2R—18 inches; basalt.

The depth to bedrock is 10 to 20 inches.

The A horizon is gravelly loam or loam. The content of rock fragments ranges from 10 to 35 percent. This horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 4.

The content of rock fragments in the BA horizon ranges from 15 to 35 percent. This horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 4.

The Bt horizon is gravelly clay or clay. The content of rock fragments ranges from 5 to 35 percent. This horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 to 6.

The Borrego soils in this survey area are a taxadjunct to the series because they are underlain by basalt and are slightly effervescent and mildly alkaline in the lower part of the argillic horizon, directly above the basalt. These differences, however, do not significantly affect the use and management of the soils.

Cabezon Series

The soils in the Cabezon series are classified as clayey, montmorillonitic, mesic Lithic Argiustolls. These shallow, well drained soils formed in windblown sediments and alluvium over basalt. They are on hills and ridges. Slope is 1 to 45 percent. Elevation is 6,400 to 7,800 feet. The average annual precipitation is 12 to 16 inches. The average annual air temperature is 47 to 52 degrees F, and the frost-free period is 100 to 135 days.

Typical pedon of Cabezon very cobbly loam, in an area of Cabezon-Montecito-Rock outcrop association, 1 to 10 percent slopes; about 14 miles north of Techado; 2,100 feet west and 500 feet north of the southeast corner of sec. 2, T. 6 N., R. 15 W.

A—0 to 2 inches; brown (10YR 5/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; many very fine vesicular pores; about 2 percent stones, 25 percent cobbles, and 10 percent gravel; neutral; abrupt smooth boundary.

Bt1—2 to 10 inches; brown (7.5YR 5/2) clay, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few coarse and common very fine roots; common very fine tubular and irregular pores; many moderately thick clay films on faces of peds and in pores; about 10 percent cobbles; mildly alkaline; clear smooth boundary.

Bt2—10 to 18 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few coarse and very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 5

percent cobbles and 5 percent gravel; mildly alkaline; abrupt smooth boundary.

2R—18 inches; basalt; thin coating of calcium carbonate at contact.

The depth to bedrock is 10 to 20 inches. Some pedons have a thin Bk horizon. The calcium carbonate equivalent in this horizon is less than 15 percent.

The A horizon is very cobbly loam or very cobbly sandy loam. It has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 or 3. The content of rock fragments ranges from 35 to 60 percent.

The Bt horizon is clay, sandy clay, or clay loam. It has value of 4 or 5. The content of rock fragments ranges from 10 to 25 percent.

Cantina Series

The soils in the Cantina series are classified as fine, mixed, mesic Aridic Argiustolls. These deep, well drained soils formed in mixed alluvium. They are in valleys between lava ridges and on hills. Slope is 1 to 3 percent. Elevation is 7,100 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Cantina sandy loam, in an area of Cabezon-Cantina complex, 1 to 7 percent slopes; about 1.5 miles northwest of Mujeres Camp; 1,800 feet south and 2,100 feet east of the northwest corner of sec. 16, T. 5 N., R. 14 W.

A—0 to 2 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable, nonsticky and nonplastic; few coarse and common very fine roots; many fine vesicular pores; neutral; abrupt smooth boundary.

Bt1—2 to 9 inches; brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few coarse and common very fine roots; common very fine tubular and irregular pores; common moderately thick clay films on faces of peds and in pores; neutral; abrupt wavy boundary.

Bt2—9 to 16 inches; brown (10YR 4/3) sandy clay, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; few coarse and common very fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt3—16 to 24 inches; brown (10YR 5/3) sandy clay, dark yellowish brown (10YR 4/4) moist; weak medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; few coarse and common very fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Btk—24 to 31 inches; brown (10YR 5/3) sandy clay, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; common fine and very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; strongly effervescent; disseminated calcium carbonate and few medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk—31 to 54 inches; brown (7.5YR 5/4) sandy clay loam, strong brown (7.5YR 4/6) moist; massive; hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate and few medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—54 inches; basalt.

The depth to bedrock ranges from 40 to 60 inches. The A horizon has value of 4 or 5 and chroma of 2 or 3. The Bk horizon is sandy clay loam or sandy clay. It has hue of 7.5YR or 10YR and value of 4 to 6 (4 or 5 moist). The calcium carbonate equivalent in this horizon is 2 to 10 percent.

Catman Series

The soils in the Catman series are classified as very fine, montmorillonitic, mesic Udorthentic Chromusterts. These deep, well drained soils formed in alluvium derived dominantly from shale. They are on flood plains, in swales, on alluvial fans, and in drainageways and valleys. Slope is 1 to 5 percent. Elevation is 6,500 to 7,500 feet. The average annual precipitation is 12 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 135 days.

Typical pedon of Catman clay loam, in an area of Catman-Silkie association, 1 to 10 percent slopes; about 0.25 mile southeast of Crockett Peak; 560 feet north and 2,580 feet east of the southwest corner of sec. 28, T. 8 N., R. 17 W.

A—0 to 3 inches; light olive brown (2.5Y 5/4) clay loam, olive brown (2.5Y 4/4) moist; moderate medium granular structure; soft, friable, slightly sticky and slightly plastic; common very fine roots; common fine irregular pores; cracks 1 to 3 centimeters wide; slightly effervescent; neutral; clear smooth boundary.

C1—3 to 32 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; very hard, very firm, very sticky and very plastic; common very fine and few fine roots; common very fine irregular pores; cracks 0.5 inch wide; many intersecting slickensides; slightly effervescent; neutral; clear smooth boundary.

C2—32 to 60 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, sticky and plastic; few very fine roots; common very fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; mildly alkaline.

Cracks more than 0.5 inch wide extend to a depth of 32 inches. The A horizon is clay loam, sandy clay loam, or silty clay loam. It has hue of 10YR or 2.5Y, value of 4 to 7 (4 to 6 moist), and chroma of 3 or 4. The C horizon has hue of 10YR or 2.5Y, value of 4 to 7 (4 to 6 moist), and chroma of 3 or 4.

Catman Variant

The soils in the Catman Variant are classified as very fine, montmorillonitic (calcareous), mesic Mollic Ustifluvents. These deep, somewhat poorly drained soils formed in mixed alluvium. They are on alluvial fans and flood plains and in valleys. Slope is 1 to 3 percent. Elevation is 6,800 to 6,900 feet. The average annual precipitation is 13 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Catman Variant clay loam, 1 to 3 percent slopes; 300 feet south and 800 feet west of the northeast corner of sec. 3, T. 10 N., R. 16 W.

Ap—0 to 10 inches; dark brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; massive; hard, firm, sticky and plastic; common very fine and fine and few coarse roots; many very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C1—10 to 25 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; massive; very hard, very firm, very sticky and plastic; common very fine and fine and few coarse roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—25 to 33 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; massive; very hard, very firm, very sticky and plastic; few very fine and fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C3—33 to 60 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; common medium distinct reddish yellow (7.5YR 6/8) mottles; massive; very hard, very firm, very sticky and plastic; few fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

The water table in these soils fluctuates between depths of 24 and 40 inches. Electrical conductivity ranges from 8 to 16 millimhos per centimeter.

Cebolleta Series

The soils in the Cebolleta series are classified as clayey-skeletal, mixed Typic Argiborolls. These moderately deep, well drained soils formed in windblown sediments and alluvium. They are on hills, mountainsides, and mesas. Slope is 1 to 50 percent. Elevation is 7,500 to 9,400 feet. The average annual precipitation is 18 to 24 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 80 to 110 days.

Typical pedon of Cebolleta cobbly loam, 2 to 10 percent slopes, very stony; about 0.75 mile west of Big Lake; long. 107 degrees 31 minutes 17 seconds W. and lat. 35 degrees 15 minutes 36 seconds N.

Oi—1 inch to 0; pine needles and oak leaves.

A—0 to 4 inches; very dark grayish brown (10YR 3/2) cobbly loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few medium and common fine and very fine roots; few very fine pores; about 2 percent stones, 20 percent cobbles, and 5 percent gravel; slightly acid; abrupt smooth boundary.

BA—4 to 10 inches; dark grayish brown (10YR 4/2) very cobbly loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and slightly plastic; common coarse, fine, and very fine roots; common very fine tubular pores; about 30 percent cobbles and 5 percent gravel; neutral; abrupt smooth boundary.

Bt1—10 to 19 inches; reddish brown (5YR 5/4) very cobbly clay, reddish brown (5YR 4/4) moist;

moderate medium subangular blocky structure; hard, friable, sticky and plastic; few coarse and common fine and very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 30 percent cobbles and 10 percent gravel; slightly acid; clear smooth boundary.

Bt2—19 to 25 inches; brown (7.5YR 4/4) very cobbly clay, dark brown (7.5YR 3/4) moist; strong medium angular blocky structure; very hard, firm, sticky and plastic; few very fine roots; few very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 25 percent cobbles and 20 percent gravel; slightly acid; abrupt wavy boundary.

2R—25 inches; basalt.

The depth to bedrock, or to the base of the Bt horizon, is 20 to 40 inches. The thickness of the mollic epipedon is 8 to 15 inches.

The A horizon is cobbly or very cobbly loam. It has hue of 7.5YR or 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. The content of rock fragments ranges from 25 to 45 percent, by volume, including 0 to 5 percent stones, 20 to 30 percent cobbles, and 5 to 10 percent gravel.

The BA horizon is very cobbly loam and very cobbly clay loam. It has hue of 5YR to 10YR, value of 4 or 5, and chroma of 2 or 3. The content of rock fragments ranges from 35 to 50 percent, by volume, including 0 to 5 percent stones, 30 to 35 percent cobbles, and 5 to 10 percent gravel.

The Bt horizon has hue of 5YR to 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4.

Celacy Series

The soils in the Celacy series are classified as fine-loamy, mixed, mesic Aridic Haplustalfs. These moderately deep, well drained soils formed in alluvium and eolian material derived dominantly from interbedded sandstone and shale. They are on mesa tops and cuestas. Slope is 1 to 5 percent. Elevation is 6,600 to 7,300 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 115 to 130 days.

Typical pedon of Celacy sandy loam, in an area of Celacy-Atarque complex, 1 to 10 percent slopes; about 3.75 miles east of Broom Mountain; 1,375 feet west and 500 feet north of the southeast corner of sec. 22, T. 5 N., R. 7 W.

A—0 to 2 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few coarse, medium, and fine roots; few very fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bt1—2 to 6 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few coarse, medium, fine, and very fine roots; common fine and very fine tubular pores; few thin clay films on faces of peds and in pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bt2—6 to 12 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; soft, friable, slightly sticky and nonplastic; common fine and very fine roots; common fine and very fine tubular pores; common moderately thick clay films on faces of peds and in pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bk—12 to 24 inches; reddish yellow (7.5YR 6/8) sandy clay loam, strong brown (7.5YR 5/8) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine irregular pores; violently effervescent; few fine irregular seams and filaments of calcium carbonate; mildly alkaline; abrupt smooth boundary.

2R—24 inches; sandstone.

The depth to bedrock is 20 to 40 inches, and depth to the base of the Bt horizon is 10 to 24 inches. The content of rock fragments ranges from 0 to 10 percent.

The Bt and Bk horizons are sandy clay loam or clay loam. The 2R horizon is sandstone or interbedded sandstone and shale.

Charo Series

The soils in the Charo series are classified as fine, mixed Typic Argiborolls. These moderately deep, well drained soils formed in windblown sediments and mixed alluvium. They are on ridges and hills, in swales, and on mesa tops. Slope is 0 to 5 percent. Elevation is 7,200 to 8,300 feet. The average annual precipitation is 16 to 20 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Charo loam, 0 to 5 percent slopes;

about 8 miles northeast of Bibo; long. 107 degrees 22 minutes 16 seconds W. and lat. 35 degrees 16 minutes 47 seconds N.

A—0 to 5 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; common fine and many very fine roots; few fine irregular pores; neutral; abrupt smooth boundary.

Bt1—5 to 11 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; common fine and many very fine roots; few fine and very fine tubular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—11 to 18 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate fine angular blocky structure; very hard, firm, sticky and plastic; few fine and many very fine roots; few fine and very fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt3—18 to 28 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate fine prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; common very fine roots; few fine and very fine tubular pores; many moderately thick clay films on faces of peds and in pores; mildly alkaline; abrupt wavy boundary.

2R—28 inches; basalt.

The depth to bedrock, or to the base of the Bt horizon, ranges from 20 to 40 inches. The thickness of the mollic epipedon is 8 to 13 inches.

The A horizon is loam or cobbly loam. It has hue of 10YR or 7.5YR and chroma of 2 or 3. The content of rock fragments ranges from 0 to 25 percent, by volume, including 0 to 15 percent cobbles and 0 to 10 percent gravel.

The Bt horizon has value of 4 or 5 (3 or 4 moist) and chroma of 3 to 6. The content of rock fragments ranges from 0 to 15 percent, by volume, including 0 to 10 percent cobbles and 0 to 5 percent gravel.

Cinnadale Series

The soils in the Cinnadale series are classified as loamy-skeletal, mixed, frigid Lithic Ustochrepts. These shallow, well drained soils formed in alluvium and windblown sediments derived dominantly from siltstone and sandstone. They are on ridges and hills. Slope is 1 to 15 percent. Elevation is 7,800 to 8,400 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Cinnadale gravelly very fine sandy loam, 1 to 15 percent slopes; about 3 miles southeast of Page; 1,500 feet west and 1,800 feet south of the northeast corner of sec. 10, T. 12 N., R. 15 W.

Oi—1 inch to 0; partially decomposed pine needles.

A—0 to 4 inches; light reddish brown (5YR 6/3) gravelly very fine sandy loam, dark reddish brown (5YR 3/3) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; few very fine irregular pores; about 20 percent gravel; neutral; clear smooth boundary.

Bw—4 to 12 inches; light reddish brown (5YR 6/4) very channery loam, dark reddish brown (5YR 3/3) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; about 30 percent channers and 20 percent gravel; neutral; abrupt smooth boundary.

2R—12 inches; red sandstone.

The depth to bedrock is 10 to 20 inches. The content of clay ranges from 10 to 15 percent. In some pedons the upper few inches of the sandstone is weathered.

The A horizon has hue of 2.5YR or 5YR. It has 15 to 25 percent angular pebble-sized fragments. The B horizon has 20 to 30 percent angular pebble-sized fragments and 20 to 30 percent channers.

Clovis Series

The soils in the Clovis series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in mixed alluvium and windblown sediments. They are on fan terraces. Slope is 1 to 3 percent. Elevation is 5,750 to 5,900 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 125 to 140 days.

Typical pedon of Clovis sandy clay loam, 1 to 3 percent slopes; about 0.5 mile southwest of Lady Lake, in New Laguna; 2,000 feet east and 1,200 feet south of the northwest corner of sec. 1, T. 9 N., R. 6 W.

Ap—0 to 8 inches; dark yellowish brown (10YR 4/6) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; many very fine and common fine irregular pores; slightly effervescent;

disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bt—8 to 21 inches; strong brown (7.5YR 4/6) sandy clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and slightly plastic; common very fine and few fine roots; few very fine and fine tubular pores; common moderately thick clay films on faces of peds and in pores; slightly effervescent; few fine irregular soft filaments of calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bk1—21 to 37 inches; pink (7.5YR 8/4) sandy clay loam, pink (7.5YR 7/4) moist; massive; hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; strongly alkaline; clear smooth boundary.

Bk2—37 to 60 inches; pink (7.5YR 7/4) sandy clay loam, light brown (7.5YR 6/4) moist; massive; hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; strongly alkaline.

The Clovis soils in this survey area are a taxadjunct to the series because they are slightly effervescent in the upper part. This difference, however, does not significantly affect the use and management of the soils.

Flaco Series

The soils in the Flaco series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These moderately deep, well drained soils formed in mixed alluvium and windblown sediments. They are on basalt-capped mesas. Slope is 0 to 10 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Flaco loam, in an area of Flaco-Berto loams, 0 to 5 percent slopes; on Mesa Lucero; 800 feet west and 1,060 feet north of the southeast corner of sec. 21, T. 6 N., R. 3 W.

A—0 to 2 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine irregular pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

Bt—2 to 7 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common very fine irregular pores; few thin clay films in pores; slightly effervescent; moderately alkaline; clear smooth boundary.

Btk—7 to 11 inches; yellowish brown (10YR 5/4) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few fine and very fine roots; common fine and very fine irregular pores; common thin clay films on faces of peds and in pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk1—11 to 16 inches; yellowish brown (10YR 5/6) clay loam, dark yellowish brown (10YR 4/6) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—16 to 29 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—29 inches; basalt that has a thin layer of partially cemented calcium carbonate.

The depth to bedrock is 20 to 40 inches. Depth to the base of the Bt horizon is 9 to 18 inches.

The A horizon is loam or cobbly loam. It has hue of 7.5YR or 10YR, value of 3 to 5 dry or moist, and chroma of 3 or 4. The content of rock fragments ranges from 0 to 20 percent.

The Bt horizon has hue of 7.5YR or 10YR and value of 4 or 5 (3 or 4 moist). The content of rock fragments ranges from 0 to 10 percent.

The Bk horizon is loam, clay loam, or gravelly loam. It has hue of 7.5YR or 10YR, value of 4 to 6 dry or moist, and chroma of 4 to 6. The content of rock fragments ranges from 0 to 20 percent. The calcium carbonate equivalent is more than 15 percent.

Flugle Series

The soils in the Flugle series are classified as fine-loamy, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in wind-modified, mixed alluvium. They are on hills, ridges, fan terraces, and mesas. Slope is 1 to 8 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 12 to 14

inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 115 to 135 days.

Typical pedon of Flugle loamy fine sand, in an area of Flugle-Goesling loamy fine sands, 1 to 8 percent slopes; about 2.5 miles east of the intersection of the Cibola-Catron County line and the Arizona State line; 500 feet north and 120 feet west of the southeast corner of sec. 11, T. 4 N., R. 21 W.

A—0 to 5 inches; brown (7.5YR 5/4) loamy fine sand, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine irregular pores; neutral; clear smooth boundary.

Bt1—5 to 18 inches; strong brown (7.5YR 4/6) sandy clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine and fine roots; common fine tubular pores; common thin clay films on faces of peds; neutral; gradual wavy boundary.

Bt2—18 to 27 inches; brown (7.5YR 5/4) sandy clay loam, brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few medium and very fine roots; few fine tubular pores; few thin clay films on faces of peds and in pores; mildly alkaline; gradual wavy boundary.

Bk1—27 to 41 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bk2—41 to 55 inches; pink (7.5YR 7/4) sandy loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; strongly effervescent; few thin irregular seams and filaments of calcium carbonate; mildly alkaline; gradual smooth boundary.

Bk3—55 to 61 inches; pink (7.5YR 7/4) sandy loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; strongly effervescent; few thin irregular seams and filaments of calcium carbonate; mildly alkaline.

The depth to calcium carbonate is 20 to 30 inches. The calcium carbonate equivalent is less than 10 percent. The content of rock fragments ranges from 0 to 15 percent throughout the profile.

The A horizon is loamy fine sand or sandy loam. It has hue of 7.5YR or 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The Bt horizon is sandy clay loam, clay loam, or loam. It has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. The Bk horizon is sandy clay loam, sandy loam, loam, fine sandy loam, or clay loam. It has hue of 7.5YR or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 to 6.

Galestina Series

The soils in the Galestina series are classified as fine, mixed, mesic Aridic Paleustalfs. These deep, well drained soils formed in alluvium derived from shale. They are on hillsides and mesa tops. Slope is 1 to 8 percent. Elevation is 6,800 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Galestina sandy loam, in an area of Nogal-Galestina sandy loams, 1 to 10 percent slopes; about 0.5 mile north of Ojo Pueblo Ruins; 2,160 feet east and 600 feet north of the southwest corner of sec. 21, T. 8 N., R. 16 W.

A—0 to 2 inches; yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common fine vesicular pores; neutral; abrupt smooth boundary.

BA—2 to 7 inches; yellowish brown (10YR 5/4) loam, dark yellowish brown (10YR 4/4) moist; weak medium subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common fine tubular and few fine vesicular pores; mildly alkaline; clear smooth boundary.

Bt1—7 to 24 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to strong medium angular blocky; very hard, very firm, very sticky and very plastic; common very fine and fine roots; common fine tubular pores; continuous thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—24 to 31 inches; yellowish brown (10YR 5/4) clay, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common very fine and few fine roots; few fine tubular pores; many thick clay films on faces of peds and in pores; slightly effervescent; mildly alkaline; clear smooth boundary.

Bk1—31 to 42 inches; yellowish brown (10YR 5/8) clay,

yellowish brown (10YR 5/6) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; common very fine irregular pores; strongly effervescent; few medium irregular soft masses of calcium carbonate; mildly alkaline; gradual smooth boundary.

Bk2—42 to 46 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine irregular pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; mildly alkaline; clear wavy boundary.

Cr—46 to 60 inches; shale.

Depth to the Cr horizon is 40 to 60 inches. Depth to the base of the Bt horizon is 12 to 35 inches.

The Bt horizon is clay or clay loam. The calcium carbonate equivalent in the Bk horizon is less than 5 percent. The Cr horizon is dominantly shale and some interbedded sandstone.

Glenberg Series

The soils in the Glenberg series are classified as coarse-loamy, mixed (calcareous), mesic Ustic Torrifluvents. These deep, well drained soils formed in alluvium derived dominantly from sandstone. They are on flood plains and alluvial fans. Slope is 0 to 2 percent. Elevation is 6,200 to 6,600 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 110 to 140 days.

Typical pedon of Glenberg sandy loam, in an area of Glenberg-San Mateo complex, 0 to 2 percent slopes; about 0.5 mile northwest of Milan; 600 feet east and 2,400 feet south of the northwest corner of sec. 4, T. 11 N., R. 10 W.

A—0 to 11 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C1—11 to 21 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

C2—21 to 60 inches; pale brown (10YR 6/3) sandy loam stratified with thin lenses of loam and loamy sand; brown (10YR 5/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

Goesling Series

The soils in the Goesling series are classified as fine-loamy, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in wind-modified, mixed alluvium. They are on mesas, fan terraces, hills, and ridges. Slope is 1 to 8 percent. Elevation is 6,000 to 6,800 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 115 to 135 days.

Typical pedon of Goesling loamy fine sand, in an area of Flugle-Goesling loamy fine sands, 1 to 8 percent slopes; about 6 miles northeast of the intersection of the southern Cibola County line and the Arizona State line; 400 feet south and 1,580 feet east of the northwest corner of sec. 8, T. 4 N., R. 20 W.

A—0 to 5 inches; light yellowish brown (10YR 6/4) loamy fine sand, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and common fine roots; few very fine irregular pores; about 10 percent gravel; neutral; abrupt smooth boundary.

Bt1—5 to 10 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, sticky and slightly plastic; common very fine, fine, and medium roots; common fine tubular pores; few thin clay films on faces of peds and in pores; about 5 percent gravel; neutral; clear wavy boundary.

Bt2—10 to 18 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, friable, sticky and slightly plastic; common fine and very fine roots; few fine tubular pores; few thin clay films on faces of peds and in pores; about 5 percent gravel; mildly alkaline; clear wavy boundary.

Bk1—18 to 25 inches; light yellowish brown (10YR 6/4) sandy loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; about 5 percent cobbles and 5 percent gravel; violently effervescent; many coarse irregular soft masses of calcium carbonate; mildly alkaline; clear wavy boundary.

Bk2—25 to 46 inches; white (10YR 8/2) loam, very pale brown (10YR 7/4) moist; massive; slightly hard,

friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; about 5 percent gravel; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear wavy boundary.

Bk3—46 to 60 inches; very pale brown (10YR 7/3) sandy loam, yellowish brown (10YR 5/4) moist; massive; loose, very friable, nonsticky and nonplastic; few very fine roots; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline.

Depth to the Bk horizon is 15 to 20 inches. The calcium carbonate equivalent is 15 to 30 percent.

The Bt horizon is sandy clay loam or clay loam. The Bk horizon is loam, sandy loam, or sandy clay loam.

Grieta Series

The soils in the Grieta series are classified as fine-loamy, mixed, mesic Typic Haplargids. These deep, well drained soils formed in wind-modified, mixed alluvium. They are on fan terraces, hills, and ridges and in interdune areas. Slope is 1 to 10 percent. Elevation is 5,400 to 6,100 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Grieta sandy loam, in an area of Grieta-Shiprock association, 1 to 10 percent slopes; about 3.75 miles west of Suwanee; 420 feet east and 1,050 feet south of the northwest corner of sec. 7, T. 8 N., R. 3 W.

A—0 to 3 inches; strong brown (7.5YR 5/6) sandy loam, brown (7.5YR 4/4) moist; soft, very friable, nonsticky and nonplastic; many fine and few very fine roots; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

AB—3 to 8 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bt1—8 to 16 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; few very fine tubular pores; common thin clay films on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—16 to 28 inches; strong brown (7.5YR 5/6) sandy clay loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine tubular pores; few thin clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bk1—28 to 42 inches; pink (7.5YR 8/4) sandy loam, light brown (7.5YR 6/4) moist; massive; hard, friable, slightly sticky and nonplastic; few fine roots; few fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—42 to 60 inches; pinkish white (7.5YR 8/2) sandy loam, pink (7.5YR 7/4) moist; massive; hard, friable, slightly sticky and nonplastic; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline.

Depth to the base of the Bt horizon is 20 to 34 inches. The calcium carbonate equivalent in the Bk horizon is more than 15 percent.

The A horizon has hue of 5YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6. The content of rock fragments ranges from 0 to 10 percent.

The Bt horizon is sandy clay loam or clay loam. It has hue of 5YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6.

The Bk horizon is sandy clay loam or sandy loam. It has hue of 5YR or 7.5YR, value of 5 to 8 (5 to 7 moist), and chroma of 2 to 6. The content of rock fragments ranges from 0 to 10 percent.

Hackroy Series

The soils in the Hackroy series are classified as clayey, mixed, mesic Lithic Haplustalfs. These shallow, well drained soils formed in alluvium and windblown sediments. They are on the tops of basalt-capped mesas and on plateaus. Slope is 1 to 5 percent. Elevation is 7,000 to 8,000 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 52 degrees F, and the frost-free period is 110 to 130 days.

Typical pedon of Hackroy cobbly loam, in an area of Paguate-Hackroy complex, 1 to 5 percent slopes; at the top of Chicken Mountain; 900 feet north and 980 feet west of the southeast corner of sec. 19, T. 5 N., R. 4 W.

A—0 to 3 inches; brown (7.5YR 5/4) cobbly loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, very friable, nonsticky and slightly plastic; many very fine roots; common fine

irregular pores; about 15 percent cobbles; mildly alkaline; abrupt smooth boundary.

Bt1—3 to 11 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium prismatic structure parting to moderate medium angular blocky; very hard, firm, sticky and plastic; few fine and common very fine roots; common fine tubular pores; many thick clay films on faces of peds and in pores; about 10 percent cobbles; mildly alkaline; clear smooth boundary.

Bt2—11 to 14 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 10 percent cobbles; mildly alkaline; abrupt smooth boundary.

2R—14 inches; basalt.

The depth to bedrock is 10 to 20 inches. The content of rock fragments in the A horizon ranges from 15 to 20 percent. The Bt horizon is clay loam or clay. It has 35 to 50 percent clay and 0 to 15 percent rock fragments.

Hagerman Series

The soils in the Hagerman series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These moderately deep, well drained soils formed in eolian material and alluvium derived dominantly from sandstone. They are on hills, ridges, mesas, and cuestas. Slope is 1 to 5 percent. Elevation is 6,000 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Hagerman fine sandy loam, in an area of Hagerman-Bond association, 1 to 10 percent slopes; about 3 miles east of Bibo; long. 107 degrees 16 minutes 11 seconds W. and lat. 35 degrees 11 minutes 10 seconds N.

A—0 to 3 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few very fine irregular pores; mildly alkaline; abrupt smooth boundary.

AB—3 to 6 inches; dark brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 4/6) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; few fine and common very fine tubular pores; mildly alkaline; abrupt smooth boundary.

Bt—6 to 23 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine and fine roots; few fine and very fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bk—23 to 34 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular pores; strongly effervescent; few medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—34 inches; sandstone.

The depth to sandstone is 20 to 40 inches. Depth to the base of the Bt horizon is 12 to 25 inches.

The Bt horizon is sandy clay loam or clay loam. The Bk horizon is sandy clay loam or sandy loam. It has a calcium carbonate equivalent of 3 to 10 percent.

Harvey Series

The soils in the Harvey series are classified as fine-loamy, mixed, mesic Ustollic Calciorthids. These deep, well drained soils formed in alluvium and windblown sediments derived dominantly from limestone. They are on fan terraces and mesa tops. Slope is 1 to 5 percent. Elevation is 6,000 to 6,500 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Harvey loam, in an area of Harvey-Oelop association, 0 to 5 percent slopes; about 2 miles northeast of Lucero Windmill; 1,700 feet east and 400 feet north of the southwest corner of sec. 34, T. 8 N., R. 3 W.

A—0 to 2 inches; brown (7.5YR 5/4) loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and medium roots; few fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bw1—2 to 10 inches; reddish yellow (7.5YR 6/6) clay loam, strong brown (7.5YR 5/6) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few very fine and common fine and medium roots; few very fine irregular pores; strongly effervescent; few medium irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bw2—10 to 18 inches; light brown (7.5YR 6/4) clay

loam, brown (7.5YR 5/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and medium roots; few very fine irregular pores; strongly effervescent; few medium irregular soft masses of calcium carbonate; moderately alkaline; clear wavy boundary.

Bk1—18 to 21 inches; pink (7.5YR 7/4) loam, light brown (7.5YR 6/4) moist; weak fine subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic: common fine and few medium roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear wavy boundary.

Bk2—21 to 31 inches; pink (7.5YR 8/4) loam, pink (7.5YR 8/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common fine and few medium roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear wavy boundary.

Bk3—31 to 60 inches; pink (7.5YR 8/4) loam, pink (7.5YR 8/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few fine and medium roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; moderately alkaline.

The content of rock fragments ranges from 0 to 15 percent throughout the profile. The Bw and Bk horizons are loam or clay loam.

Hickman Series

The soils in the Hickman series are classified as fine-loamy, mixed (calcareous), mesic Typic Ustifluvents. These deep, well drained soils formed in mixed alluvium. They are on flood plains and alluvial fans and in valleys. Slope is 1 to 6 percent. Elevation is 6,500 to 7,500 feet. The average annual precipitation is 12 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 135 days.

Typical pedon of Hickman loam, in an area of Hickman-Catman complex, 1 to 6 percent slopes; about 1.5 miles north of the intersection of the Cibola-Catron County line and the Arizona State line; 1,056 feet west and 2,112 feet south of the northeast corner of sec. 4, T. 4 N., R. 21 W.

A—0 to 4 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate thin platy structure parting to weak fine granular; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

C1—4 to 32 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and few very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—32 to 52 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; about 10 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C3—52 to 60 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; about 5 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

The content of rock fragments ranges from 0 to 15 percent throughout the profile.

The A horizon is loam or sandy clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4.

The C horizon is clay loam, loam, sandy clay loam, silty clay loam, or sandy loam. The content of clay ranges from 18 to 35 percent. This horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6.

Ildefonso Series

The soils in the Ildefonso series are classified as loamy-skeletal, mixed, mesic Ustollic Calciorthids. These deep, well drained soils formed in mixed alluvium. They are on ridges and fan terraces. Slope is 3 to 15 percent. Elevation is 5,900 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typical pedon of Ildefonso very gravelly sandy loam, 3 to 15 percent slopes; about 1.5 miles north of Ponia Canyon; 2,600 feet east and 50 feet south of the northwest corner of sec. 5, T. 7 N., R. 4 W.

A—0 to 3 inches; brown (7.5YR 5/4) very gravelly sandy loam, dark brown (7.5YR 3/4) moist; weak fine granular structure; soft, very friable, nonsticky

and nonplastic; few very fine and fine roots; common fine irregular pores; about 5 percent cobbles and 35 percent gravel; slightly effervescent; mildly alkaline; clear smooth boundary.

Bw—3 to 8 inches; brown (7.5YR 5/4) very gravelly loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, very friable, slightly sticky and nonplastic; few very fine and fine roots; common fine irregular pores; about 10 percent cobbles and 30 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk1—8 to 16 inches; light brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; common fine irregular pores; about 10 percent cobbles and 28 percent gravel; violently effervescent; common fine irregular soft masses and seams of calcium carbonate; moderately alkaline; gradual smooth boundary.

Bk2—16 to 60 inches; pink (7.5YR 7/4) very gravelly loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; common fine irregular pores; about 10 percent cobbles and 28 percent gravel; violently effervescent; many medium irregular soft masses of calcium carbonate; strongly alkaline.

The content of rock fragments ranges from 35 to 60 percent throughout the profile. The calcium carbonate equivalent ranges from 15 to 30 percent.

The Ildefonso soils in this survey area have more clay in the particle-size control section than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Kenray Series

The soils in the Kenray series are classified as mixed, frigid Typic Ustipsamments. These deep, excessively drained soils formed in eolian material derived dominantly from sandstone. They are on dunes, hills, and mesas. Slope is 3 to 15 percent. Elevation is 7,300 to 8,000 feet. The average annual precipitation is 16 to 20 inches. The average annual air temperature is 43 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Kenray fine sand, 3 to 15 percent slopes; about 20 miles south of Grants; 1,740 feet west and 360 feet north of the southeast corner of sec. 2, T. 7 N., R. 10 W.

A1—0 to 5 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; common fine and very fine roots; common fine irregular pores; neutral; clear smooth boundary.

A2—5 to 15 inches; brown (10YR 5/3) fine sand, dark brown (10YR 4/3) moist; single grain; loose, nonsticky and nonplastic; common very fine and few fine and medium roots; common fine irregular pores; neutral; clear smooth boundary.

C1—15 to 32 inches; light yellowish brown (10YR 6/4) loamy sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; common fine irregular pores; neutral; gradual wavy boundary.

C2—32 to 60 inches; brownish yellow (10YR 6/6) loamy sand, yellowish brown (10YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common fine irregular pores; neutral.

The C horizon is loamy sand, fine sand, or sand.

Kiki Series

The soils in the Kiki series are classified as fine-loamy, mixed, mesic Typic Haplargids. These moderately deep, well drained soils formed in eolian material and alluvium derived dominantly from sandstone. They are on knolls and ridges. Slope is 3 to 15 percent. Elevation is 5,500 to 6,000 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Kiki sandy loam, in an area of Grieta-Kiki sandy loams, 3 to 15 percent slopes; about 2 miles west of Suwanee; 2,000 feet east and 2,100 feet north of the southwest corner of sec. 6, T. 8 N., R. 3 W.

A1—0 to 3 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and few medium roots; few very fine irregular pores; mildly alkaline; clear smooth boundary.

A2—3 to 6 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; weak medium granular structure; soft, very friable, nonsticky and nonplastic; many very fine, common fine, and few medium roots; few fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bt—6 to 14 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 4/6) moist; strong medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common very fine, fine, and medium roots; few very fine and fine tubular pores; common thin clay films on faces of

peds and in pores; mildly alkaline; clear smooth boundary.

Bw—14 to 19 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bk—19 to 24 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine and fine roots; violently effervescent; common medium irregular soft masses of calcium carbonate; mildly alkaline; abrupt smooth boundary.

2R—24 inches; basalt.

The depth to bedrock is 20 to 40 inches. The depth to an accumulation of calcium carbonate is 15 to 25 inches.

The content of rock fragments in the A horizon ranges from 0 to 15 percent. The Bt horizon is sandy clay loam or clay loam. The Bk horizon is sandy clay loam, clay loam, or loam. The calcium carbonate equivalent in this horizon is less than 15 percent.

Laporte Series

The soils in the Laporte series are classified as loamy, carbonatic, mesic Lithic Haplustolls. These shallow, well drained soils formed in mixed colluvium and windblown sediments. They are on hills and ridges. Slope is 3 to 60 percent. Elevation is 6,650 to 7,500 feet. The average annual precipitation is 12 to 15 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 110 to 135 days.

Typical pedon of Laporte gravelly loam, in an area of Laporte-Rock outcrop complex, 3 to 20 percent slopes; about 2 miles west of Bluewater Lake; 400 feet east and 750 feet south of the northwest corner of sec. 18, T. 12 N., R. 12 W.

A—0 to 3 inches; dark brown (10YR 4/3) gravelly loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common fine irregular pores; strongly effervescent; disseminated calcium carbonate and few fine irregular soft masses of calcium carbonate; about 25 percent gravel; mildly alkaline; abrupt smooth boundary.

C—3 to 11 inches; dark grayish brown (10YR 4/2) gravelly loam, very dark grayish brown (10YR 3/2) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium and coarse roots; common fine irregular pores; strongly effervescent; disseminated calcium carbonate and few fine irregular soft masses of calcium carbonate; about 20 percent gravel; moderately alkaline; abrupt smooth boundary.

2R—11 inches; limestone.

The depth to bedrock ranges from 10 to 20 inches. The A horizon is gravelly or very cobbly loam. It has value of 4 or 5 and chroma of 2 or 3. The C horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. In some pedons the 2R horizon is fractured in the upper few inches.

Loarc Series

The soils in the Loarc series are classified as fine-loamy, mixed, mesic Aridic Argiustolls. These deep, well drained soils formed in mixed alluvium. They are on fan terraces, hills, and mesas. Slope is 0 to 10 percent. Elevation is 7,200 to 7,800 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Loarc fine sandy loam, in an area of Millpaw-Loarc complex, 0 to 10 percent slopes; about 0.5 mile south of the Ponderosa Ranch House; 2,100 feet west and 300 feet north of the southeast corner of sec. 26, T. 5 N., R. 15 W.

A—0 to 4 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common very fine irregular pores; neutral; clear smooth boundary.

Bt1—4 to 10 inches; brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine and very fine roots; common very fine irregular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—10 to 17 inches; brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few fine and very fine roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; neutral; clear wavy boundary.

Bt3—17 to 31 inches; dark yellowish brown (10YR 4/4) sandy clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard,

friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; few thin clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bk—31 to 60 inches; yellowish brown (10YR 5/6) sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common very fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; mildly alkaline.

The mollic epipedon ranges from 10 to 19 inches in thickness. Depth to the Bk horizon ranges from 25 to 50 inches. The calcium carbonate equivalent in this horizon is less than 15 percent.

Manzano Series

The soils in the Manzano series are classified as fine-loamy, mixed, mesic Cumulic Haplustolls. These deep, well drained soils formed in mixed alluvium. They are on alluvial fans. Slope is 1 to 5 percent. Elevation is 6,500 to 7,300 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 115 to 135 days.

Typical pedon of Manzano loam, 1 to 5 percent slopes; about 1 mile southwest of the Grants-Milan Airport; 800 feet west and 1,700 feet north of the southeast corner of sec. 29, T. 11 N., R. 10 W.

A—0 to 4 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine, fine, and medium roots; common fine irregular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bw—4 to 22 inches; brown (10YR 4/3) silt loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common fine tubular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk1—22 to 49 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common fine irregular pores; violently effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—49 to 60 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline.

The thickness of the mollic epipedon ranges from 20 to 30 inches. The Bw horizon is silt loam, loam, or clay loam. The Bk horizon is loam or clay loam. The calcium carbonate equivalent in this horizon is less than 15 percent.

The Manzano soils in this survey area have more calcium carbonate in the upper 22 inches than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

McGaffey Series

The soils in the McGaffey series are classified as fine-loamy, mixed Cumulic Haploborolls. These deep, well drained soils formed in mixed alluvium. They are on fan terraces and valley floors. Slope is 1 to 5 percent. Elevation is 7,500 to 8,500 feet. The average annual precipitation is 18 to 22 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 105 days.

Typical pedon of McGaffey loam, 1 to 5 percent slopes; about 5 miles west of the Ice Caves; 2,300 feet south and 800 feet west of the northeast corner of sec. 12, T. 9 N., R. 13 W.

A—0 to 3 inches; reddish brown (5YR 5/3) loam, dark reddish brown (5YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common fine irregular pores; neutral; abrupt smooth boundary.

Bw1—3 to 14 inches; reddish brown (5YR 5/3) loam, dark reddish brown (5YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine roots; few fine tubular pores; neutral; clear smooth boundary.

Bw2—14 to 23 inches; reddish brown (5YR 5/3) clay loam, dark reddish brown (5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bk—23 to 33 inches; reddish brown (5YR 4/3) loam, dark reddish brown (5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; few very fine and fine roots; common fine tubular pores; strongly

effervescent; common fine irregular filaments, threads, and soft masses of calcium carbonate; mildly alkaline; clear smooth boundary.

C1—33 to 45 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; common fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—45 to 60 inches; reddish yellow (5YR 6/6) loam, yellowish red (5YR 5/6) moist; massive; slightly hard, slightly sticky and nonplastic; few very fine roots; common fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline.

The mollic epipedon ranges from 18 to 35 inches in thickness. The calcium carbonate equivalent in the Bk horizon is less than 7 percent. The C horizon is loam or clay loam.

Mespun Series

The soils in the Mespun series are classified as mixed, mesic Ustic Torripsamments. These deep, excessively drained soils formed in eolian material derived dominantly from sandstone. They are on dunes and ridges. Slope is 1 to 12 percent. Elevation is 5,900 to 7,100 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Mespun fine sand, in an area of Mespun-Palma association, 1 to 12 percent slopes; about 1 mile south of the old Roundy Ranch House; 1,300 feet west and 1,100 feet north of the southeast corner of sec. 17, T. 12 N., R. 9 W.

A—0 to 2 inches; yellowish brown (10YR 5/6) fine sand, dark yellowish brown (10YR 4/6) moist; single grain; loose, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; mildly alkaline; abrupt smooth boundary.

C1—2 to 15 inches; reddish yellow (7.5YR 7/6) loamy fine sand, strong brown (7.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; mildly alkaline; clear smooth boundary.

C2—15 to 29 inches; reddish yellow (7.5YR 7/6) loamy fine sand, strong brown (7.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; mildly alkaline; gradual smooth boundary.

C3—29 to 60 inches; reddish yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 5/6) moist; single grain; loose, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; mildly alkaline.

The A horizon is loamy sand or fine sand. The C horizon is fine sand, loamy sand, or loamy fine sand. It has hue of 5YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 5 or 6.

Microy Series

The soils in the Microy series are classified as fine, mixed Typic Argiborolls. These moderately deep, well drained soils formed in mixed alluvium. They are on hills. Slope is 5 to 30 percent. Elevation is 8,000 to 8,900 feet. The average annual precipitation is 18 to 22 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 100 days.

Typical pedon of Microy cobbly loam, in an area of Microy-Rock outcrop complex, 5 to 30 percent slopes; about 100 feet southwest of the summit of Cerro Redondo; long. 107 degrees 29 minutes 36 seconds W. and lat. 35 degrees 17 minutes 39 seconds N.

A—0 to 3 inches; brown (7.5YR 4/2) cobbly loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few medium and common fine roots; many very fine irregular pores; about 15 percent cobble-sized and 10 percent pebble-sized cinders; neutral; abrupt smooth boundary.

Bt1—3 to 12 inches; dark reddish gray (5YR 4/2) cobbly clay, dark reddish brown (5YR 3/2) moist; moderate medium subangular blocky structure; very hard, firm, very sticky and plastic; few coarse and common medium and fine roots; many very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 15 percent cobble-sized and 15 percent pebble-sized cinders; neutral; clear smooth boundary.

Bt2—12 to 28 inches; reddish brown (5YR 4/3) cobbly clay, dark reddish brown (5YR 4/3) moist; strong medium prismatic structure parting to strong medium angular blocky; very hard, firm, very sticky and plastic; few coarse and very fine roots; common very fine tubular pores; many thick clay films on faces of peds and in pores; about 15 percent cobble-sized and 15 percent pebble-sized cinders; mildly alkaline; clear wavy boundary.

C—28 to 36 inches; reddish brown (5YR 4/3) very cobbly clay, reddish brown (5YR 4/3) moist; massive; very hard, firm, very sticky and plastic; few medium and very fine roots; few very fine irregular

pores; about 20 percent cobble-sized and 20 percent pebble-sized cinders; mildly alkaline; abrupt wavy boundary.

2R—36 inches; basalt.

The depth to bedrock ranges from 20 to 40 inches. The mollic epipedon ranges from 9 to 15 inches in thickness. Depth to the base of the Bt horizon ranges from 14 to 31 inches.

The A horizon has hue of 7.5YR or 5YR, value of 4 or 5, and chroma of 2 or 3. The content of rock fragments ranges from 15 to 35 percent, by volume, including 10 to 20 percent cobble-sized and 5 to 15 percent pebble-sized cinders.

The Bt horizon has hue of 5YR or 2.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4. The content of rock fragments ranges from 15 to 35 percent, by volume, including 10 to 20 percent cobble-sized and 5 to 15 percent pebble-sized cinders.

The C horizon has hue of 5YR or 2.5YR. The content of rock fragments ranges from 20 to 40 percent, by volume, including 20 percent cobble-sized and 0 to 20 percent pebble-sized cinders.

Mikim Series

The soils in the Mikim soils are classified as fine-loamy, mixed (calcareous), mesic Ustic Torriorthents. These deep, well drained soils formed in mixed alluvium. They are on fan terraces and valley sides. Slope is 1 to 5 percent. Elevation is 5,800 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 51 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typical pedon of Mikim loam, 1 to 5 percent slopes; about 1 mile south of Casa Blanca; 1,900 feet east and 2,360 feet north of the southwest corner of sec. 9, T. 9 N., R. 6 W.

A—0 to 4 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common fine and very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

C1—4 to 11 inches; pale brown (10YR 6/3) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; common fine and very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—11 to 25 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common very fine and few medium roots; few fine and very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C3—25 to 42 inches; very pale brown (10YR 7/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable, sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C4—42 to 60 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, slightly sticky and nonplastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

Millpaw Series

The soils in the Millpaw series are classified as fine, mixed, mesic Pachic Argiustolls. These deep, well drained soils formed in mixed alluvium. They are in valleys and swales and on mesas. Slope is 0 to 5 percent. Elevation is 7,000 to 7,800 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Millpaw loam, 0 to 5 percent slopes; about 1.5 miles west of the Towner Ranch House; 500 feet east and 160 feet south of the northwest corner of sec. 31, T. 5 N., R. 15 W.

A—0 to 3 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common fine vesicular pores; mildly alkaline; abrupt smooth boundary.

BA—3 to 8 inches; dark brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; few very fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bt1—8 to 19 inches; dark brown (10YR 4/3) clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, friable, sticky and plastic; few fine and common very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—19 to 29 inches; dark brown (10YR 4/3) clay, very dark grayish brown (10YR 3/2) moist; weak medium

subangular blocky structure; hard, friable, sticky and slightly plastic; few fine and common very fine roots; common very fine tubular pores; common thin clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bt3—29 to 41 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; weak fine subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine irregular pores; few thin clay films in pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Bk—41 to 60 inches; brownish yellow (10YR 6/6) sandy clay loam, yellowish brown (10YR 5/6) moist; massive; hard, friable, sticky and slightly plastic; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate and few small irregular soft masses of calcium carbonate; moderately alkaline.

The mollic epipedon ranges from 20 to 35 inches in thickness. The Bt horizon is clay or sandy clay in the upper part and sandy clay loam in the lower part. It has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. The Bk horizon has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6.

Mion Series

The soils in the Mion series are classified as clayey, mixed (calcareous), mesic, shallow Ustic Torriorthents. These shallow, well drained soils formed in colluvium and alluvium derived dominantly from shale. They are on hills, benches, and ridges. Slope is 3 to 65 percent. Elevation is 5,800 to 7,400 feet. The average annual precipitation is 10 to 14 inches. The average annual air temperature is 49 to 54 degrees F, and the average frost-free period is 115 to 160 days.

Typical pedon of Mion stony loam, in an area of Rock outcrop-Mion complex, 15 to 65 percent slopes; about 1 mile south of Sky City; 400 feet east and 1,700 feet north of the southwest corner of sec. 31, T. 8 N., R. 7 W.

A—0 to 3 inches; light olive brown (2.5Y 5/4) stony loam, olive brown (2.5Y 4/4) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and very fine roots; common fine irregular pores; about 10 percent stones, 5 percent cobbles, and 10 percent gravel; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

C1—3 to 8 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; massive; hard, firm, sticky and plastic; few fine and very fine roots; few very fine irregular pores; about 5 percent gravel; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—8 to 13 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) moist; massive; slightly hard, friable, slightly sticky and plastic; few fine and very fine roots; few very fine irregular pores; about 5 percent gravel; slightly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

2Cr—13 to 60 inches; grayish brown (2.5YR 5/2) shale.

The depth to shale ranges from 10 to 20 inches. The soils are mildly alkaline or moderately alkaline throughout. The content of rock fragments ranges from 0 to 35 percent.

The A horizon is stony loam or loam. It has hue of 10YR or 2.5Y, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. The C horizon is clay, silty clay loam, or silty clay. It has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6.

Mirabal Series

The soils in the Mirabal series are classified as loamy-skeletal, mixed, nonacid, frigid Typic Ustorthents. These moderately deep, well drained soils formed in mixed alluvium and windblown sediments. They are on hills. Slope is 2 to 15 percent. Elevation is 8,100 to 8,800 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 85 to 105 days.

Typical pedon of Mirabal very gravelly loam, 2 to 15 percent slopes; about 1.5 miles southwest of Lookout Mountain; 1,550 feet east and 2,350 feet south of the northwest corner of sec. 10, T. 11 N., R. 14 W.

A—0 to 3 inches; brown (7.5YR 5/4) very gravelly loam, dark brown (10YR 4/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and few very fine and medium roots; common fine and very fine tubular pores; about 5 percent cobbles and 40 percent gravel; slightly acid; abrupt smooth boundary.

C1—3 to 14 inches; light brown (7.5YR 6/4) very gravelly loam, brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; common medium and fine and few very fine roots; common very fine and few fine irregular pores; about 20 percent cobbles and 35 percent gravel; slightly acid; clear smooth boundary.

C2—14 to 21 inches; pink (5YR 7/3) very cobbly sandy clay loam, strong brown (7.5YR 4/6) moist; massive;

soft, very friable, nonsticky and nonplastic; few medium, fine, and very fine roots; common very fine irregular pores; about 30 percent cobbles and 30 percent gravel; slightly acid; abrupt smooth boundary.

2R—21 inches; granite.

Moncha Series

The soils in the Moncha series are classified as fine-silty, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in alluvium derived dominantly from siltstone and shale. They are on fan terraces, in valleys, and on mesas. Slope is 2 to 10 percent. Elevation is 6,800 to 7,300 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 115 to 130 days.

Typical pedon of Moncha silt loam, 2 to 10 percent slopes; about 7 miles north of Atarque Lake; 640 feet east and 600 feet north of the southwest corner of sec. 30, T. 8 N., R. 18 W.

A—0 to 2 inches; light red (2.5YR 6/6) silt loam, reddish brown (2.5YR 4/4) moist; moderate fine granular structure; soft, very friable, slightly sticky and nonplastic; common very fine roots; slightly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bt1—2 to 12 inches; red (2.5YR 5/6) silty clay loam, dark reddish brown (2.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; few thin clay films on faces of peds and in pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

Bt2—12 to 21 inches; red (2.5YR 5/6) silty clay loam, dark reddish brown (2.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; many fine tubular pores; few thin clay films on faces of peds and in pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; gradual smooth boundary.

C1—21 to 38 inches; red (2.5YR 5/6) silty clay loam, reddish brown (2.5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; many very fine roots; common very fine irregular pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; gradual smooth boundary.

C2—38 to 60 inches; red (2.5YR 5/8) silty clay loam, red (2.5YR 4/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine and very fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline.

The depth to the base of the Bt horizon is 14 to 30 inches. The Bt and C horizons are silty clay loam or silt loam. The content of clay in the Bt horizon is 25 to 35 percent.

Montecito Series

The soils in the Montecito series are classified as fine, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in mixed alluvium. They are on mesas and hills, in valleys between lava ridges, and on ridges. Slope is 1 to 15 percent. Elevation is 6,800 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 52 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Montecito fine sandy loam, 1 to 15 percent slopes; about 3 miles southwest of Fence Lake, 0.5 mile west of a gravel pit; 1,300 feet west and 120 feet south of the northeast corner of sec. 9, T. 4 N., R. 18 W.

A—0 to 5 inches; dark brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, friable, slightly sticky and nonplastic; common very fine and fine roots; common fine irregular pores; neutral; abrupt smooth boundary.

Bt—5 to 20 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; moderate medium angular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; common fine irregular pores; common moderately thick clay films on faces of peds and in pores; neutral; abrupt smooth boundary.

Btk—20 to 30 inches; strong brown (7.5YR 4/6) clay, strong brown (7.5YR 4/6) moist; moderate medium prismatic structure; very hard, firm, sticky and plastic; common very fine and fine roots; few very fine tubular pores; common thick clay films on faces of peds and in pores; about 5 percent cobbles and 5 percent gravel; slightly effervescent; common medium irregular seams and soft masses of calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bk1—30 to 42 inches; pink (7.5YR 8/4) gravelly clay loam, reddish yellow (7.5YR 6/6) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common fine irregular pores; about 10 percent cobbles and 25 percent gravel; violently effervescent; many coarse irregular

soft masses of calcium carbonate; mildly alkaline; clear smooth boundary.

Bk2—42 to 60 inches; pink (7.5YR 8/4) gravelly clay loam, pink (7.5YR 7/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine irregular pores; about 10 percent cobbles and 25 percent gravel; violently effervescent; many coarse irregular soft masses of calcium carbonate; mildly alkaline.

Depth to the Bk horizon is 25 to 35 inches. The content of rock fragments is less than 15 percent in the Bt horizon, but it may increase to as much as 40 percent in the lower part of the Bk horizon.

The A horizon is fine sandy loam or clay loam. It has hue of 7.5YR or 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The Bt horizon is clay or clay loam. It has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. The Bk horizon is clay loam, clay, or sandy clay. It has 10 to 35 percent rock fragments. It has hue of 7.5YR or 10YR, value of 7 or 8 (6 or 7 moist), and chroma of 2 to 4.

Moreno Series

The soils in the Moreno series are classified as fine, mixed Typic Argiborolls. These deep, well drained soils formed in mixed alluvium. They are on fan terraces. Slope is 1 to 10 percent. Elevation is 7,800 to 8,200 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Moreno loam, 1 to 10 percent slopes; about 1.25 miles south of Page; 2,200 feet west and 1,800 feet south of the northeast corner of sec. 5, T. 12 N., R. 15 W.

A—0 to 11 inches; reddish brown (5YR 5/3) loam, dark reddish brown (5YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; neutral; clear smooth boundary.

Bw—11 to 14 inches; yellowish red (5YR 5/6) loam, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; hard, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; about 10 percent gravel; neutral; clear smooth boundary.

Bt1—14 to 20 inches; red (2.5YR 4/6) clay loam, dark red (2.5YR 3/6) moist; moderate fine subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; few very fine roots; few very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 10 percent gravel; neutral; clear smooth boundary.

Bt2—20 to 35 inches; reddish brown (2.5YR 4/4) clay, dark red (2.5YR 3/6) moist; moderate fine subangular blocky structure; hard, friable, sticky and slightly plastic; few very fine tubular pores; many thick clay films on faces of peds and in pores; about 10 percent gravel; mildly alkaline; clear smooth boundary.

Bt3—35 to 60 inches; red (2.5YR 5/6) very gravelly clay loam, red (2.5YR 4/6) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 35 percent gravel; mildly alkaline.

The content of rock fragments ranges from 0 to 10 percent in the A horizon, from 0 to 15 percent in the upper part of the Bt horizon, and from 25 to 45 percent in the lower part of the Bt horizon. The Bt horizon is clay loam, clay, gravelly clay, or very gravelly clay loam.

Moreno Variant

The soils in the Moreno Variant are classified as fine-loamy, mixed Mollic Eutroboralfs. These deep, well drained soils formed in mixed alluvium. They are on fan terraces and toe slopes. Slope is 2 to 10 percent. Elevation is 8,000 to 8,300 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 85 to 105 days.

Typical pedon of Moreno Variant loam, 2 to 10 percent slopes; about 0.5 mile north of Johnny Mack Canyon; 180 feet west and 200 feet north of the southeast corner of sec. 6, T. 11 N., R. 14 W.

A—0 to 7 inches; dark brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many very fine and fine and few medium roots; common very fine irregular pores; slightly acid; clear smooth boundary.

E1—7 to 13 inches; brown (7.5YR 5/4) very fine sandy loam, dark brown (7.5YR 3/4) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine irregular pores; neutral; clear smooth boundary.

E2—13 to 22 inches; strong brown (7.5YR 5/6) very fine sandy loam, strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—22 to 35 inches; red (2.5YR 4/6) clay loam, reddish brown (2.5YR 4/4) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; few very fine, fine, and medium roots; common very fine irregular and few fine tubular pores; many moderately thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—35 to 49 inches; red (2.5YR 5/6) clay loam, dark red (2.5YR 3/6) moist; moderate medium subangular blocky structure; hard, friable, slightly sticky and nonplastic; few very fine and fine roots; few very fine irregular and tubular pores; common moderately thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt3—49 to 60 inches; red (2.5YR 5/6) sandy clay loam, dark red (2.5YR 3/6) moist; weak fine subangular blocky structure; hard, friable, slightly sticky and nonplastic; few very fine and fine roots; few very fine irregular and tubular pores; few thin clay films on faces of peds and in pores; neutral.

Navajo Series

The soils in the Navajo series are classified as fine, mixed (calcareous), mesic Vertic Torrifluvents. These deep, well drained soils formed in mixed alluvium. They are on alluvial fans, in drainageways, and on flood plains. Slope is 1 to 5 percent. Elevation is 5,400 to 6,000 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Navajo silty clay loam, 1 to 5 percent slopes; about 3 miles west of Suwanee; 2,376 feet west and 2,904 feet south of the northeast corner of sec. 7, T. 8 N., R. 3 W.

A—0 to 3 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; common medium and fine roots; common very fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

C1—3 to 8 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; massive; slightly hard, friable, sticky and plastic; common medium and fine roots; common very fine irregular pores; cracks more than 0.5 inch wide common during dry periods; violently effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—8 to 32 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; massive; very hard, firm, very sticky and very plastic; common very fine and fine roots; common very fine irregular pores; cracks more than 0.5 inch wide common during dry periods; common moderately thick slickensides; violently effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C3—32 to 60 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline.

The A horizon is silty clay loam or clay loam. It has hue of 2.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The C horizon is silty clay, clay, silty clay loam, or clay loam. It has hue of 2.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. In some pedons it has gypsum crystals in the lower part.

Netoma Series

The soils in the Netoma series are classified as coarse-loamy, gypsic, mesic Typic Gypsiorthids. These deep, well drained soils formed in alluvium derived dominantly from gypsiferous material. They are on fan terraces and hills. Slope is 2 to 12 percent. Elevation is 5,800 to 6,500 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Netoma sandy loam, 2 to 12 percent slopes; about 1 mile southeast of Chicken Mountain; 2,112 feet west and 1,584 feet north of the southeast corner of sec. 36, T. 6 N., R. 4 W.

A—0 to 4 inches; strong brown (7.5YR 5/6) sandy loam, dark brown (7.5YR 3/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common very fine irregular pores; slightly effervescent; about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

Bw—4 to 12 inches; strong brown (7.5YR 5/6) sandy loam, strong brown (7.5YR 4/6) moist; weak fine subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; few fine and very fine roots; common very fine irregular pores; slightly effervescent; about 5 percent gravel; moderately alkaline; clear smooth boundary.

By1—12 to 22 inches; light brown (7.5YR 6/4), gypsiferous sandy loam, strong brown (7.5YR 4/6) moist; massive; soft, friable, nonsticky and

nonplastic; few fine and very fine roots; few very fine irregular pores; common medium nests of gypsum crystals; strongly effervescent; disseminated calcium carbonate; about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

By2—22 to 37 inches; reddish yellow (7.5YR 6/6), gypsiferous sandy loam, strong brown (7.5YR 4/6) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; common medium nests of gypsum crystals; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

By3—37 to 60 inches; reddish yellow (7.5YR 6/6), gypsiferous sandy loam, strong brown (7.5YR 4/6) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; common medium nests of gypsum crystals; strongly effervescent; disseminated calcium carbonate; mildly alkaline.

Depth to the gypsiferous material ranges from 5 to 15 inches. The content of rock fragments ranges from 0 to 10 percent throughout the profile.

Nogal Series

The soils in the Nogal series are classified as fine, mixed, mesic Aridic Haplustalfs. These moderately deep, well drained soils formed in alluvium derived dominantly from shale and sandstone. They are on mesas and hills. Slope is 1 to 10 percent. Elevation is 6,800 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Nogal sandy loam, in an area of Nogal-Galestina sandy loams, 1 to 10 percent slopes; about 1.5 miles west of New Mexico Highway 32 and 3.25 miles south of the McKinley County line; 1,000 feet east and 1,180 feet south of the northwest corner of sec. 24, T. 8 N., R. 18 W.

A—0 to 1 inch; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many fine and very fine roots; common fine and very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—1 to 7 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, firm, sticky and slightly plastic; many fine and very fine roots; common fine and very fine irregular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—7 to 15 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; common very fine tubular pores; common thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt3—15 to 19 inches; brown (7.5YR 4/4) clay, brown (7.5YR 4/4) moist; moderate medium prismatic structure parting to strong medium angular blocky; hard, firm, very sticky and plastic; few very fine roots; few very fine tubular pores; many thick clay films on faces of peds and in pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bk—19 to 31 inches; strong brown (7.5YR 5/6) clay, strong brown (7.5YR 4/6) moist; massive; hard, firm, sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; few medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

Cr—31 inches; interbedded shale and sandstone.

The depth to paralithic contact is 20 to 40 inches. Depth to the base of the argillic horizon is 16 to 35 inches. The calcium carbonate equivalent in the Bk horizon is 1 to 14 percent.

Oelop Series

The soils in the Oelop series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in mixed alluvium. They are in the lower areas on mesas and in swales and drainageways. Slope is 0 to 3 percent. Elevation is 6,000 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Oelop loam, in an area of Harvey-Oelop association, 0 to 5 percent slopes; about 4.5 miles southwest of South Garcia; 2,480 feet east and 100 feet north of the southwest corner of sec. 33, T. 8 N., R. 3 W.

A—0 to 3 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; few fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bt1—3 to 8 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist;

moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few very fine and medium roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—8 to 16 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and plastic; few very fine and medium and common fine roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bk1—16 to 34 inches; dark yellowish brown (10YR 4/4) clay loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, sticky and plastic; few very fine and fine roots; few fine irregular pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—34 to 44 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine irregular pores; strongly effervescent; few fine irregular filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk3—44 to 60 inches; dark yellowish brown (10YR 4/4) loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline.

Depth to the base of the Bt horizon is 15 to 30 inches. The content of rock fragments ranges from 0 to 5 percent throughout the profile.

The A horizon has hue of 7.5YR or 10YR and value of 4 to 6 (3 to 5 moist). The Bt horizon is loam or clay loam. It has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 or 4. The Bk horizon has hue of 7.5YR or 10YR, value of 4 to 7 (4 or 5 moist), and chroma of 3 to 6. The calcium carbonate equivalent in this horizon is less than 10 percent.

Paguate Series

The soils in the Paguate series are classified as fine, mixed, mesic Aridic Haplustalfs. These moderately deep, well drained soils formed in alluvium and windblown sediments. They are on basalt-capped mesas and plateaus. Slope is 1 to 5 percent. Elevation is 7,000 to 8,000 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 52 degrees F, and the frost-free period is 100 to 130 days.

Typical pedon of Paguate loam, in an area of Paguate-Hackroy complex, 1 to 5 percent slopes; about 4 miles west of Bibo; long. 107 degrees 25 minutes 08 seconds W. and lat. 35 degrees 11 minutes 53 seconds N.

A—0 to 3 inches; dark brown (7.5YR 4/4) loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; few fine and common very fine roots; common fine irregular pores; about 10 percent gravel; neutral; abrupt smooth boundary.

BA—3 to 8 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; weak medium subangular blocky structure; slightly hard, friable, sticky and plastic; few medium and common very fine roots; few fine tubular pores; neutral; clear smooth boundary.

Bt1—8 to 16 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; weak medium prismatic structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; few medium and common very fine roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—16 to 19 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; few fine and common very fine roots; few very fine tubular pores; mildly alkaline; abrupt smooth boundary.

Bk—19 to 33 inches; pink (5YR 7/3) gravelly clay loam, light reddish brown (5YR 6/3) moist; massive; soft, friable, slightly sticky and slightly plastic; about 20 percent gravel; violently effervescent; disseminated calcium carbonate and many medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—33 inches; basalt.

The depth to bedrock is 20 to 40 inches. Depth to the base of the Bt horizon, or the top of the Bk horizon, is 11 to 33 inches.

The A horizon is loam or cobbly clay loam. The content of rock fragments ranges from 0 to 20 percent. This horizon has value of 4 to 6 (3 to 5 moist) and chroma of 3 or 4.

The content of rock fragments in the BA horizon ranges from 0 to 15 percent. This horizon has hue of

5YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 3 or 4.

The Bt horizon is clay or gravelly clay. The content of rock fragments ranges from 0 to 20 percent. This horizon has hue of 5YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 3 to 6.

The Bk horizon is gravelly clay loam or clay loam. The content of rock fragments ranges from 10 to 30 percent. This horizon has hue of 5YR or 7.5YR, value of 6 to 8 (5 to 7 moist), and chroma of 3 to 6. The calcium carbonate equivalent is 25 to 40 percent.

Palma Series

The soils in the Palma series are classified as coarse-loamy, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in eolian material derived dominantly from sandstone. They are on stable sand dunes and in interdune areas. Slope is 1 to 7 percent. Elevation is 5,900 to 7,100 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Palma loamy fine sand, in an area of Mespun-Palma association, 1 to 12 percent slopes; about 1 mile east of the Roundy Ranch House; 1,800 feet west and 1,620 feet north of the southeast corner of sec. 9, T. 12 N., R. 9 W.

A—0 to 4 inches; light brown (7.5YR 6/4) loamy fine sand, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common very fine irregular pores; mildly alkaline; abrupt smooth boundary.

Bt1—4 to 11 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; few very fine irregular pores; few thin clay films coating sand grains; mildly alkaline; clear smooth boundary.

Bt2—11 to 21 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine tubular pores; few thin clay films coating and bridging sand grains; mildly alkaline; abrupt smooth boundary.

Bk1—21 to 32 inches; reddish yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; slightly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—32 to 60 inches; reddish yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; strongly effervescent; few fine irregular seams, filaments, and soft masses of calcium carbonate; moderately alkaline.

The Bk horizon is fine sandy loam or sandy loam.

Parkay Series

The soils in the Parkay series are classified as loamy-skeletal, mixed Argic Pachic Cryoborolls. These deep, well drained soils formed in colluvium and alluvium derived dominantly from basalt and andesite. They are on mountains, hills, and ridges. Slope is 15 to 45 percent. Elevation is 8,200 to 10,300 feet. The average annual precipitation is 22 to 26 inches. The average annual air temperature is 36 to 42 degrees F, and the frost-free period is 60 to 80 days.

Typical pedon of Parkay stony loam, in an area of Parkay-Rock outcrop complex, 15 to 45 percent slopes; about 1.5 miles southwest of Big Lake; long. 107 degrees 32 minutes 00 seconds W. and lat. 35 degrees 15 minutes 01 second N.

Oi—1 inch to 0; thin covering of partly decomposed fir and pine needles and aspen leaves.

A1—0 to 2 inches; dark grayish brown (10YR 4/2) stony loam, black (10YR 2/1) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; common very fine irregular pores; about 5 percent stones, 5 percent cobbles, and 15 percent gravel; mildly alkaline; abrupt smooth boundary.

A2—2 to 8 inches; dark grayish brown (10YR 4/2) very gravelly sandy clay loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; few medium and common very fine roots; common very fine irregular pores; about 10 percent cobbles and 25 percent gravel; neutral; clear smooth boundary.

Bt1—8 to 20 inches; brown (7.5YR 5/4) very cobbly sandy clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few medium and common very fine roots; common very fine tubular and irregular pores; few thin clay films on faces of peds and in pores; about 15 percent cobbles and 25 percent gravel; slightly acid; clear smooth boundary.

Bt2—20 to 23 inches; brown (7.5YR 5/4) very cobbly sandy clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, friable, sticky and slightly plastic; few coarse and common very fine roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; about 15 percent cobbles and 25 percent gravel; slightly acid; clear smooth boundary.

C1—23 to 35 inches; brown (7.5YR 5/4) very cobbly sandy clay loam, dark brown (7.5YR 3/4) moist; massive; hard, friable, slightly sticky and slightly plastic; few coarse and common very fine roots; common very fine irregular pores; about 25 percent cobbles and 20 percent gravel; neutral; abrupt smooth boundary.

C2—35 to 60 inches; light brown (7.5YR 6/4) very cobbly sandy clay loam, dark brown (7.5YR 4/4) moist; massive; hard, friable; slightly sticky and slightly plastic; few fine and very fine roots; common very fine irregular pores; about 30 percent cobbles and 20 percent gravel; neutral.

The content of rock fragments in the control section ranges from 35 to 60 percent. Depth to the base of the Bt horizon ranges from 20 to 30 inches. The thickness of the mollic epipedon ranges from 20 to 24 inches.

The Bt horizon is very gravelly sandy clay loam, very cobbly sandy clay loam, or very cobbly clay loam. The C horizon is very cobbly sandy clay loam or extremely cobbly sandy clay loam. The content of rock fragments in this horizon ranges from 40 to 70 percent, including 25 to 45 percent cobbles and 15 to 25 percent gravel.

Penistaja Series

The soils in the Penistaja series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in alluvium and eolian material derived dominantly from sandstone. They are on cuestas and ridges, in valleys between lava ridges and in other valleys, and on fan terraces. Slope is 0 to 10 percent. Elevation is 5,700 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 115 to 140 days.

Typical pedon of Penistaja fine sandy loam, 2 to 10 percent slopes; about 2.25 miles north of Anaconda Mill; 400 feet west and 2,000 feet north of the southeast corner of sec. 6, T. 12 N., R. 10 W.

A—0 to 2 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; neutral; abrupt smooth boundary.

BA—2 to 6 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine tubular pores; few thin clay films in pores; neutral; abrupt smooth boundary.

Bt1—6 to 16 inches; strong brown (7.5YR 4/6) sandy clay loam, brown (7.5YR 4/4) moist; strong medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—16 to 22 inches; strong brown (7.5YR 5/6) sandy clay loam, strong brown (7.5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bk—22 to 53 inches; light brown (7.5YR 6/4) sandy loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; violently effervescent; disseminated calcium carbonate and common medium rounded soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

C—53 to 60 inches; reddish yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

Depth to the base of the Bt horizon is 13 to 35 inches. In some pedons this horizon is slightly calcareous. The calcium carbonate equivalent is less than 15 percent in the upper 40 inches. In some pedons the soils have as much as 15 percent gravel throughout. In other pedons buried horizons are below a depth of 40 inches.

The A horizon is fine sandy loam or sandy loam. It has hue of 5YR to 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. The Bt horizon is sandy clay loam or clay loam. It has hue of 5YR or 7.5YR, value of 4 to 6 (4 or 5 moist), and chroma of 4 to 6. The Bk and C horizons are sandy loam, fine sandy loam, sandy clay loam, or loam. They have hue of 5YR to 10YR, value of 5 to 8 (4 to 6 moist), and chroma of 3 to 6.

Pinitos Series

The soils in the Pinitos series are classified as fine-loamy, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in wind-modified alluvium derived dominantly from sandstone. They are on hills and mesa tops. Slope is 1 to 10 percent. Elevation is 6,800 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Pinitos sandy loam, in an area of Pinitos-Ribera sandy loams, 1 to 10 percent slopes; about 1 mile east of Balok Ranch; 1,080 feet west and 700 feet north of the southwest corner of sec. 3, T. 8 N., R. 16 W.

A—0 to 2 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; neutral; clear smooth boundary.

Bt1—2 to 6 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine and few medium roots; common very fine irregular and few very fine tubular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—6 to 14 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and slightly plastic; common fine and very fine and few medium roots; common fine tubular pores; many moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt3—14 to 24 inches; light brown (7.5YR 6/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and nonplastic; common very fine and few fine roots; few fine tubular pores; few thin clay films in pores and on faces of peds; mildly alkaline; abrupt smooth boundary.

Bk1—24 to 38 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bk2—38 to 60 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/6) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; mildly alkaline.

Depth to the base of the Bt horizon and to an accumulation of calcium carbonate is 18 to 31 inches. The Bt horizon is sandy clay loam or clay loam. The Bk horizon is sandy loam or sandy clay loam. The calcium carbonate equivalent in this horizon is 1 to 10 percent.

Pojoaque Series

The soils in the Pojoaque series are classified as fine-loamy, mixed (calcareous), mesic Ustic Torriorthents. These deep, well drained soils formed in alluvium and colluvium derived dominantly from sandstone and shale. They are on mesa breaks. Slope is 5 to 30 percent. Elevation is 6,200 to 6,900 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Pojoaque very cobbly loam, in an area of Poley-Pojoaque very cobbly loams, 5 to 30 percent slopes; about 3 miles southeast of Marquez on New Mexico State Road 279; long. 107 degrees 15 minutes 44.6 seconds W. and lat. 35 degrees 15 minutes 32 seconds N.

A1—0 to 3 inches; brown (10YR 4/3) very cobbly loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, very friable, nonsticky and slightly plastic; few coarse, common fine, and many very fine roots; few fine irregular pores; about 5 percent stones, 20 percent cobbles, and 20 percent gravel; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

A2—3 to 7 inches; brown (10YR 5/3) gravelly clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; few coarse and many very fine roots; few fine irregular pores; about 5 percent cobbles and 25 percent gravel; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Ck1—7 to 30 inches; light yellowish brown (10YR 6/4) cobbly clay loam, yellowish brown (10YR 5/4) moist; massive; hard, firm, slightly sticky and slightly plastic; few coarse and common very fine roots; common very fine irregular pores; about 10 percent cobbles and 15 percent gravel; violently

effervescent; few fine irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Ck2—30 to 45 inches; very pale brown (10YR 7/3) gravelly sandy clay loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common fine and very fine roots; common very fine irregular pores; about 5 percent cobbles and 25 percent gravel; violently effervescent; common fine irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Ck3—45 to 60 inches; very pale brown (10YR 7/3) gravelly sandy clay loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few fine and common very fine roots; about 5 percent cobbles and 20 percent gravel; violently effervescent; common medium irregular soft masses of calcium carbonate; mildly alkaline.

A few stones are on the surface. The content of rock fragments in the A horizon ranges from 30 to 60 percent. The C horizon is gravelly sandy clay loam, cobbly clay loam, or gravelly clay loam. The content of rock fragments in this horizon ranges from 15 to 35 percent. The calcium carbonate equivalent ranges from 5 to 15 percent.

Poley Series

The soils in the Poley series are classified as fine, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in alluvium and colluvium derived dominantly from shale. They are on benches, ridges, hills, and mesa breaks. Slope is 2 to 30 percent. Elevation is 5,800 to 7,100 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Poley very cobbly loam, in an area of Poley-Rock outcrop complex, 2 to 25 percent slopes; about 1 mile west of Chicken Mountain; 2,100 feet east and 100 feet north of the southwest corner of sec. 28, T. 6 N., R. 4 W.

A—0 to 3 inches; reddish brown (5YR 4/4) very cobbly loam, reddish brown (5YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and very fine roots; common fine irregular pores; about 5 percent stones, 15 percent cobbles, and 15 percent gravel; slightly effervescent; disseminated calcium carbonate; neutral; abrupt smooth boundary.

Bt—3 to 12 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; strong medium subangular blocky structure; hard, firm, sticky and plastic; few coarse and fine and common very fine roots; common fine tubular pores; many thick clay films on faces of peds and in pores; about 1 percent cobbles; mildly alkaline; abrupt smooth boundary.

Btk—12 to 22 inches; yellowish red (5YR 5/6) clay, yellowish red (5YR 4/6) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few coarse and very fine roots; common fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 1 percent cobbles; violently effervescent; common coarse irregular soft masses of calcium carbonate; moderately alkaline; gradual smooth boundary.

Bk1—22 to 49 inches; light reddish brown (5YR 6/4) clay, reddish brown (5YR 5/4) moist; massive; hard, firm, sticky and plastic; few coarse and very fine roots; common fine tubular pores; about 10 percent cobbles and 5 percent gravel; violently effervescent; common coarse irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—49 to 60 inches; pink (5YR 7/3) clay loam, light reddish brown (5YR 6/4) moist; massive; soft, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; about 10 percent cobbles; violently effervescent; many coarse irregular soft masses of calcium carbonate; strongly alkaline.

The A horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 3 or 4. The content of rock fragments ranges from 35 to 50 percent.

The Bt horizon is clay or clay loam. It has hue of 5YR to 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 to 6. The content of rock fragments ranges from 0 to 15 percent.

The Bk horizon is loam, clay, or clay loam. It has hue of 5YR to 10YR. The content of rock fragments ranges from 0 to 15 percent. The calcium carbonate equivalent is 15 to 30 percent.

Quintana Series

The soils in the Quintana series are classified as fine-loamy, mixed, mesic Typic Ustochrepts. These deep, well drained soils formed in wind-modified, mixed alluvium. They are in valleys and on ridges and terraces. Slope is 5 to 15 percent. Elevation is 6,400 to 6,900 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 115 to 130 days.

Typical pedon of Quintana fine sandy loam, in an area of Flugle-Quintana complex, 2 to 15 percent slopes; about 1.5 miles north of Thompson Draw; 1,750 feet south and 180 feet east of the northwest corner of sec. 6, T. 7 N., R. 19 W.

A—0 to 2 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bw—2 to 11 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bk1—11 to 33 inches; pink (7.5YR 7/4) loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; violently effervescent; common medium irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—33 to 46 inches; pink (7.5YR 7/4) sandy clay loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few very fine roots; few fine tubular pores; violently effervescent; common medium irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk3—46 to 60 inches; pink (7.5YR 7/4) sandy loam, light brown (7.5YR 6/4) moist; massive; soft, friable, nonsticky and nonplastic; few very fine roots; common very fine irregular pores; violently effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline.

The A horizon is sandy loam or fine sandy loam. It has value of 5 or 6 (4 or 5 moist) and chroma of 3 or 4. The Bw horizon is fine sandy loam or sandy clay loam. It has hue of 10YR or 7.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4. The Bk horizon is sandy clay loam, sandy loam, loam, clay loam, or fine sandy loam. It has value of 4 to 8 (4 to 7 moist) and chroma of 4 to 6.

The Quintana soils in this survey receive less annual precipitation and more precipitation in winter than is defined as the range for the series. These differences, however, do not significantly affect the use and management of the soils.

Rana Series

The soils in the Rana series are classified as very fine, montmorillonitic (calcareous), mesic Ustertic Torriorthents. These deep, well drained soils formed in alluvium and colluvium derived dominantly from red-bed shale. They are on mesa breaks. Slope is 2 to 25 percent. Elevation is 5,800 to 7,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Rana very cobbly clay, in an area of Rana-Rock outcrop complex, 2 to 25 percent slopes; about 8 miles southwest of the headquarters of Harrington Ranch; 1,600 feet east and 990 feet south of the northwest corner of sec. 3, T. 6 N., R. 5 W.

A—0 to 3 inches; red (2.5YR 4/6) very cobbly clay, yellowish red (5YR 4/6) moist; strong fine granular structure; soft, firm, sticky and plastic; few very fine and common fine and medium roots; common very fine irregular pores; about 30 percent cobbles and 10 percent gravel; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

C1—3 to 20 inches; red (2.5YR 4/6) clay, yellowish red (5YR 4/6) moist; massive; very hard, very firm, very sticky and very plastic; few very fine and common fine and medium roots; few very fine irregular and few fine tubular pores; few small slickensides; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—20 to 34 inches; red (2.5YR 4/6) clay, yellowish red (5YR 4/6) moist; massive; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine irregular and few fine tubular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

C3—34 to 52 inches; red (2.5YR 4/6) clay, dark red (2.5YR 3/6) moist; massive; very hard, firm, sticky and plastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; strongly alkaline; gradual wavy boundary.

C4—52 to 60 inches; reddish brown (2.5YR 4/4) clay, red (2.5YR 4/6) moist; massive; very hard, firm, sticky and plastic; few very fine irregular pores; about 5 percent pebble-sized shale fragments; strongly effervescent; disseminated calcium carbonate; strongly alkaline.

The content of rock fragments in the A horizon ranges from 35 to 55 percent. The content of rock

fragments, mainly shale, in the C horizon is less than 10 percent. Most of the fragments are in the lower part of the horizon.

Raton Series

The soils in the Raton series are classified as clayey-skeletal, mixed Lithic Argiborolls. These shallow and very shallow, well drained soils formed in windblown sediments and mixed alluvium. They are on mesas, in depressions and swales, and on basalt plains, ridges, and hills. Slope is 1 to 10 percent. Elevation is 7,200 to 8,800 feet. The average annual precipitation is 16 to 24 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 80 to 110 days.

Typical pedon of Raton very cobbly loam, in an area of Raton-Rock outcrop complex, 1 to 10 percent slopes; about 1.5 miles southwest of "Hole in the Wall"; 400 feet west and 2,400 feet south of the northeast corner of sec. 26, T. 7 N., R. 12 W.

Oi—1 inch to 0; pine needles and leaves.

A—0 to 5 inches; dark reddish brown (5YR 3/3) very cobbly loam, dark reddish brown (5YR 2.5/2) moist; moderate fine granular structure; soft, friable, slightly sticky and slightly plastic; many very fine and common fine roots; common very fine irregular pores; about 30 percent cobbles, 5 percent stones, and 10 percent gravel; neutral; clear smooth boundary.

Bt1—5 to 9 inches; reddish brown (5YR 4/3) very cobbly clay, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few very fine and fine and common coarse roots; common fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 30 percent cobbles and 10 percent gravel; neutral; clear wavy boundary.

Bt2—9 to 13 inches; reddish brown (5YR 4/4) very cobbly clay, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few very fine and fine and common coarse roots; few fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 45 percent cobbles and 10 percent gravel; neutral; abrupt smooth boundary.

2R—13 inches; basalt.

The depth to bedrock ranges from 6 to 20 inches. The mollic epipedon is 6 to 14 inches thick.

The A horizon is very cobbly or cobbly loam. The content of rock fragments ranges from 25 to 60 percent, by volume, including 0 to 15 percent stones, 20 to 35 percent cobbles, and 5 to 10 percent gravel. This horizon has hue of 5YR to 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3.

The Bt horizon is very cobbly clay or very cobbly clay loam. The content of rock fragments ranges from 40 to 60 percent, by volume, including 0 to 5 percent stones, 35 to 45 percent cobbles, and 5 to 10 percent gravel. This horizon has hue of 5YR or 7.5YR, value of 3 to 5 dry or moist, and chroma of 2 to 4.

Ribera Series

The soils in the Ribera series are classified as fine-loamy, mixed, mesic Aridic Haplustalfs. These moderately deep, well drained soils formed in wind-modified alluvium derived dominantly from sandstone. They are on hills and mesas. Slope is 1 to 10 percent. Elevation is 6,800 to 7,500 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Ribera sandy loam, in an area of Pinitos-Ribera sandy loams, 1 to 10 percent slopes; about 7 miles north of Beggs Cattle Camp; 150 feet west and 890 feet south of the northeast corner of sec. 27, T. 8 N., R. 18 W.

A—0 to 3 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; neutral; abrupt smooth boundary.

BA—3 to 6 inches; brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; soft, very friable, slightly sticky and nonplastic; common very fine and fine roots; few very fine and fine irregular pores; neutral; clear smooth boundary.

Bt1—6 to 10 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky and nonplastic; common very fine and fine roots; common very fine tubular pores; common thin clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—10 to 16 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; strong medium subangular blocky structure; hard, firm, sticky and slightly plastic; common very fine and fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bk1—16 to 27 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; hard, firm, sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bk2—27 to 39 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; massive; hard, firm, sticky and slightly plastic; few very fine roots; few very fine irregular pores; violently effervescent; common medium irregular seams and filaments of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—39 inches; sandstone.

The depth to bedrock is 20 to 40 inches. Depth to the base of the Bt horizon is 11 to 25 inches. This horizon is sandy clay loam or clay loam. The calcium carbonate equivalent in the Bk horizon is less than 15 percent.

Rizozo Series

The soils in the Rizozo series are classified as loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents. These shallow and very shallow, well drained soils formed in eolian material derived dominantly from sandstone. They are on hills, ridges, and mesas. Slope is 3 to 55 percent. Elevation is 6,000 to 6,700 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Rizozo loam, in an area of Bond-Rizozo-Rock outcrop complex, 2 to 20 percent slopes; about 2 miles southeast of Harrington Ranch House; 250 feet south and 1,600 feet west of the northeast corner of sec. 4, T. 5 N., R. 3 W.

A—0 to 2 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, very friable, slightly sticky and nonplastic; few very fine roots; common very fine irregular pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C—2 to 14 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; massive; soft, very friable, slightly sticky and nonplastic; few very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—14 inches; sandstone.

The depth to bedrock is 4 to 20 inches. The content of rock fragments ranges from 0 to 15 percent in the A and C horizons. These horizons are sandy loam or loam. The A horizon has hue of 2.5YR or 5YR, value of 3 or 4 dry or moist, and chroma of 4 or 5. The C horizon has hue of 2.5YR or 5YR, value of 3 or 4 dry or moist, and chroma of 4 to 6.

The Rizozo soil in map unit 434 has less silt than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soil.

Saido Series

The soils in the Saido series are classified as coarse-silty, gypsic, mesic Typic Gypsiorthids. These deep, well drained soils formed in alluvium derived dominantly from gypsiferous material. They are on fans and knolls. Slope is 1 to 12 percent. Elevation is 5,500 to 6,400 feet. The average annual precipitation is 8 to 12 inches. The average annual air temperature is 51 to 53 degrees F, and the frost-free period is 130 to 150 days.

Typical pedon of Saido loam, 1 to 12 percent slopes; about 7 miles south of Interstate 40 from the New Mexico Highway 6 exit; 528 feet west and 515 feet north of the southeast corner of sec. 19, T. 8 N., R. 3 W.

A—0 to 2 inches; reddish brown (5YR 5/4) loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, friable, slightly sticky and nonplastic; common very fine and few fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

By1—2 to 11 inches; white (10YR 8/1), gypsiferous loam, very pale brown (10YR 7/3) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine irregular pores; common medium nests of gypsum; slightly effervescent; disseminated calcium carbonate; neutral; gradual wavy boundary.

By2—11 to 25 inches; white (10YR 8/1), gypsiferous loam, very pale brown (10YR 7/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; common medium nests of gypsum; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

By3—25 to 32 inches; white (10YR 8/2), gypsiferous loam, very pale brown (10YR 7/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine irregular pores; common medium nests of

gypsum; violently effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

By4—32 to 44 inches; very pale brown (10YR 8/4), gypsiferous loam, very pale brown (10YR 7/4) moist; massive; hard, friable, nonsticky and nonplastic; common medium nests of gypsum; violently effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

By5—44 to 60 inches; white (10YR 8/1), gypsiferous loam, light gray (10YR 7/2) moist; massive; hard, friable, nonsticky and nonplastic; common soft accumulations of gypsum; violently effervescent; disseminated calcium carbonate; mildly alkaline.

Saladon Series

The soils in the Saladon series are classified as fine, montmorillonitic Typic Cryaquolls. These deep, poorly drained soils formed in mixed alluvium. They are in valleys and drainageways. Slope is 0 to 5 percent. Elevation is 7,900 to 8,300 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Saladon clay loam, 0 to 5 percent slopes; about 1.5 miles southwest of Lookout Mountain; 200 feet east and 1,600 feet north of the southwest corner of sec. 11, T. 11 N., R. 14 W.

A—0 to 4 inches; dark brown (10YR 4/3) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; many very fine, fine, and medium roots; common very fine and few fine irregular pores; slightly acid; abrupt smooth boundary.

C1—4 to 19 inches; black (10YR 2/1) clay, black (10YR 2/1) moist; massive; very hard, firm, sticky and plastic; common very fine and fine roots; few very fine irregular pores; slightly acid; clear smooth boundary.

C2—19 to 25 inches; black (10YR 2/1) clay, black (10YR 2/1) moist; few medium prominent dark yellowish brown (10YR 4/4) mottles; massive; very hard, firm, sticky and plastic; common very fine and few fine roots; few very fine irregular pores; about 5 percent gravel; slightly acid; abrupt smooth boundary.

C3—25 to 35 inches; yellowish brown (10YR 5/4) sandy clay, dark yellowish brown (10YR 4/4) moist; few medium prominent dark yellowish brown (10YR 4/6) mottles; massive; very hard, very firm, sticky and plastic; few very fine roots; common very fine and fine irregular pores; about 15 percent gravel; slightly acid; abrupt smooth boundary.

C4—35 to 45 inches; grayish brown (10YR 5/2) clay, very dark gray (N 3/0) moist; common medium prominent dark yellowish brown (10YR 4/6) mottles; massive; very hard, very firm, sticky and plastic; common very fine and few fine irregular pores; about 15 percent gravel; slightly acid; clear smooth boundary.

C5—45 to 60 inches; very dark gray (10YR 3/1) clay, very dark gray (N 3/0) moist; common medium prominent dark yellowish brown (10YR 4/6, 4/4) mottles; massive; very hard, very firm, sticky and plastic; few very fine irregular pores; slightly acid.

The mollic epipedon ranges from 20 to 40 inches in thickness. A fluctuating water table is at a depth of 18 to 36 inches.

The Saladon soils in this survey area are a taxadjunct to the series because the average annual temperature is about 5 degrees warmer, the temperature in summer is warmer, and the mollic epipedon is thicker than is defined as the range for the series. These differences, however, do not significantly affect the use and management of the soils.

San Mateo Series

The soils in the San Mateo series are classified as fine-loamy, mixed (calcareous), mesic Ustic Torrifluvents. These deep, well drained soils formed in mixed alluvium. They are on flood plains and alluvial fans and in valleys and drainageways. Slope is 0 to 5 percent. Elevation is 5,800 to 6,600 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 110 to 145 days.

Typical pedon of San Mateo loam, in an area of Sparank-San Mateo complex, 0 to 5 percent slopes; about 1 mile northwest of Moquino; long. 107 degrees 18 minutes 21 seconds W. and lat. 35 degrees 11 minutes 10 seconds N.

A—0 to 2 inches; light yellowish brown (2.5Y 6/4) loam, olive brown (2.5Y 4/4) moist; moderate fine granular structure; soft, friable, nonsticky and nonplastic; common fine and very fine roots; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

C1—2 to 12 inches; light olive brown (2.5Y 5/4) loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, nonsticky and nonplastic; common fine and very fine roots; common fine and very fine irregular

pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—12 to 29 inches; light olive brown (2.5Y 5/6) sandy clay loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; common very fine and few fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; gradual smooth boundary.

C3—29 to 60 inches; light olive brown (2.5Y 5/6) sandy clay loam, olive brown (2.5Y 4/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline.

The soils are mildly alkaline or moderately alkaline throughout.

The A horizon is loam, clay loam, or sandy clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6 (3 to 5 moist), and chroma of 3 to 6. The calcium carbonate equivalent is less than 15 percent.

The C horizon is dominantly sandy clay loam, loam, clay loam, or silty clay loam. In some pedons it has thin strata of loam, silt loam, clay loam, silty clay loam, fine sandy loam, loamy sand, or sandy loam. It has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 to 6. The content of rock fragments ranges from 0 to 10 percent. The calcium carbonate equivalent is less than 15 percent.

Sheppard Series

The soils in the Sheppard series are classified as mixed, mesic Typic Torripsamments. These deep, somewhat excessively drained soils formed in eolian material derived dominantly from sandstone. They are on sand dunes and fans. Slope is 3 to 12 percent. Elevation is 5,400 to 6,000 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Sheppard loamy fine sand, in an area of Sheppard-Shiprock association, 1 to 12 percent slopes; about 1 mile northeast of the headquarters of Marmon Ranch; 2,100 feet south and 2,380 feet east of the northwest corner of sec. 2, T. 7 N., R. 6 W.

A—0 to 4 inches; reddish yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; weak fine granular structure; loose, nonsticky and nonplastic; few very fine and fine roots; mildly alkaline; clear smooth boundary.

C1—4 to 22 inches; reddish yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; common very fine irregular pores; mildly alkaline; clear smooth boundary.

C2—22 to 47 inches; reddish yellow (5YR 6/6) loamy sand, yellowish red (5YR 4/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C3—47 to 60 inches; reddish yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; slightly effervescent; disseminated calcium carbonate; mildly alkaline.

Shiprock Series

The soils in the Shiprock series are classified as coarse-loamy, mixed, mesic Typic Haplargids. These deep, well drained soils formed in wind-modified alluvium derived dominantly from sandstone. They are on stable dunes, in interdune areas, and on fan terraces, hills, and ridges. Slope is 1 to 10 percent. Elevation is 5,400 to 6,100 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Shiprock sandy loam, in an area of Grieta-Shiprock association, 1 to 10 percent slopes; about 1.5 miles south of Suwanee; 217 feet south and 80 feet west of the northeast corner of sec. 15, T. 8 N., R. 3 W.

A1—0 to 3 inches; reddish yellow (7.5YR 6/6) sandy loam, strong brown (7.5YR 5/6) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine irregular pores; mildly alkaline; abrupt smooth boundary.

A2—3 to 13 inches; brown (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine and few medium roots; common very fine irregular pores; moderately alkaline; clear smooth boundary.

Bt—13 to 25 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky and nonplastic; many very fine roots; common fine irregular pores; few thin clay films on faces of peds and bridging sand grains; moderately alkaline; abrupt smooth boundary.

Bk1—25 to 37 inches; reddish yellow (7.5YR 6/6) sandy

loam, strong brown (7.5YR 5/6) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine roots; common fine irregular pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline; gradual smooth boundary.

Bk2—37 to 60 inches; reddish yellow (7.5YR 7/6) sandy loam, reddish yellow (7.5YR 6/6) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine and fine roots; few fine irregular pores; strongly effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline.

The A horizon has hue of 5YR or 7.5YR, value of 5 to 7 (4 or 5 moist), and chroma of 4 to 6. The Bt horizon is sandy loam or fine sandy loam. It has hue of 5YR or 7.5YR, value of 4 to 6 dry or moist, and chroma of 3 to 6. The Bk horizon is sandy loam or fine sandy loam. It has hue of 5YR or 7.5YR, value of 6 to 8 (4 to 7 moist), and chroma of 4 to 6.

Silkie Series

The soils in the Silkie series are classified as fine, mixed, mesic Vertic Haplustalfs. These deep, well drained soils formed in alluvium derived dominantly from shale. They are on valley sides. Slope is 3 to 10 percent. Elevation is 6,600 to 7,500 feet. The average annual precipitation is 13 to 16 inches. The average annual air temperature is 47 to 51 degrees F, and the frost-free period is 100 to 120 days.

Typical pedon of Silkie clay loam, in an area of Catman-Silkie association, 1 to 10 percent slopes; about 0.25 mile east of Crockett Peak; 2,550 feet west and 780 feet north of the southeast corner of sec. 28, T. 8 N., R. 17 W.

A—0 to 4 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; common very fine roots; common very fine irregular pores; mildly alkaline; clear smooth boundary.

Bt—4 to 16 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; moderate medium prismatic structure parting to strong medium subangular blocky; very hard, firm, very sticky and very plastic; common very fine and fine roots; common fine irregular pores; cracks 0.5 to 1.0 inch wide; many thick clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bk1—16 to 35 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; massive; hard, firm, sticky and plastic; few very fine and fine roots; few fine irregular pores; few small slickensides; few cracks 0.5 to 1.0 inch wide; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

Bk2—35 to 60 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; massive; very hard, firm, very sticky and plastic; few very fine roots; few very fine irregular pores; violently effervescent; common medium irregular soft masses of calcium carbonate; mildly alkaline.

Depth to the base of the Bt horizon is 15 to 27 inches. Cracks 0.5 to 1.0 inch wide extend to a depth of 21 to 35 inches. The Bt and Bk horizons are clay or clay loam. The calcium carbonate equivalent in the Bk horizon is 1 to 10 percent.

Skyvillage Series

The soils in the Skyvillage series are classified as loamy, mixed (calcareous), mesic Lithic Ustic Torriorthents. These shallow, well drained soils formed in eolian material derived dominantly from fine grained sandstone. They are on benches and the edges of mesas. Slope is 3 to 40 percent. Elevation is 6,000 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typical pedon of Skyvillage sandy loam, in an area of Skyvillage-Rock outcrop-Bond complex, 3 to 40 percent slopes; about 2 miles east of the Lobo Cow Camp; long. 107 degrees 14 minutes 02 seconds W. and lat. 35 degrees 12 minutes 00 seconds N.

A—0 to 4 inches; light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; few fine irregular pores; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C—4 to 12 inches; yellowish brown (10YR 5/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; common fine and few very fine roots; few fine irregular pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2R—12 inches; sandstone.

The depth to bedrock ranges from 10 to 20 inches. The content of rock fragments ranges from 0 to 15 percent in the A and C horizons.

Sparank Series

The soils in the Sparank series are classified as fine, mixed (calcareous), mesic Ustic Torrifluvents. These deep, well drained soils formed in mixed alluvium. They are on valley floors, in drainageways, and on flood plains, valley bottoms, and alluvial fans. Slope is 0 to 3 percent. Elevation is 5,800 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 120 to 150 days.

Typical pedon of Sparank clay loam, in an area of Sparank-San Mateo complex, 0 to 5 percent slopes; about 1 mile east of Grants; 900 feet east and 200 feet north of the southwest corner of sec. 28, T. 11 N., R. 9 W.

A—0 to 2 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) moist; strong fine granular structure; soft, friable, sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C1—2 to 21 inches; light yellowish brown (2.5Y 6/4) silty clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine irregular pores; few small slickensides; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—21 to 42 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C3—42 to 46 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; massive; hard, firm, sticky and plastic; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C4—46 to 60 inches; light olive brown (2.5Y 5/4) silty clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline.

The soils are mildly alkaline to strongly alkaline throughout. Electrical conductivity ranges from 2 to 16 millimhos per centimeter, and the sodium adsorption ratio is 0 to 13 or more.

The A horizon is clay loam or sandy clay loam. It has hue of 10YR or 2.5YR, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4. The C horizon dominantly is clay, silty clay, or silty clay loam. In some pedons, however, it has thin strata of loamy sand or silt loam in the lower part. This horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4.

Sparham Series

The soils in the Sparham series are classified as fine, mixed (calcareous), mesic Typic Ustifluvents. These deep, somewhat poorly drained soils formed in mixed alluvium. They are on flood plains. Slope is 0 to 2 percent. Elevation is 6,200 to 6,600 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Sparham clay loam, 0 to 2 percent slopes; about 3 miles west of Santa Maria Mission; 200 feet east and 1,900 feet south of the northwest corner of sec. 30, T. 10 N., R. 8 W.

A—0 to 10 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; strong fine granular structure; soft, friable, sticky and slightly plastic; few very fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C1—10 to 44 inches; pale brown (10YR 6/3) silty clay, brown (10YR 5/3) moist; massive; very hard, very firm, very sticky and very plastic; few very fine roots; few very fine irregular pores; slightly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—44 to 60 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine irregular pores; mildly alkaline.

The C horizon is silty clay or clay. Electrical conductivity ranges from 4 to 16 millimhos per centimeter.

Stout Series

The soils in the Stout series are classified as loamy, mixed, nonacid, frigid Lithic Ustorthents. These very shallow and shallow, well drained soils formed in eolian material derived dominantly from sandstone. They are on hills and ridges. Slope is 3 to 15 percent. Elevation is 7,800 to 8,500 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Stout sandy loam, in an area of Rock outcrop-Stout complex, 3 to 15 percent slopes;

about 3 miles southwest of Page; 900 feet west and 1,000 feet north of the southeast corner of sec. 7, T. 12 N., R. 15 W.

Oi—1 inch to 0; partially decomposed pine needles and oak leaves.

A—0 to 3 inches; brown (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; moderate very fine granular structure; soft, very friable, nonsticky and nonplastic; common fine roots; common very fine irregular pores; about 10 percent gravel; neutral; clear smooth boundary.

C—3 to 14 inches; brown (7.5YR 5/4) sandy loam, brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; few very fine irregular pores; about 10 percent gravel; neutral; abrupt wavy boundary.

2R—14 inches; sandstone.

The depth to bedrock is 6 to 20 inches. The content of rock fragments averages less than 15 percent in the A and C horizons.

Suwanee Series

The soils in the Suwanee series are classified as fine-loamy, mixed (calcareous), mesic Ustic Torrifluvents. These deep, well drained soils formed in mixed alluvium. They are on flood plains, in drainageways, and on alluvial fans. Slope is 1 to 5 percent. Elevation is 5,400 to 6,000 feet. The average annual precipitation is 7 to 10 inches. The average annual air temperature is 51 to 55 degrees F, and the frost-free period is 140 to 165 days.

Typical pedon of Suwanee silty clay loam, in an area of Navajo-Suwanee complex, 1 to 5 percent slopes; about 4 miles south of the intersection of New Mexico Highway 6 and Interstate 40; about 1,320 feet east and 1,056 feet north of the southwest corner of sec. 19, T. 8 N., R. 3 W.

A—0 to 3 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C1—3 to 16 inches; yellowish red (5YR 5/6) silty clay loam, yellowish red (5YR 4/6) moist; massive; soft, very friable, slightly sticky and slightly plastic; few fine and medium roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—16 to 21 inches; reddish brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine and medium roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C3—21 to 27 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable, sticky and slightly plastic; few fine and medium roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C4—27 to 32 inches; brown (7.5YR 5/4) sandy loam, dark brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and medium roots; few fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C5—32 to 35 inches; reddish brown (5YR 5/4) silty clay loam, reddish brown (5YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few fine and medium roots; few very fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C6—35 to 38 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and medium roots; few fine irregular pores; violently effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C7—38 to 46 inches; reddish brown (5YR 5/4) silt loam, reddish brown (5YR 4/4) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few very fine, fine, and medium roots; few very fine irregular pores; violently effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C8—46 to 60 inches; reddish brown (5YR 4/4) silty clay, dark reddish brown (5YR 3/4) moist; massive; hard, firm, sticky and plastic; few very fine, fine, and medium roots; few very fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline.

The C horizon is stratified silty clay loam, silt loam, sandy loam, silty clay, clay loam, sandy clay loam, or loamy fine sand. The content of clay in this horizon ranges from 18 to 35 percent.

Tanbark Series

The soils in the Tanbark series are classified as loamy, gypsic, mesic, shallow Ustic Torriorthents. These shallow, well drained soils formed in eolian material

derived dominantly from gypsum. They are on hills and ridges. Slope is 25 to 60 percent. Elevation is 5,800 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Tanbark loam, in an area of Winona-Tanbark-Rock outcrop association, 15 to 60 percent slopes; about 15 miles southeast of Chicken Mountain; 1,500 feet west and 2,380 feet south of the northeast corner of sec. 1, T. 4 N., R. 5 W.

A—0 to 2 inches; very pale brown (10YR 8/4) loam, very pale brown (10YR 7/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; about 10 percent gravel; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

C1—2 to 12 inches; very pale brown (10YR 8/3), gypsiferous silt loam, very pale brown (10YR 7/3) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine and few medium roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate; mildly alkaline; clear smooth boundary.

C2—12 to 17 inches; white (10YR 8/2), gypsiferous sandy loam, very pale brown (10YR 7/4) moist; massive; soft, very friable, nonsticky and nonplastic; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

2Cr—17 inches; white (10YR 8/2) gypsum.

The depth to gypsum is 10 to 20 inches. The C horizon is gypsiferous silt loam or loam in the upper part and gypsiferous sandy loam in the lower part.

Tapia Series

The soils in the Tapia series are classified as fine-loamy, mixed, mesic Ustollic Haplargids. These deep, well drained soils formed in mixed alluvium. They are on fan terraces. Slope is 1 to 5 percent. Elevation is 6,200 to 6,900 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 120 to 150 days.

Typical pedon of Tapia sandy loam, 1 to 5 percent slopes; about 3 miles northeast of Cubero; long. 107 degrees 30 minutes 05 seconds W. and lat. 35 degrees 07 minutes 59 seconds N.

A—0 to 4 inches; brown (7.5YR 4/4) sandy loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; many very fine irregular pores; about 3 percent gravel; mildly alkaline; abrupt smooth boundary.

Bt1—4 to 9 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; few thin clay films on faces of peds and in pores; about 5 percent gravel; mildly alkaline; clear smooth boundary.

Bt2—9 to 16 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure; slightly hard, firm, sticky and plastic; common very fine and fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 10 percent gravel; slightly effervescent; mildly alkaline; abrupt smooth boundary.

Btk—16 to 23 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; slightly hard, firm, sticky and slightly plastic; common very fine and few fine roots; common very fine irregular pores; few thin clay films on faces of peds and in pores; about 10 percent gravel; violently effervescent; many medium irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk1—23 to 40 inches; very pale brown (10YR 7/3) cobbly sandy loam, yellowish brown (10YR 5/4) moist; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; about 15 percent cobbles and 20 percent gravel; violently effervescent; weakly cemented in the upper part; many medium irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—40 to 60 inches; very pale brown (10YR 7/4) cobbly sand, dark yellowish brown (10YR 4/4) moist; massive; hard, firm, nonsticky and nonplastic; few very fine and fine roots; common very fine irregular pores; about 15 percent cobbles and 20 percent gravel; violently effervescent; many medium irregular soft masses of calcium carbonate; moderately alkaline.

Depth to the base of the Bt horizon is 19 to 30 inches. The content of rock fragments ranges from 0 to 15 percent in the upper 20 inches and from 25 to 50 percent below that depth. The upper part of the Bk horizon is cobbly sandy loam or very cobbly sandy clay loam.

Techado Series

The soils in the Techado series are classified as clayey, mixed, nonacid, frigid, shallow Typic Ustorthents. These shallow, well drained soils formed in alluvium and colluvium derived dominantly from shale and sandstone. They are on hills, ridges, and mountains. Slope is 5 to 55 percent. Elevation is 7,200 to 8,900 feet. The average annual precipitation is 16 to 22 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Techado channery clay loam, in an area of Valnor-Techado association, 2 to 25 percent slopes; about 5 miles south of Cebollita Peak; 2,375 feet east and 25 feet south of the northwest corner of sec. 19, T. 5 N., R. 9 W.

A—0 to 3 inches; light olive brown (2.5Y 5/4) channery clay loam, olive brown (2.5Y 4/4) moist; strong fine granular structure; soft, friable, sticky and plastic; few very fine and fine roots; common fine irregular pores; about 25 percent channers; neutral; abrupt smooth boundary.

C—3 to 16 inches; light olive brown (2.5Y 5/4) clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; common very fine and few fine, medium, and coarse roots; common very fine irregular pores; about 10 percent channers; neutral; clear smooth boundary.

2Cr—16 inches; soft shale interbedded with sandstone.

The depth to soft shale ranges from 10 to 20 inches. The A horizon is channery or cobbly clay loam. It has hue of 2.5Y or 10YR and value of 4 or 5 (3 or 4 moist). The content of rock fragments in this horizon ranges from 15 to 35 percent, by volume. The C horizon is clay, clay loam, or sandy clay. It has hue of 2.5Y or 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 to 4. The content of rock fragments in this horizon ranges from 0 to 15 percent, by volume.

Teco Series

The soils in the Teco series are classified as fine, mixed, mesic Aridic Haplustalfs. These deep, well drained soils formed in mixed alluvium and wind-modified alluvium. They are on mesas, ridges, and hills and in valleys and swales. Slope is 1 to 10 percent. Elevation is 6,500 to 7,500 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 115 to 135 days.

Typical pedon of Teco fine sandy loam, in an area of Teco-Atarque association, 1 to 8 percent slopes; about 7 miles west of Atarque Lake; 320 feet south and 2,300 feet east of the northwest corner of sec. 2, T. 6 N., R. 20 W.

A1—0 to 4 inches; light brown (7.5YR 6/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; neutral; clear smooth boundary.

A2—4 to 6 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and fine roots; few very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—6 to 9 inches; reddish brown (5YR 4/4) clay loam, reddish brown (5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common very fine and fine roots; few fine tubular pores; few thin clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—9 to 15 inches; reddish brown (5YR 4/4) clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common very fine roots; common fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Btk—15 to 24 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; weak medium subangular blocky structure; hard, firm, sticky and plastic; few very fine roots; few fine tubular pores; slightly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk1—24 to 29 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 5/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; common very fine irregular pores; strongly effervescent; disseminated calcium carbonate and many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk2—29 to 41 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; about 10 percent gravel; violently effervescent; disseminated calcium carbonate and many coarse irregular soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

Bk3—41 to 60 inches; reddish yellow (7.5YR 6/6) gravelly sandy loam, strong brown (7.5YR 5/6)

moist; massive; slightly hard, friable, nonsticky and nonplastic; about 30 percent gravel; strongly effervescent; disseminated calcium carbonate and common coarse irregular soft masses of calcium carbonate; moderately alkaline.

Depth to the Bk horizon is 20 to 40 inches. The A horizon is fine sandy loam, clay loam, or sandy loam. It has hue of 7.5YR or 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 or 4. The Bt horizon is clay loam, clay, or sandy clay. It has hue of 2.5YR to 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 4 to 6. The Bk horizon is clay loam, sandy clay, or sandy clay loam in the fine-earth fraction. It has 5 to 25 percent gravel. It has hue of 2.5YR to 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 4 to 6.

Timhus Series

The soils in the Timhus series are classified as loamy-skeletal over fragmental, mixed, mesic Aridic Ustochrepts. These deep, somewhat excessively drained soils formed in alluvial material and windblown volcanic sediments. They are on cinder cones. Slope is 20 to 50 percent. Elevation is 7,400 to 8,100 feet. The average annual precipitation is 14 to 16 inches. The average annual air temperature is 47 to 49 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Timhus extremely gravelly loam, in an area of Timhus-Bandera association, 20 to 50 percent slopes; on the south side of Cerro American; 1,300 feet west and 100 feet north of the southeast corner of sec. 11, T. 8 N., R. 13 W.

A—0 to 5 inches; yellowish brown (10YR 5/4) extremely gravelly loam, dark yellowish brown (10YR 3/4) moist; moderate fine granular structure; slightly hard, friable, slightly sticky and nonplastic; common fine roots; few fine tubular pores; about 70 percent pebble-sized cinders; neutral; abrupt smooth boundary.

Bk1—5 to 13 inches; yellowish brown (10YR 5/4) very gravelly loam, dark yellowish brown (10YR 3/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common fine and medium roots; common very fine irregular and few fine tubular pores; about 55 percent pebble-sized cinders; slightly effervescent; disseminated calcium carbonate and coatings of calcium carbonate on the underside of cinders; mildly alkaline; clear smooth boundary.

Bk2—13 to 20 inches; light yellowish brown (10YR 6/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; common fine and medium and few coarse roots; common very fine irregular pores; about 50 percent pebble-sized cinders; strongly effervescent; common coarse irregular soft masses of calcium carbonate and coatings of calcium carbonate on cinders; moderately alkaline; abrupt smooth boundary.

Bk3—20 to 29 inches; light yellowish brown (10YR 6/4) extremely gravelly loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable, slightly sticky and nonplastic; few fine, medium, and coarse roots; common very fine irregular pores; about 65 percent pebble-sized cinders; violently effervescent; many coarse irregular soft masses of calcium carbonate and coatings of calcium carbonate on cinders; moderately alkaline; abrupt smooth boundary.

2C—29 to 60 inches; pebble-sized cinders.

The depth to cinders ranges from 20 to 40 inches. The content of cinders in the 2C horizon is 80 percent or more.

Torreon Series

The soils in the Torreon series are classified as fine, montmorillonitic, mesic Aridic Argiustolls. These deep, well drained soils formed in mixed alluvium and colluvium. They are on hills and ridges. Slope is 15 to 35 percent. Elevation is 6,400 to 7,800 feet. The average annual precipitation is 12 to 16 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 100 to 135 days.

Typical pedon of Torreon very cobbly loam, in an area of Torreon-Rock outcrop-Cabezon complex, 15 to 45 percent slopes; about 0.5 mile west of Chicken Mountain; 2,450 feet west and 1,500 feet south of the northeast corner of sec. 18, T. 5 N., R. 4 W.

A—0 to 2 inches; brown (7.5YR 4/2) very cobbly loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; common fine and many very fine roots; common very fine irregular pores; about 5 percent stones, 20 percent cobbles, and 20 percent gravel; neutral; abrupt smooth boundary.

Bt1—2 to 7 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine and very fine roots; few fine and common very fine tubular pores; few moderately thick clay films on faces of peds and in pores; about 5 percent gravel; neutral; clear smooth boundary.

Bt2—7 to 11 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; strong medium subangular blocky structure; hard, firm, very sticky and very plastic; common fine and very fine roots; few fine and common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 5 percent gravel; mildly alkaline; abrupt smooth boundary.

Btk—11 to 25 inches; reddish brown (5YR 5/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium subangular blocky structure; hard, firm, very sticky and very plastic; few fine and very fine roots; few fine and very fine tubular pores; few thin clay films on faces of peds and in pores; about 5 percent gravel; strongly effervescent; few medium irregular soft masses of calcium carbonate; mildly alkaline; clear smooth boundary.

Bk—25 to 60 inches; pinkish white (5YR 8/2) silty clay loam, pinkish gray (5YR 7/2) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few very fine roots; few very fine irregular pores; violently effervescent; many coarse irregular soft masses of calcium carbonate; strongly alkaline.

Trag Series

The soils in the Trag series are classified as fine-loamy, mixed Typic Argiborolls. These deep, well drained soils formed in mixed alluvium and colluvium. They are in valleys and on mountains and benches. Slope is 1 to 30 percent. Elevation is 7,200 to 8,900 feet. The average annual precipitation is 16 to 22 inches. The average annual air temperature is 40 to 46 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Trag loam, 1 to 8 percent slopes; on Mesa Chivato; long. 107 degrees 22 minutes 38 seconds W. and lat. 35 degrees 14 minutes 26 seconds N.

A—0 to 3 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; soft, very friable, slightly sticky and slightly plastic; many fine and very fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—3 to 7 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine and few fine and medium roots; few fine and very fine tubular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—7 to 15 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few medium, fine, and very fine roots; few fine and common very fine tubular pores; common thin clay films on faces of peds and in pores; neutral; abrupt smooth boundary.

Bt3—15 to 24 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; few medium, fine, and very fine roots; few fine and common very fine tubular pores; many moderate thick clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

C1—24 to 36 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; massive; hard, firm, slightly sticky and nonplastic; few fine roots; few very fine irregular pores; about 5 percent gravel; mildly alkaline; gradual smooth boundary.

C2—38 to 60 inches; light brown (7.5YR 6/4) sandy clay loam, brown (7.5YR 4/4) moist; massive; hard, firm, slightly sticky and nonplastic; few fine roots; few fine irregular pores; about 5 percent gravel; mildly alkaline.

The mollic epipedon ranges from 10 to 15 inches in thickness. The content of rock fragments ranges from 0 to 25 percent throughout the profile.

The A horizon is loam or cobbly loam. It has value of 4 or 5 and chroma of 2 or 3. The Bt horizon is clay loam, cobbly sandy clay loam, or sandy clay loam. It has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 2 to 4. The C horizon is cobbly sandy clay loam, sandy clay loam, clay loam, or sandy loam. It has hue of 5YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 4 or 5.

The Trag soil in map unit 276 is a taxadjunct to the series because it has hue of 5YR, and that in map unit 615 is a taxadjunct because it has more than 15 percent gravel in the particle-size control section. These differences, however, do not significantly affect the use and management of the soils.

Valnor Series

The soils in the Valnor series are classified as fine, mixed Mollic Eutroboralfs. These moderately deep, well drained soils formed in alluvium derived dominantly from interbedded shale and sandstone. They are on mesas, hills, and plateaus. Slope is 2 to 7 percent. Elevation is 7,500 to 8,200 feet. The average annual precipitation is 16 to 20 inches. The average annual air temperature is 40 to 45 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Valnor clay loam, in an area of Valnor-Techado association, 2 to 25 percent slopes; 6.5 miles south of Cebollita Peak; 825 feet west and 1,375 feet north of the southeast corner of sec. 26, T. 5 N., R. 10 W.

A—0 to 2 inches; yellowish brown (10YR 5/4) clay loam, dark brown (10YR 3/3) moist; moderate fine granular structure; soft, friable, sticky and plastic; common fine and very fine roots; common very fine irregular pores; neutral; abrupt smooth boundary.

Bt1—2 to 10 inches; dark yellowish brown (10YR 4/6) clay, dark yellowish brown (10YR 4/4) moist; moderate fine subangular blocky structure; hard, firm, sticky and plastic; common fine and very fine roots; few very fine tubular pores; few thin clay films on faces of peds and in pores; neutral; clear smooth boundary.

Bt2—10 to 18 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; strong medium prismatic structure; very hard, very firm, very sticky and very plastic; few fine and common very fine roots; few very fine tubular pores; common moderately thick clay films on faces of peds and in pores; mildly alkaline; abrupt smooth boundary.

Bk—18 to 38 inches; light yellowish brown (10YR 6/4) clay, olive brown (2.5Y 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few fine and very fine roots; few very fine irregular pores; strongly effervescent; few fine irregular seams and filaments of calcium carbonate; moderately alkaline; gradual smooth boundary.

Cr—38 to 60 inches; shale interbedded with weathered sandstone.

Venadito Series

The soils in the Venadito series are classified as very fine, montmorillonitic, mesic Udorthentic Chromusterts. These deep, well drained soils formed in alluvium derived dominantly from shale. They are fans and in valleys. Slope is 0 to 5 percent. Elevation is 6,200 to 7,500 feet. The average annual precipitation is 10 to 14 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 110 to 140 days.

Typical pedon of Venadito clay loam, in an area of Venadito-Teco association, 0 to 10 percent slopes; about 3 miles north of the headquarters of Atarque Ranch; 500 feet east and 175 feet north of the southwest corner of sec. 19, T. 7 N., R. 18 W.

A—0 to 3 inches; reddish brown (2.5YR 4/4) clay loam, reddish brown (5YR 4/4) moist; moderate fine granular structure; soft, friable, sticky and slightly plastic; few very fine, fine, and coarse roots; few very fine irregular pores; vertical cracks 1.5 inches wide; strongly effervescent; moderately alkaline; abrupt smooth boundary.

C1—3 to 35 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine, fine, and coarse roots; few very fine irregular pores; common intersecting slickensides; vertical cracks 0.25 inch wide; strongly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

C2—35 to 60 inches; reddish brown (2.5YR 5/4) clay, reddish brown (2.5YR 4/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few very fine irregular pores; strongly effervescent; disseminated calcium carbonate; moderately alkaline.

The particle-size control section averages more than 60 percent clay. The A horizon is clay loam, sandy clay loam, or silty clay loam. It has hue of 2.5YR or 5YR, value of 3 or 4 dry or moist, and chroma of 4 to 6. The C horizon has hue of 2.5YR or 5YR, value of 3 to 5 dry or moist, and chroma of 3 to 6.

Venadito Variant

The soils in the Venadito Variant are classified as very fine, montmorillonitic, mesic Udic Chromusterts. These moderately deep, well drained soils formed in mixed alluvium. They are on flood plains and alluvial fans and in valleys. Slope is 0 to 1 percent. Elevation is 6,200 to 6,600 feet. The average annual precipitation is 10 to 13 inches. The average annual air temperature is 48 to 53 degrees F, and the frost-free period is 110 to 140 days.

Typical pedon of Venadito Variant clay loam, 0 to 1 percent slopes; about 0.5 mile north of the village of Bluewater; 2,600 feet west and 2,100 feet north of the southeast corner of sec. 15, T. 12 N., R. 11 W.

Ap—0 to 3 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate fine granular structure; slightly hard, firm, sticky and slightly plastic; few very fine and fine roots; common very fine irregular pores; vertical cracks 1 inch wide; strongly effervescent; disseminated calcium carbonate; neutral; abrupt smooth boundary.

C1—3 to 18 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few fine irregular pores; vertical

cracks 0.5 inch wide; common intersecting slickensides; strongly effervescent; disseminated calcium carbonate; neutral; clear smooth boundary.

C2—18 to 35 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; massive; very hard, very firm, very sticky and very plastic; few very fine and fine roots; few fine irregular pores; vertical cracks 0.5 inch wide; strongly effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

2R—35 inches; basalt.

Vessilla Series

The soils in the Vessilla series are classified as loamy, mixed (calcareous), mesic Lithic Ustorthents. These very shallow and shallow, well drained soils formed in eolian material and colluvium derived dominantly from sandstone. They are on hills, ridges, and benches. Slope is 3 to 55 percent. Elevation is 6,500 to 7,500 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 110 to 130 days.

Typical pedon of Vessilla sandy loam, in an area of Laporte-Vessilla complex, 3 to 15 percent slopes; about 2.25 miles east of Pueblitos Ruins; 1,600 feet north and 2,260 feet east of the southwest corner of sec. 28, T. 10 N., R. 13 W.

A—0 to 6 inches; brown (7.5YR 4/4) sandy loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; nonsticky and nonplastic; common fine and very fine roots; common very fine irregular pores; about 5 percent gravel; slightly effervescent; mildly alkaline; clear smooth boundary.

C1—6 to 12 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and common very fine roots; common very fine irregular pores; about 5 percent gravel; slightly effervescent; mildly alkaline; clear smooth boundary.

C2—12 to 18 inches; light brown (7.5YR 6/4) sandy loam, brown (7.5YR 5/4) moist; massive; soft, very friable, nonsticky and nonplastic; common very fine roots; common very fine irregular pores; about 10 percent cobbles; slightly effervescent; mildly alkaline; clear smooth boundary.

2R—18 inches; sandstone.

The depth to bedrock ranges from 6 to 20 inches. The content of rock fragments ranges from 5 to 35 percent in the A and C horizons. The A horizon has value of 4 or 5 (3 or 4 moist) and chroma of 4.

Viuda Series

The soils in the Viuda series are classified as clayey, mixed, mesic Lithic Ustollic Haplargids. These shallow, well drained soils formed in alluvium and windblown sediments. They are on benches, hills, and ridges. Slope is 1 to 10 percent. Elevation is 6,500 to 7,000 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Viuda very cobbly sandy loam, in an area of Viuda-Penistaja-Rock outcrop complex, 1 to 10 percent slopes; about 3.25 miles southwest of Four Corners Windmill; 1,040 feet east and 1,200 feet north of the southwest corner of sec. 10, T. 5 N., R. 12 W.

A—0 to 3 inches; brown (7.5YR 5/4) very cobbly sandy loam, dark brown (7.5YR 3/4) moist; moderate fine granular structure; soft, friable, nonsticky and nonplastic; few medium and fine roots; common very fine irregular pores; about 5 percent stones, 20 percent cobbles, and 15 percent gravel; mildly alkaline; abrupt smooth boundary.

Bt—3 to 10 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; moderate medium prismatic structure parting to strong medium subangular blocky; very hard, firm, sticky and plastic; few medium and common fine roots; common very fine tubular pores; many moderately thick clay films on faces of peds and in pores; about 5 percent cobbles and 5 percent gravel; slightly effervescent; disseminated calcium carbonate; moderately alkaline; clear smooth boundary.

Btk—10 to 16 inches; brown (7.5YR 5/4) clay, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few fine and very fine roots; common very fine tubular pores; common moderately thick clay films on faces of peds and in pores; about 5 percent cobbles and 5 percent gravel; strongly effervescent; disseminated calcium carbonate and few fine irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk—16 to 19 inches; light brown (7.5YR 6/4) cobbly clay loam, brown (7.5YR 5/4) moist; massive; hard, friable, sticky and plastic; few very fine roots; few very fine irregular pores; about 15 percent cobbles; violently effervescent; common medium irregular soft masses of calcium carbonate; moderately alkaline; abrupt smooth boundary.

2R—19 inches; basalt.

The depth to bedrock is 10 to 20 inches.

The A horizon is very cobbly sandy loam or very

cobbly silty clay loam. It has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The content of rock fragments ranges from 35 to 60 percent.

The Bt horizon is clay or sandy clay. It has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 or 4. The content of rock fragments ranges from 5 to 15 percent.

The Bk horizon is clay loam, cobbly clay loam, or sandy clay loam. It has hue of 10YR or 7.5YR. The content of rock fragments ranges from 5 to 20 percent.

Warm Springs Series

The soils in the Warm Springs series are classified as fine-loamy, mixed, mesic Aquic Calciustolls. These deep, somewhat poorly drained soils formed in mixed alluvium and lacustrine material. They are in old lakebeds and on flood plains. Slope is 0 to 2 percent. Elevation is 6,300 to 6,600 feet. The average annual precipitation is 12 to 14 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 115 to 135 days.

Typical pedon of Warm Springs loam, 0 to 2 percent slopes; about 0.5 mile northeast of San Rafael; 760 feet west and 430 feet south of the northeast corner of sec. 10, T. 10 N., R. 10 W.

Ap1—0 to 1 inch; brown (10YR 5/3) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Ap2—1 to 8 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) moist; weak fine granular structure; soft, friable, nonsticky and nonplastic; common very fine and fine roots; common fine irregular pores; violently effervescent; disseminated calcium carbonate; mildly alkaline; abrupt wavy boundary.

Bk1—8 to 12 inches; light brownish gray (10YR 6/2) gravelly sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and few fine roots; common fine irregular pores; about 20 percent gravel; violently effervescent; disseminated calcium carbonate; moderately alkaline; abrupt smooth boundary.

Bk2—12 to 36 inches; very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable, nonsticky and nonplastic; common very fine and fine roots; common fine and few very fine irregular pores; violently effervescent; disseminated calcium carbonate and many coarse irregular soft masses and seams of calcium carbonate; strongly alkaline; abrupt smooth boundary.

Bk3—36 to 44 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; violently effervescent; disseminated calcium carbonate; strongly alkaline; abrupt smooth boundary.

Bk4—44 to 60 inches; light brownish gray (2.5Y 6/2) sandy loam, grayish brown (2.5Y 5/2) moist; massive; slightly hard, friable, nonsticky and nonplastic; few very fine roots; few fine irregular pores; about 10 percent gravel; violently effervescent; disseminated calcium carbonate; strongly alkaline.

Depth to the water table generally is 12 to 30 inches, but it ranges from 10 to 60 inches. The sodium adsorption ratio in the Bk horizon is more than 13, and the calcium carbonate equivalent is more than 25 percent.

Winona Series

The soils in the Winona series are classified as loamy-skeletal, carbonatic, mesic Lithic Ustollic Calciorthids. These shallow and very shallow, well drained soils formed in windblown sediments derived dominantly from limestone. They are on ridges, hills, benches, and mesa breaks. Slope is 3 to 45 percent. Elevation is 5,800 to 6,800 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 49 to 53 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Winona very gravelly loam, in an area of Winona-Rock outcrop complex, 3 to 20 percent slopes; about 5 miles southeast of the headquarters of Harrington Ranch; 630 feet east and 200 feet south of the northwest corner of sec. 6, T. 6 N., R. 3 W.

A—0 to 3 inches; brown (7.5YR 5/4) very gravelly loam, dark yellowish brown (10YR 4/4) moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular pores; about 40 percent gravel and 10 percent cobbles; violently effervescent; disseminated calcium carbonate; mildly alkaline; abrupt smooth boundary.

Bk1—3 to 7 inches; pale brown (10YR 6/3) very cobbly

loam, dark yellowish brown (10YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular and few fine tubular pores; about 20 percent cobbles and 20 percent gravel; violently effervescent; many coarse irregular soft masses of calcium carbonate; mildly alkaline; clear smooth boundary.

Bk2—7 to 10 inches; very pale brown (10YR 7/3) very cobbly loam, pale brown (10YR 6/3) moist; massive; slightly hard, very friable, nonsticky and nonplastic; few fine and very fine roots; few very fine irregular and few fine tubular pores; about 20 percent cobbles and 20 percent gravel; violently effervescent; many coarse irregular soft masses of calcium carbonate; mildly alkaline; abrupt smooth boundary.

2R—10 inches; limestone.

The depth to bedrock ranges from 5 to 20 inches. The content of limestone gravel and cobbles ranges from 35 to 55 percent in the A and Bk horizons.

The A horizon has hue of 7.5YR or 10YR and value of 4 to 6 (3 or 4 moist). The Bk horizon has value of 5 to 7 (4 to 6 moist) and chroma of 3 or 4.

Yankee Series

The soils in the Yankee series are classified as fine, mixed Vertic Argiborolls. These deep, well drained soils formed in mixed alluvium. They are in valleys. Slope is 0 to 3 percent. Elevation is 7,700 to 8,300 feet. The average annual precipitation is 20 to 24 inches. The average annual air temperature is 40 to 44 degrees F, and the frost-free period is 90 to 110 days.

Typical pedon of Yankee silty clay loam, 0 to 3 percent slopes; about 4.25 miles southwest of Page; 200 feet east and 550 feet north of the southwest corner of sec. 18, T. 12 N., R. 15 W.

A—0 to 3 inches; dark reddish brown (5YR 3/2) silty clay loam, dark reddish brown (5YR 2/2) moist; strong very fine granular structure; soft, very friable, sticky and slightly plastic; many very fine roots; common very fine irregular pores; neutral; clear smooth boundary.

Bt1—3 to 11 inches; dark reddish brown (5YR 3/2) silty clay, dark reddish brown (5YR 2/2) moist; strong very fine angular blocky structure; hard, firm, very sticky and plastic; few very fine roots; few very fine tubular pores; vertical cracks 0.5 to 1.0 inch wide; many thick clay films on faces of peds and in pores; mildly alkaline; clear smooth boundary.

Bt2—11 to 28 inches; dark reddish gray (5YR 4/2) silty clay, dark reddish brown (5YR 3/2) moist; strong coarse prismatic structure; hard, firm, very sticky and plastic; few very fine roots; few very fine tubular pores; vertical cracks 0.5 to 1.0 inch wide; many thick clay films on faces of peds and in pores; slightly effervescent; moderately alkaline; gradual smooth boundary.

Bt3—28 to 60 inches; reddish brown (5YR 4/3) silty clay, dark reddish brown (5YR 2/2) moist; strong coarse prismatic structure; hard, firm, very sticky and plastic; few very fine roots; few very fine tubular pores; many thick clay films on faces of peds and in pores; slightly effervescent; moderately alkaline.

The mollic epipedon ranges from 30 to 57 inches in thickness. Vertical cracks 0.5 to 1.0 inch wide extend to a depth of 20 to 30 inches.

The Yankee soils in this survey area receive more precipitation than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Zia Series

The soils in the Zia series are classified as coarse-loamy, mixed (calcareous), mesic Ustic Torriorthents. These deep, well drained soils formed in wind-modified alluvium derived dominantly from sandstone. They are on fan terraces and valley sides. Slope is 3 to 5 percent. Elevation is 6,000 to 6,500 feet. The average annual precipitation is 10 to 12 inches. The average annual air temperature is 48 to 52 degrees F, and the frost-free period is 120 to 140 days.

Typical pedon of Zia fine sandy loam, 3 to 5 percent slopes; about 0.75 mile southwest of Santa Maria Mission; 500 feet north and 2,200 feet east of the southwest corner of sec. 28, T. 10 N., R. 8 W.

Ap—0 to 8 inches; dark yellowish brown (10YR 4/4) fine sandy loam, dark brown (10YR 4/3) moist; weak very fine granular structure; soft, very friable, nonsticky and nonplastic; common very fine and few fine roots; common very fine irregular pores; slightly effervescent; disseminated calcium carbonate; moderately alkaline; gradual wavy boundary.

C1—8 to 47 inches; brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine and fine roots; few very fine irregular pores; slightly effervescent; few fine irregular seams and soft masses of calcium carbonate; moderately alkaline; clear smooth boundary.

C2—47 to 60 inches; yellow (10YR 7/6) fine sandy loam, very pale brown (10YR 7/4) moist; massive; soft, very friable, nonsticky and nonplastic; few very fine roots; few very fine irregular pores; violently effervescent; few fine irregular seams and soft masses of calcium carbonate; moderately alkaline.

The C horizon is fine sandy loam or sandy loam.