APPENDIX A

USACE Control Structure
Marsh Flooding and Head Differential Plots for the Mermentau Lakes Sub-Basin

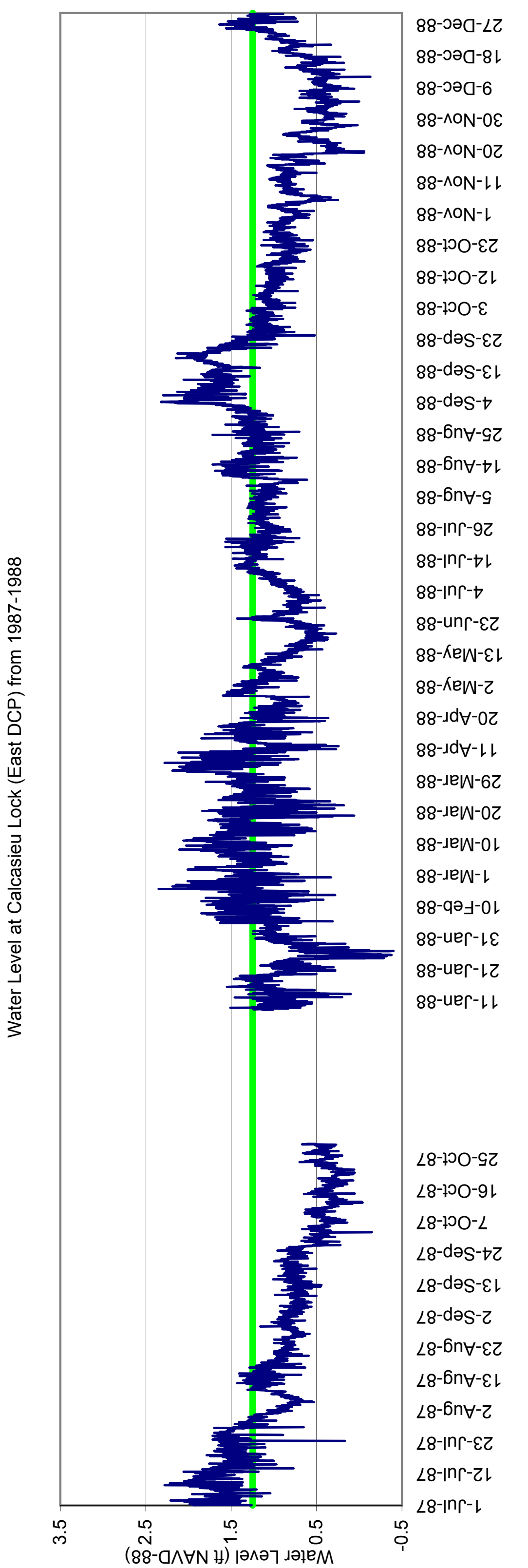
Summary

Since 1987, the U.S. Army Corps of Engineers has maintained Data Collection Platforms (DCPs) that record hourly water levels at both ends of the Calcasieu Lock, Catfish Point Control Structure, Schooner Bayou Control Structure, Leland Bowman Lock, and Freshwater Bayou Lock.

These data were plotted in two formats and are presented here to illustrate marsh flooding regimes and gravity drainage opportunities over the period of record. For clarity, each page covers a two-year time period showing water levels and marsh flooding on the top graph and head differential over the same period on the bottom graph. Local marsh elevation is plotted as a bold line on the top graph of each page. These elevations were determined by survey as described in the main report. The bottom graph illustrates head differential between the interior and exterior DCP for each structure. This information was derived from the difference in simultaneous records from the interior DCP and the exterior DCP. Positive head differentials represent times when gravity drainage is possible through the structure, and indirectly, periods when marsh drainage is possible.

These plots are intended to provide a more detailed depiction of marsh flooding regimes and marsh drainage opportunities at the five USACE lock and control structures.

Calcasieu Lock
1987-2000


Water Level at Calcasieu Lock (East DCP) from 1987-1988
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
1-Jul-87
12-Jul-87
23-Jul-87
2-Aug-87
13-Aug-87
23-Aug-87
2-Sep-87
13-Sep-87
24-Sep-87
7-Oct-87
16-Oct-87
25-Oct-87
11-Jan-88
21-Jan-88
31-Jan-88
10-Feb-88
1-Mar-88
10-Mar-88
20-Mar-88
29-Mar-88
11-Apr-88
20-Apr-88
2-May-88
13-May-88
23-Jun-88
4-Jul-88
14-Jul-88
26-Jul-88
5-Aug-88
14-Aug-88
25-Aug-88
4-Sep-88
13-Sep-88
23-Sep-88
3-Oct-88
12-Oct-88
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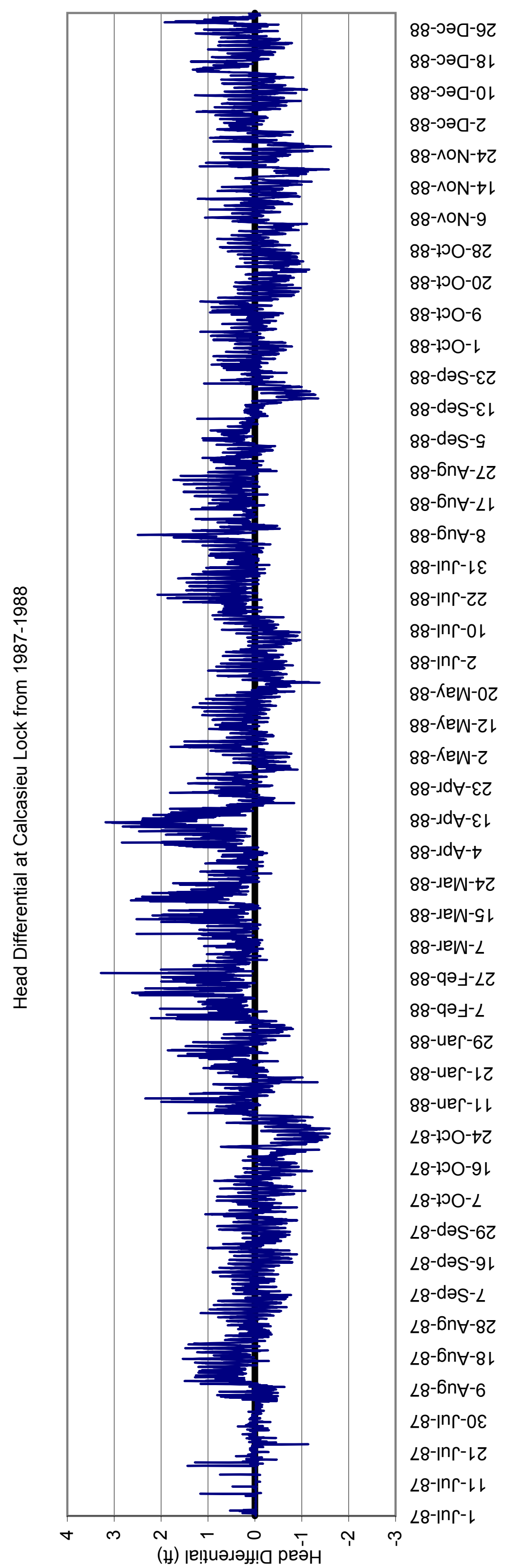
9-Dec-88
18-Dec-88
27-Dec-88


Head Differential at Calcasieu Lock from 1987-1988
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
1-Jul-87
11-Jul-87
21-Jul-87
30-Jul-87
9-Aug-87
18-Aug-87
28-Aug-87
7-Sep-87
16-Sep-87
29-Sep-87
7-Oct-87
16-Oct-87
24-Oct-87
11-Jan-88
21-Jan-88
29-Jan-88
7-Feb-88
27-Feb-88
7-Mar-88
15-Mar-88
24-Mar-88
4-Apr-88
13-Apr-88
23-Apr-88
2-May-88
12-May-88
20-May-88
2-Jul-88
10-Jul-88
22-Jul-88
31-Jul-88
8-Aug-88
17-Aug-88
27-Aug-88
5-Sep-88
13-Sep-88
23-Sep-88
1-Oct-88
9-Oct-88
20-Oct-88
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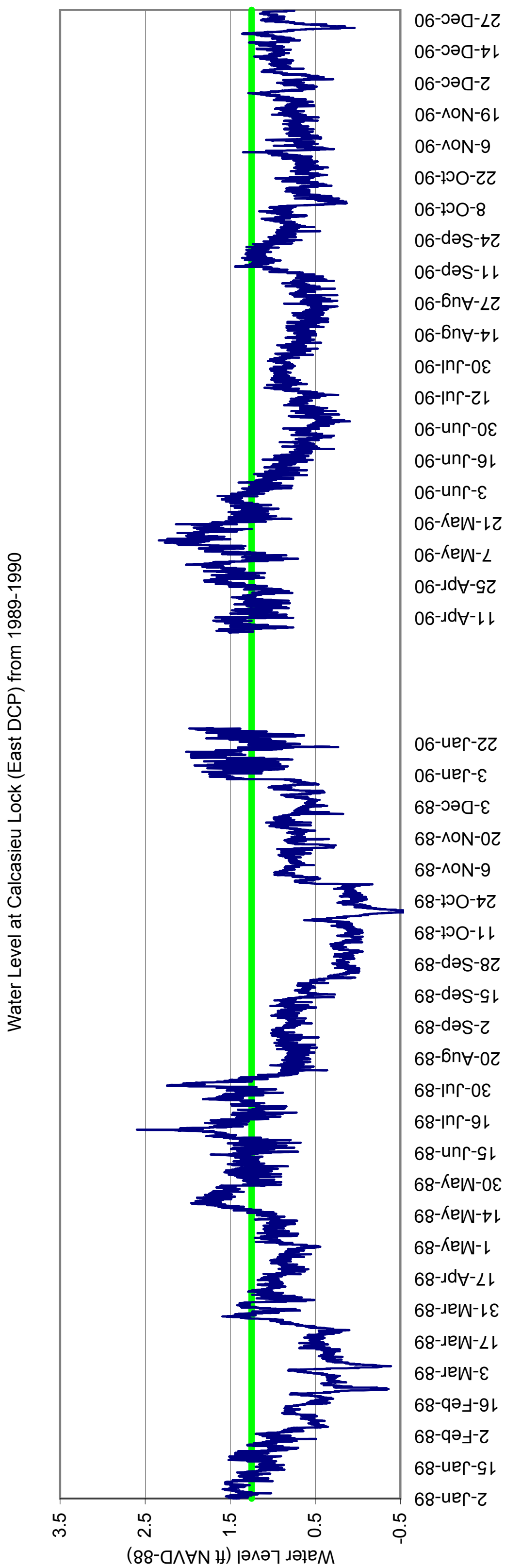
10-Dec-88
18-Dec-88
26-Dec-88


Water Level at Calcasieu Lock (East DCP) from 1989-1990
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
2-Jan-89
15-Jan-89
2-Feb-89
16-Feb-89
3-Mar-89
17-Mar-89
31-Mar-89
17-Apr-89
1-May-89
14-May-89
30-May-89
15-Jun-89
16-Jul-89
30-Jul-89
20-Aug-89
2-Sep-89
15-Sep-89
28-Sep-89
11-Oct-89
24-Oct-89
6-Nov-89
20-Nov-89
3-Dec-89
3-Jan-90
22-Jan-90
11-Apr-90
25-Apr-90
7-May-90
21-May-90
3-Jun-90
16-Jun-90
30-Jun-90
12-Jul-90
30-Jul-90
14-Aug-90
27-Aug-90
11-Sep-90
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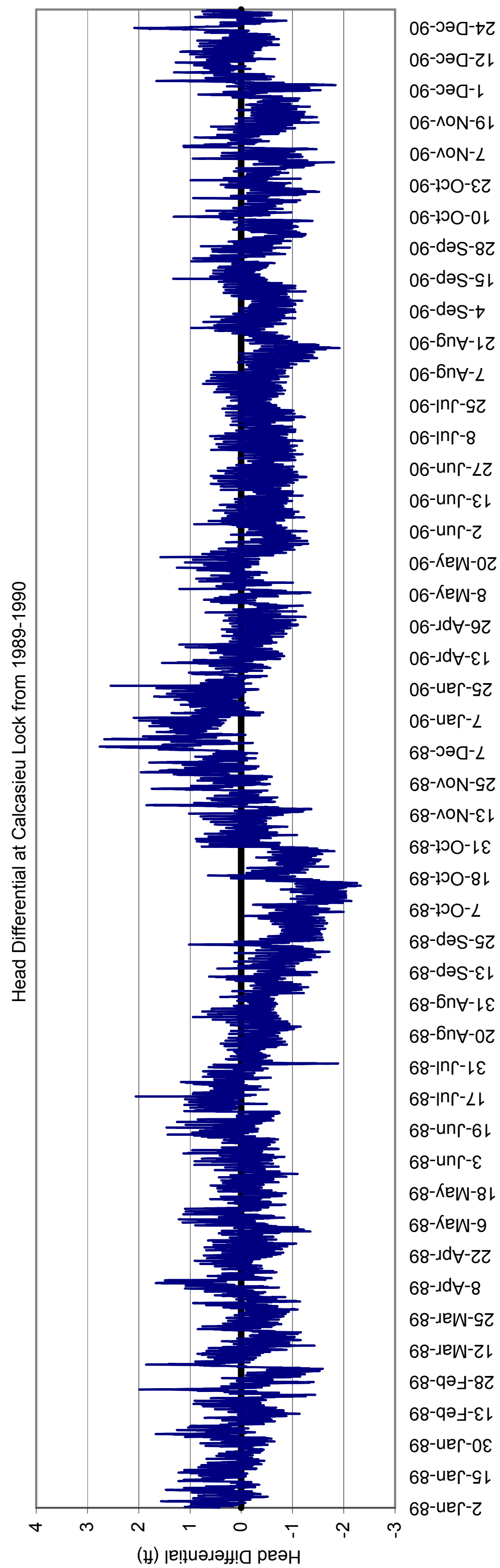
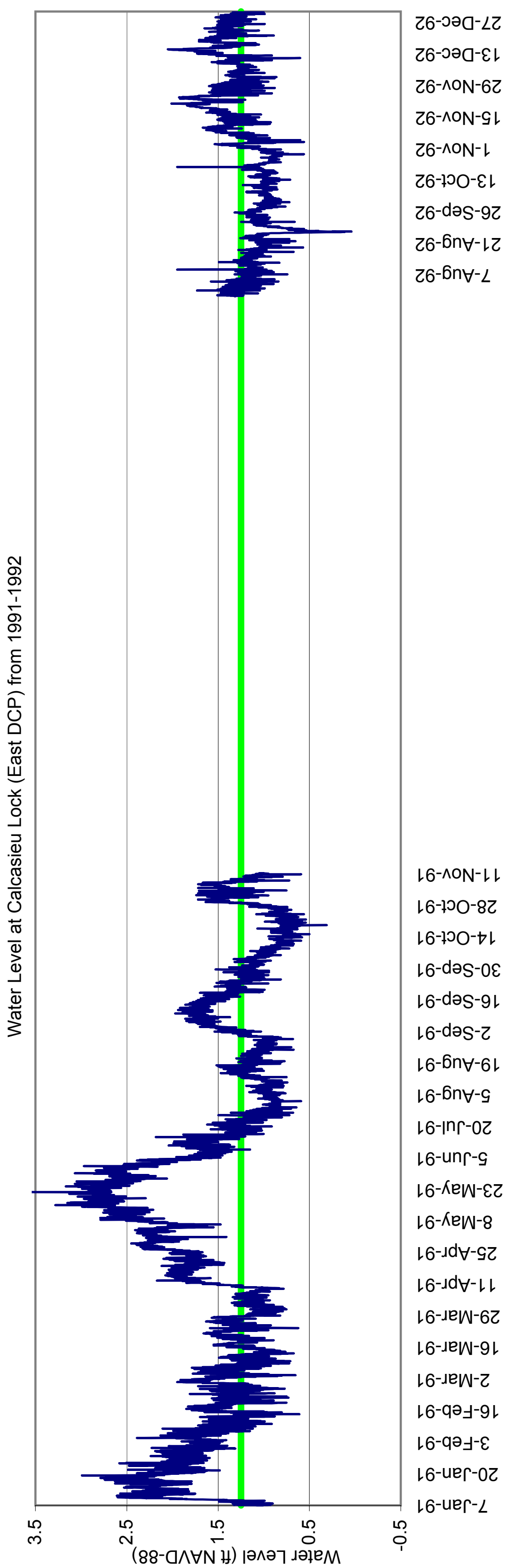
2-Dec-90
14-Dec-90
27-Dec-90


Head Differential at Calcasieu Lock from 1989-1990
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
2-Jan-89
15-Jan-89
30-Jan-89
13-Feb-89
28-Feb-89
12-Mar-89
25-Mar-89
8-Apr-89
22-Apr-89
6-May-89
18-May-89
3-Jun-89
19-Jun-89
17-Jul-89
31-Jul-89
20-Aug-89
31-Aug-89
13-Sep-89
25-Sep-89
7-Oct-89
18-Oct-89
31-Oct-89
13-Nov-89
25-Nov-89
7-Dec-89
7-Jan-90
25-Jan-90
13-Apr-90
26-Apr-90
8-May-90
20-May-90
2-Jun-90
13-Jun-90
27-Jun-90
8-Jul-90
25-Jul-90
7-Aug-90
21-Aug-90
4-Sep-90
15-Sep-90
28-Sep-90
10-Oct-90
23-Oct-90
7-Nov-90
19-Nov-90
1-Dec-90
12-Dec-90
24-Dec-90


Water Level at Calcasieu Lock (East DCP) from 1991-1992
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
7-Jan-91
20-Jan-91
3-Feb-91
16-Feb-91
2-Mar-91
16-Mar-91
29-Mar-91
11-Apr-91
25-Apr-91
8-May-91
23-May-91
5-Jun-91
20-Jul-91
5-Aug-91
19-Aug-91
2-Sep-91
16-Sep-91
30-Sep-91
14-Oct-91
28-Oct-91
11-Nov-91
7-Aug-92
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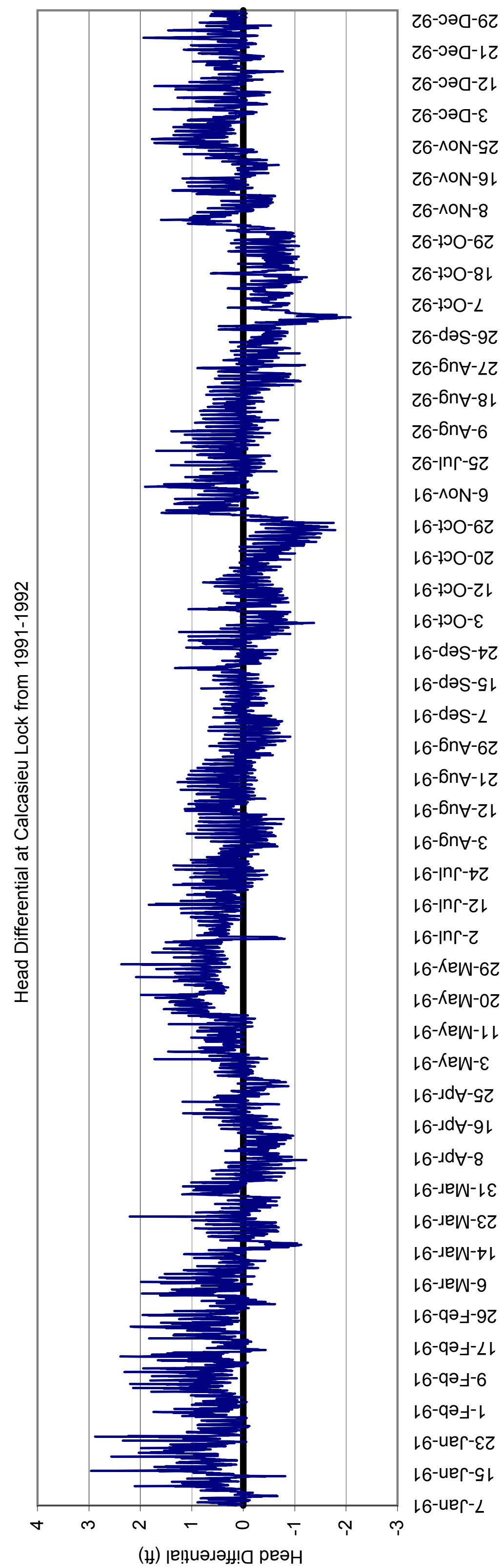
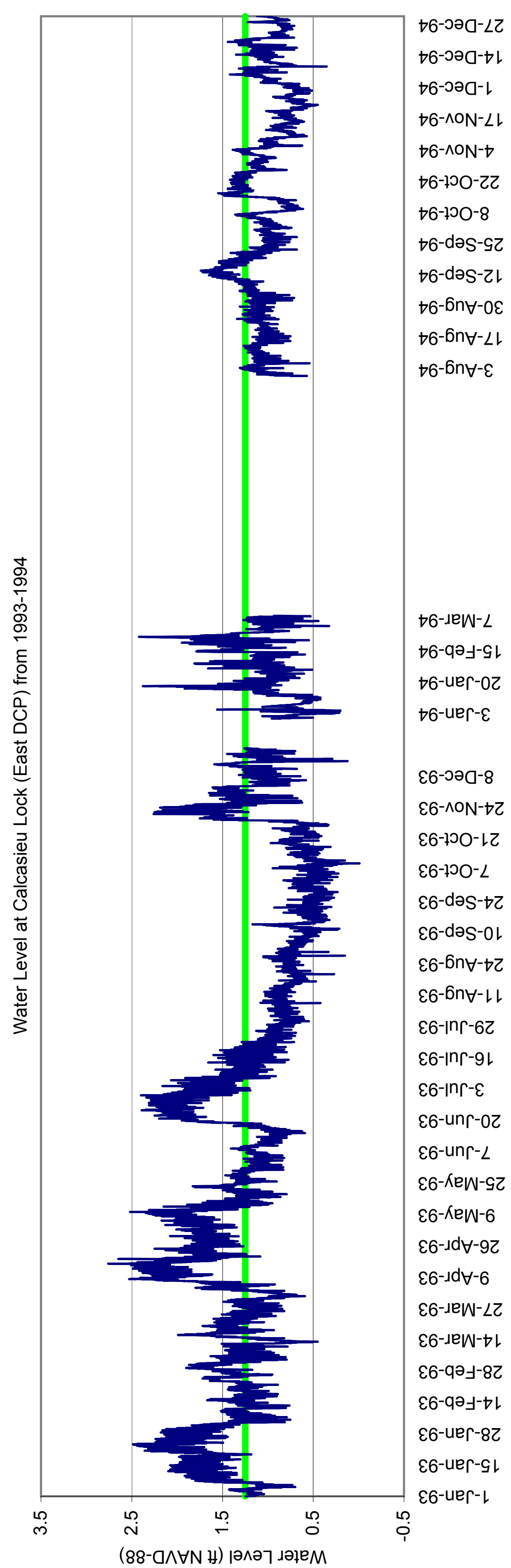
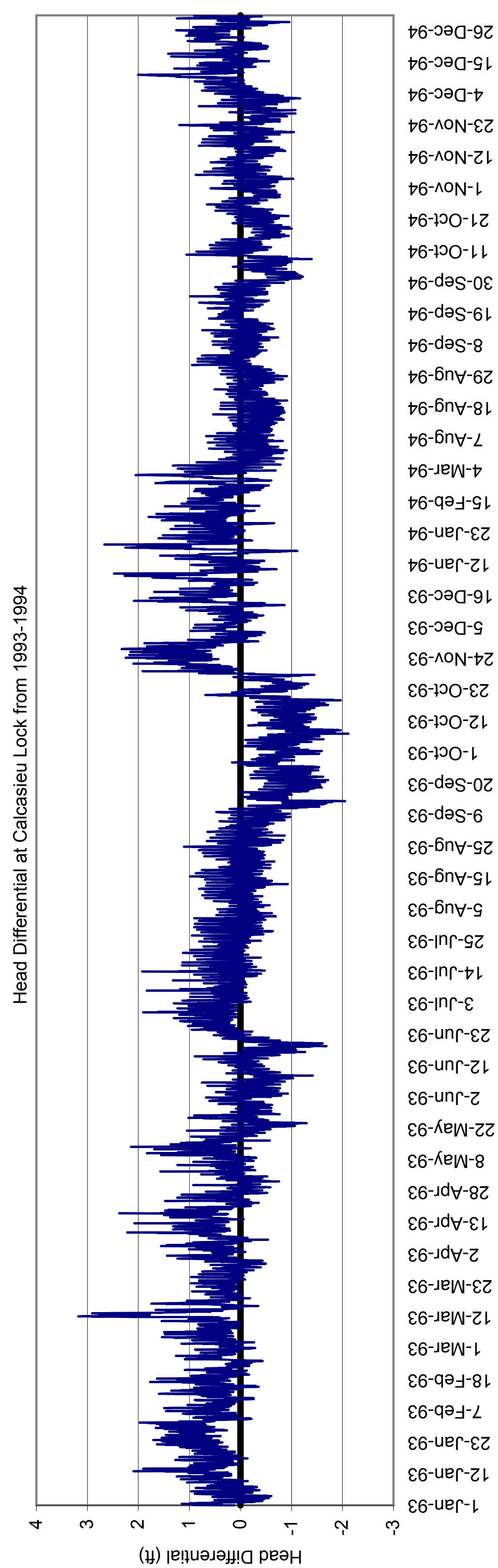
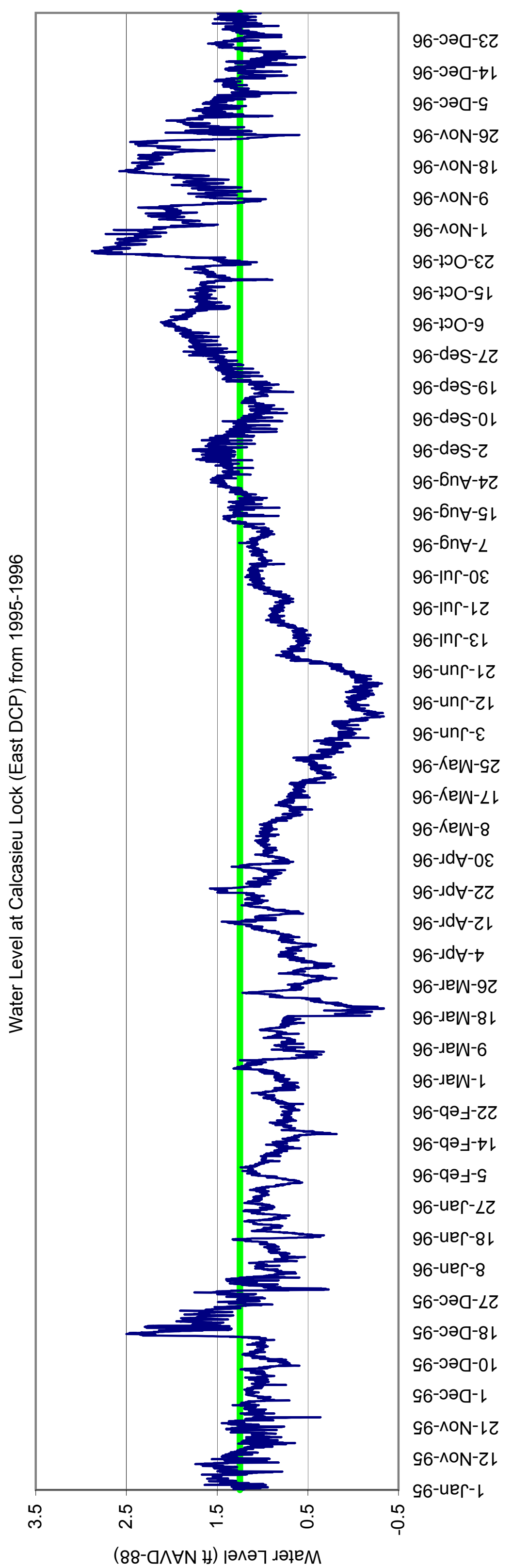
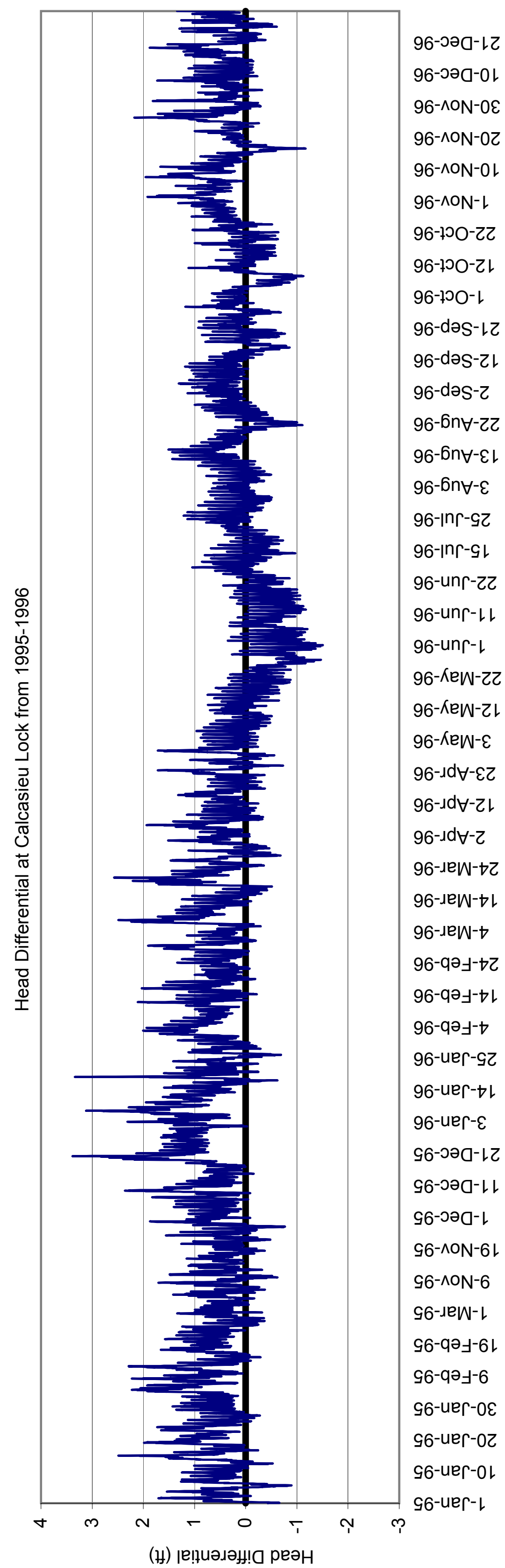
1-Nov-92
15-Nov-92
29-Nov-92
13-Dec-92
27-Dec-92

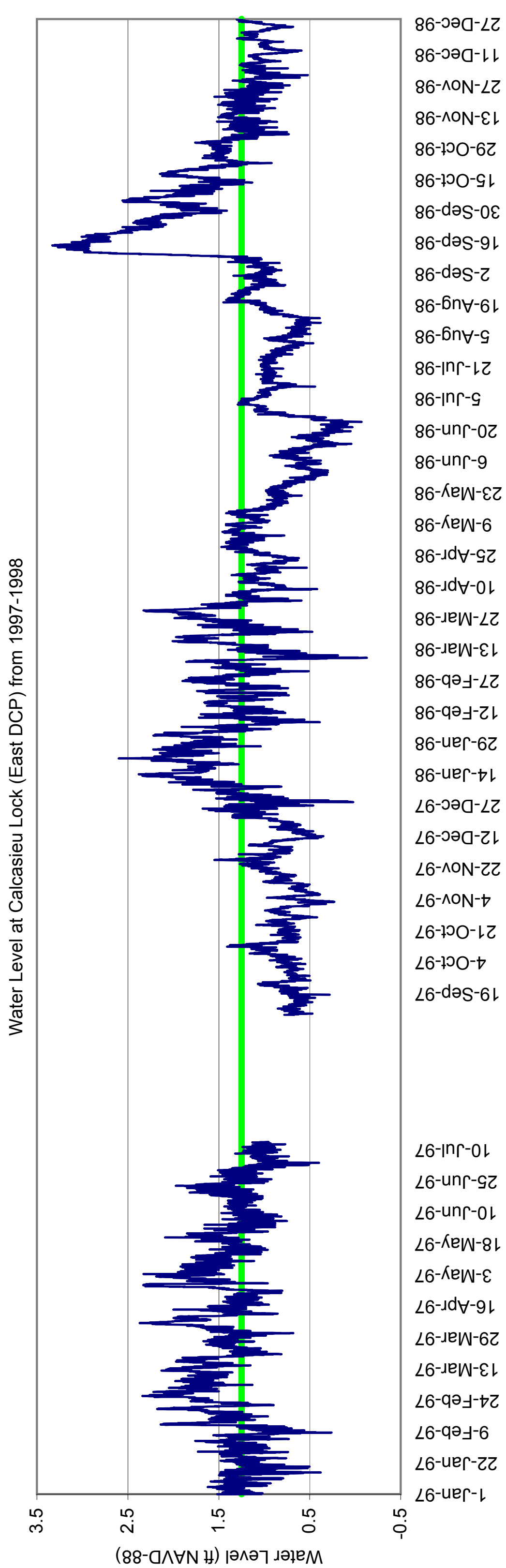

Head Differential at Calcasieu Lock from 1991-1992
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
7-Jan-91
15-Jan-91
23-Jan-91
1-Feb-91
9-Feb-91
17-Feb-91
26-Feb-91
6-Mar-91
14-Mar-91
23-Mar-91
31-Mar-91
8-Apr-91
16-Apr-91
25-Apr-91
3-May-91
11-May-91
20-May-91
29-May-91
2-Jul-91
12-Jul-91
24-Jul-91
3-Aug-91
12-Aug-91
21-Aug-91
29-Aug-91
7-Sep-91
15-Sep-91
24-Sep-91
3-Oct-91
12-Oct-91
20-Oct-91
29-Oct-91
6-Nov-91
25-Jul-92
9-Aug-92
18-Aug-92
27-Aug-92
26-Sep-92
7-Oct-92
18-Oct-92
29-Oct-92
8-Nov-92
16-Nov-92
25-Nov-92
3-Dec-92
12-Dec-92
21-Dec-92
29-Dec-92

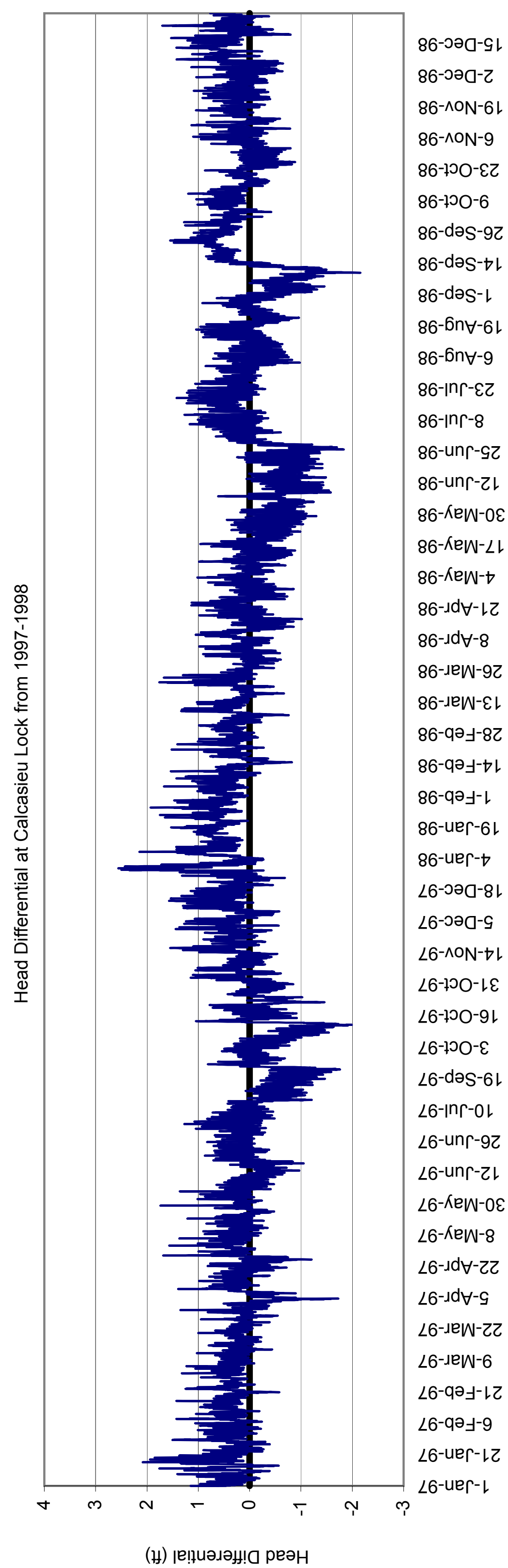

Water Level at Calcasieu Lock (East DCP) from 1993-1994
Water Level (ft NAVD-88)

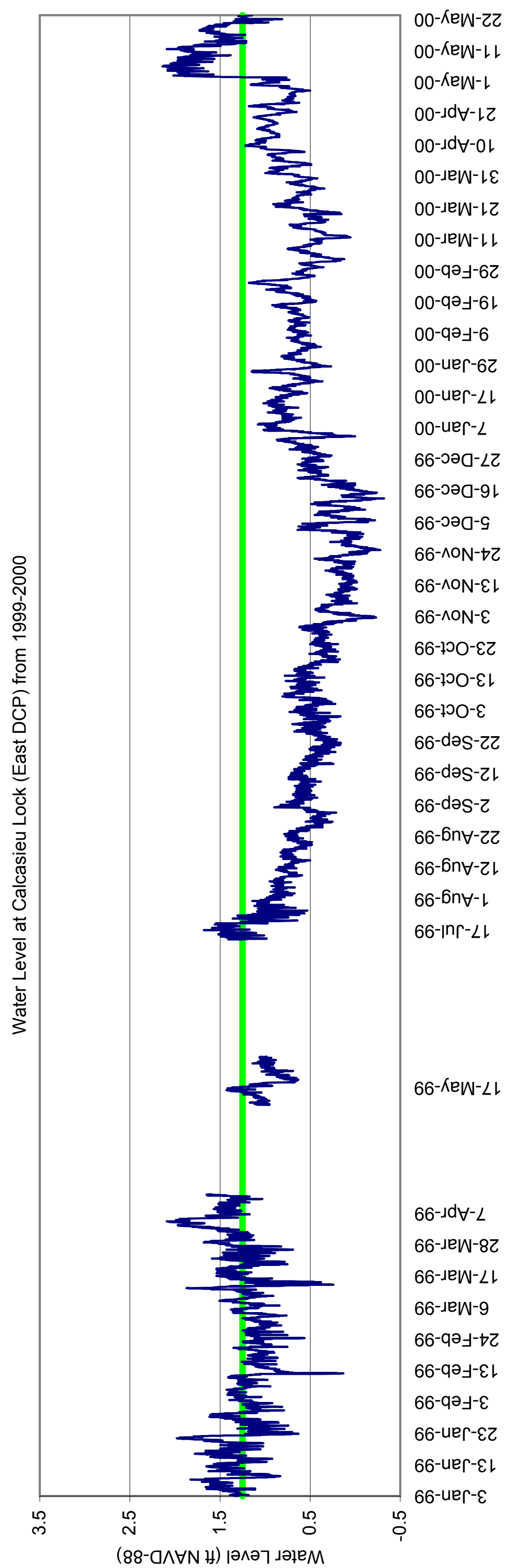

Head Differential at Calcasieu Lock from 1993-1994
Head Differential (ft)


Water Level at Calcasieu Lock (East DCP) from 1995-1996
Water Level (ft NAVD-88)


Head Differential at Calcasieu Lock from 1995-1996
Head Differential (ft)


Water Level at Calcasieu Lock (East DCP) from 1997-1998
Water Level (ft NAVD-88)


Head Differential at Calcasieu Lock from 1997-1998
Head Differential (ft)


Water Level at Calcasieu Lock (East DCP) from 1999-2000
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
3-Jan-99
13-Jan-99
23-Jan-99
3-Feb-99
13-Feb-99
24-Feb-99
6-Mar-99
17-Mar-99
28-Mar-99
7-Apr-99
17-May-99
17-Jul-99
1-Aug-99
12-Aug-99
22-Aug-99
2-Sep-99
12-Sep-99
22-Sep-99
3-Oct-99
13-Oct-99
23-Oct-99
3-Nov-99
13-Nov-99
24-Nov-99
5-Dec-99
16-Dec-99
27-Dec-99
7-Jan-00
17-Jan-00
29-Jan-00
9-Feb-00
19-Feb-00
29-Feb-00
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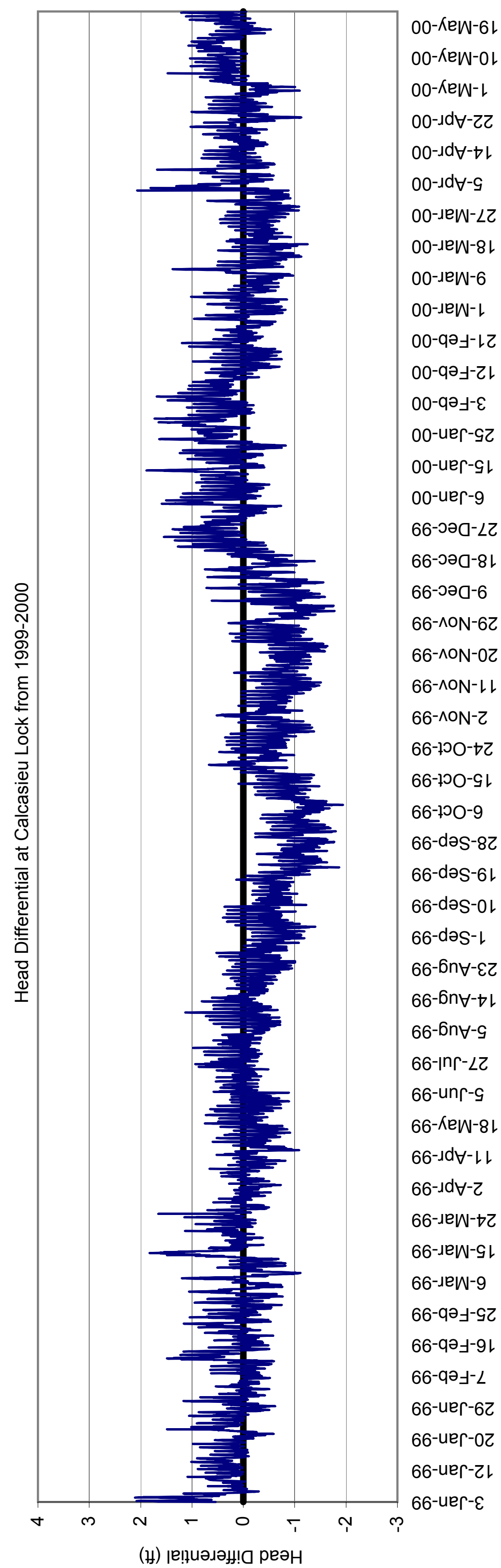
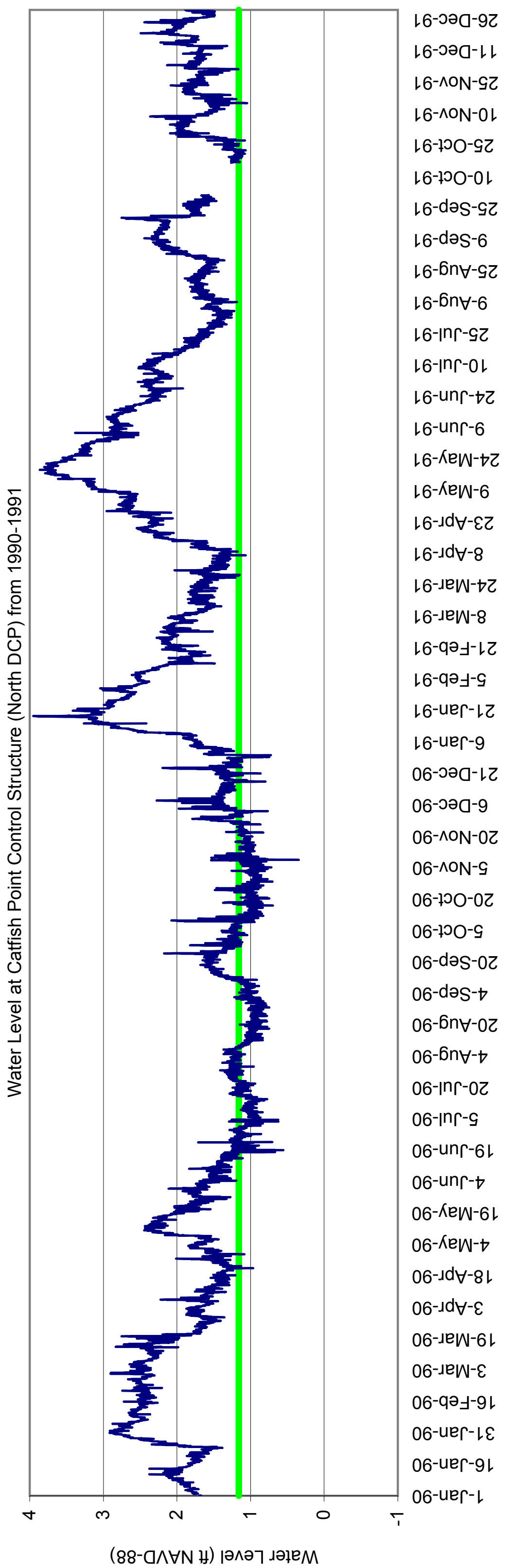
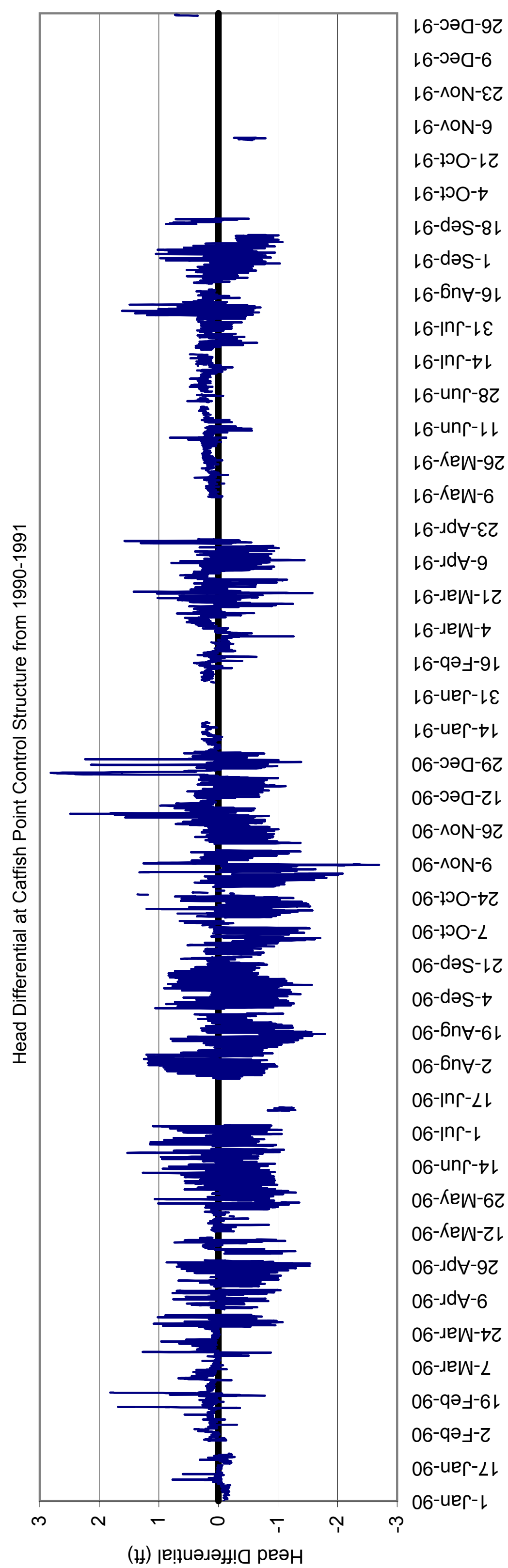
31-Mar-00
10-Apr-00
21-Apr-00
1-May-00
11-May-00
22-May-00


Head Differential at Calcasieu Lock from 1999-2000
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
3-Jan-99
12-Jan-99
20-Jan-99
29-Jan-99
7-Feb-99
16-Feb-99
25-Feb-99
6-Mar-99
15-Mar-99
24-Mar-99
2-Apr-99
11-Apr-99
18-May-99
5-Jun-99
27-Jul-99
5-Aug-99
14-Aug-99
23-Aug-99
1-Sep-99
10-Sep-99
19-Sep-99
28-Sep-99
6-Oct-99
15-Oct-99
24-Oct-99
2-Nov-99
11-Nov-99
20-Nov-99
29-Nov-99
9-Dec-99
18-Dec-99
27-Dec-99
6-Jan-00
15-Jan-00
25-Jan-00
3-Feb-00
12-Feb-00
21-Feb-00
1-Mar-00
9-Mar-00
18-Mar-00
27-Mar-00
5-Apr-00
14-Apr-00
22-Apr-00
1-May-00
10-May-00
19-May-00

Catfish Point Control Structure
1990-2000


Water Level at Catfish Point Control Structure (North DCP) from 1990-1991
Water Level (ft NAVD-88)
4
3
2
1
0
-1
1-Jan-90
16-Jan-90
31-Jan-90
16-Feb-90
3-Mar-90
19-Mar-90
3-Apr-90
18-Apr-90
4-May-90
19-May-90
4-Jun-90
19-Jun-90
5-Jul-90
20-Jul-90
4-Aug-90
20-Aug-90
4-Sep-90
20-Sep-90
5-Oct-90
20-Oct-90
5-Nov-90
20-Nov-90
6-Dec-90
21-Dec-90
6-Jan-91
21-Jan-91
5-Feb-91
21-Feb-91
8-Mar-91
24-Mar-91
8-Apr-91
23-Apr-91
9-May-91
24-May-91
9-Jun-91
24-Jun-91
10-Jul-91
25-Jul-91
9-Aug-91
25-Aug-91
9-Sep-91
25-Sep-91
10-Oct-91
25-Oct-91
10-Nov-91
25-Nov-91
11-Dec-91
26-Dec-91


Head Differential at Catfish Point Control Structure from 1990-1991
Head Differential (ft)
3
2
1
0
-1
-2
-3
1-Jan-90
17-Jan-90
2-Feb-90
19-Feb-90
7-Mar-90
24-Mar-90
9-Apr-90
26-Apr-90
12-May-90
29-May-90
14-Jun-90
1-Jul-90
17-Jul-90
2-Aug-90
19-Aug-90
4-Sep-90
21-Sep-90
7-Oct-90
24-Oct-90
9-Nov-90
26-Nov-90
12-Dec-90
29-Dec-90
14-Jan-91
31-Jan-91
16-Feb-91
4-Mar-91
21-Mar-91
6-Apr-91
23-Apr-91
9-May-91
26-May-91
11-Jun-91
28-Jun-91
14-Jul-91
31-Jul-91
16-Aug-91
1-Sep-91
18-Sep-91
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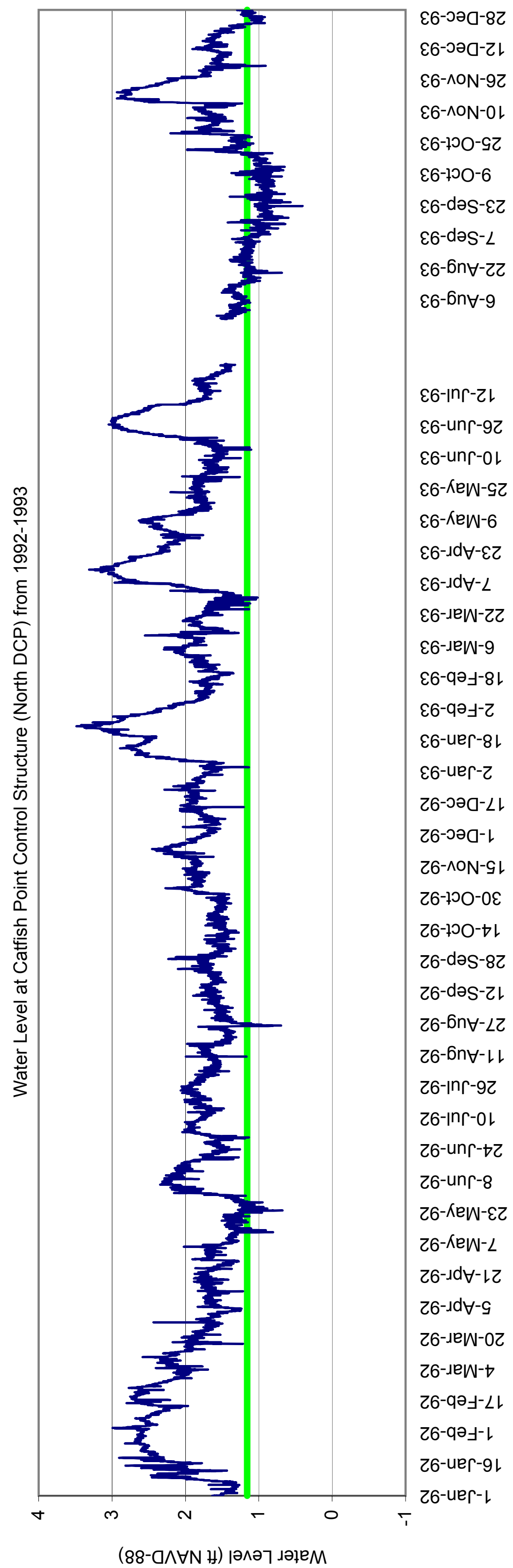
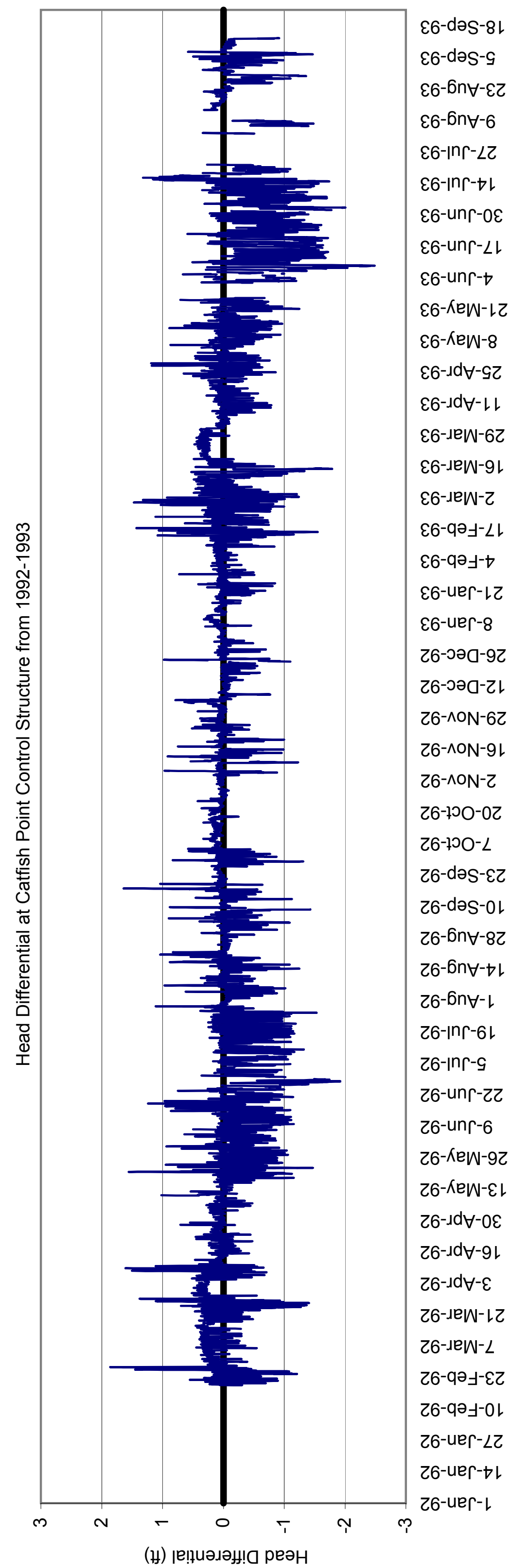
21-Oct-91
6-Nov-91
23-Nov-91
9-Dec-91
26-Dec-91

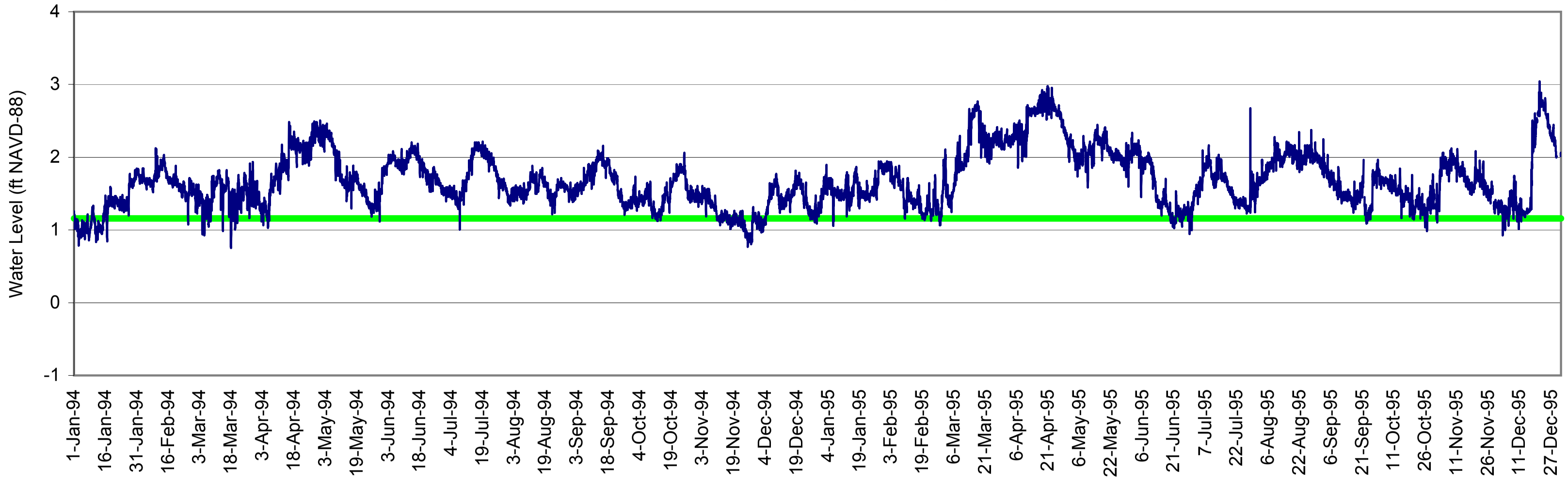


Water Level at Catfish Point Control Structure (North DCP) from 1992-1993
Water Level (ft NAVD-88)

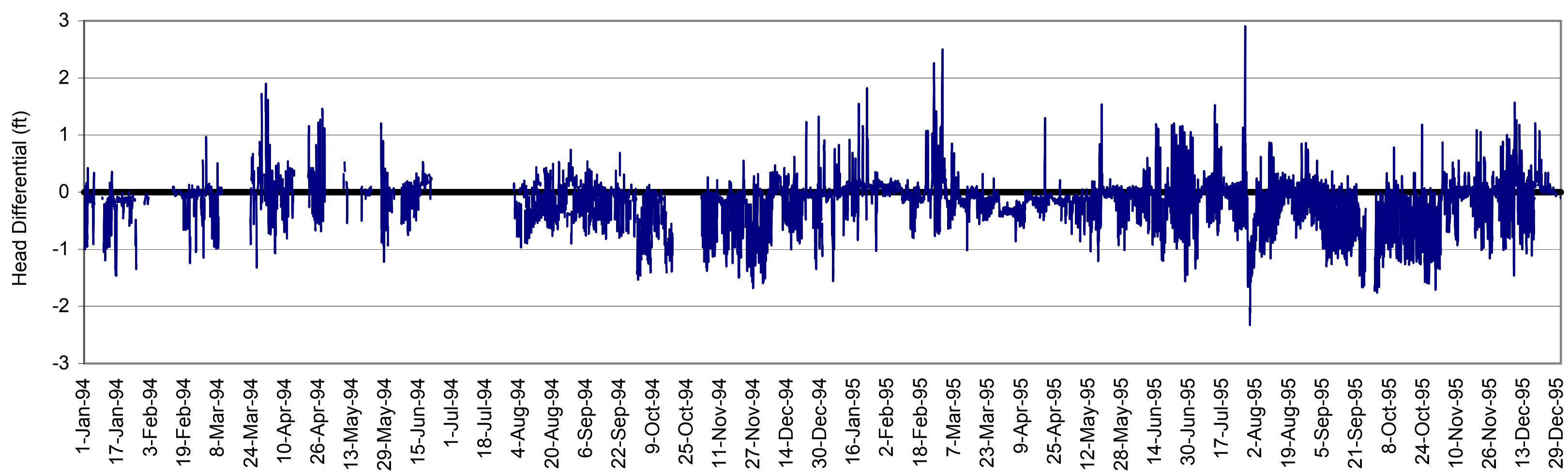


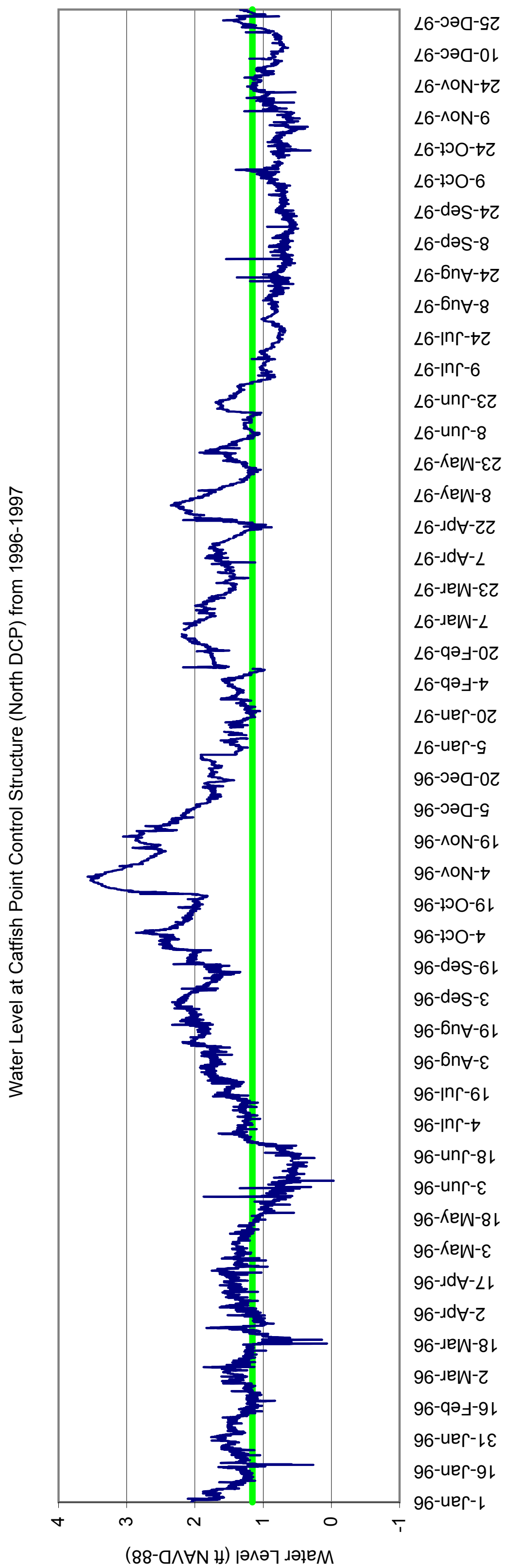
Head Differential at Catfish Point Control Structure from 1992-1993
Head Differential (ft)

Water Level at Catfish Point Control Structure (North DCP) from 1994-1995



Head Differential at Catfish Point Control Structure from 1994-1995




Water Level at Catfish Point Control Structure (North DCP) from 1996-1997
Water Level (ft NAVD-88)
4
3
2
1
0
-1
1-Jan-96
16-Jan-96
31-Jan-96
16-Feb-96
2-Mar-96
18-Mar-96
2-Apr-96
17-Apr-96
3-May-96
18-May-96
3-Jun-96
18-Jun-96
4-Jul-96
19-Jul-96
3-Aug-96
19-Aug-96
3-Sep-96
19-Sep-96
4-Oct-96
19-Oct-96
4-Nov-96
19-Nov-96
5-Dec-96
20-Dec-96
5-Jan-97
20-Jan-97
4-Feb-97
20-Feb-97
7-Mar-97
23-Mar-97
7-Apr-97
22-Apr-97
8-May-97
23-May-97
8-Jun-97
23-Jun-97
9-Jul-97
24-Jul-97
8-Aug-97
24-Aug-97
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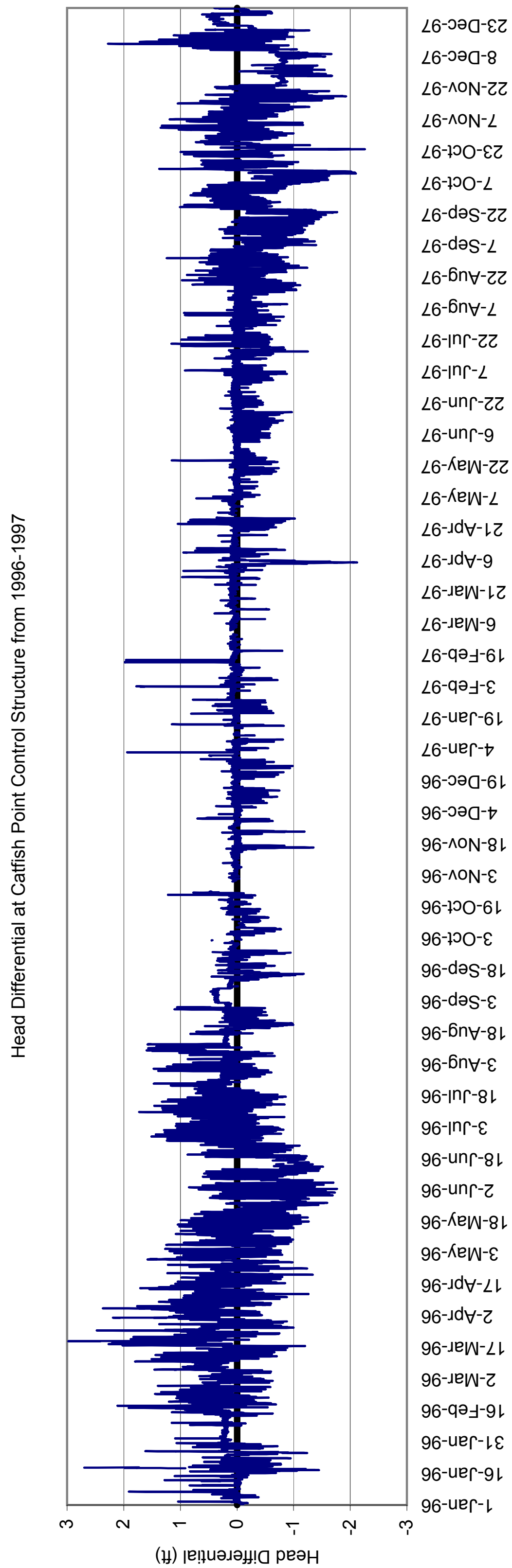
9-Nov-97
24-Nov-97
10-Dec-97
25-Dec-97


Head Differential at Catfish Point Control Structure from 1996-1997
Head Differential (ft)
3
2
1
0
-1
-2
-3
1-Jan-96
16-Jan-96
31-Jan-96
16-Feb-96
2-Mar-96
17-Mar-96
2-Apr-96
17-Apr-96
3-May-96
18-May-96
2-Jun-96
18-Jun-96
3-Jul-96
18-Jul-96
3-Aug-96
18-Aug-96
3-Sep-96
18-Sep-96
3-Oct-96
19-Oct-96
3-Nov-96
18-Nov-96
4-Dec-96
19-Dec-96
4-Jan-97
19-Jan-97
3-Feb-97
19-Feb-97
6-Mar-97
21-Mar-97
6-Apr-97
21-Apr-97
7-May-97
22-May-97
6-Jun-97
22-Jun-97
7-Jul-97
22-Jul-97
7-Aug-97
22-Aug-97
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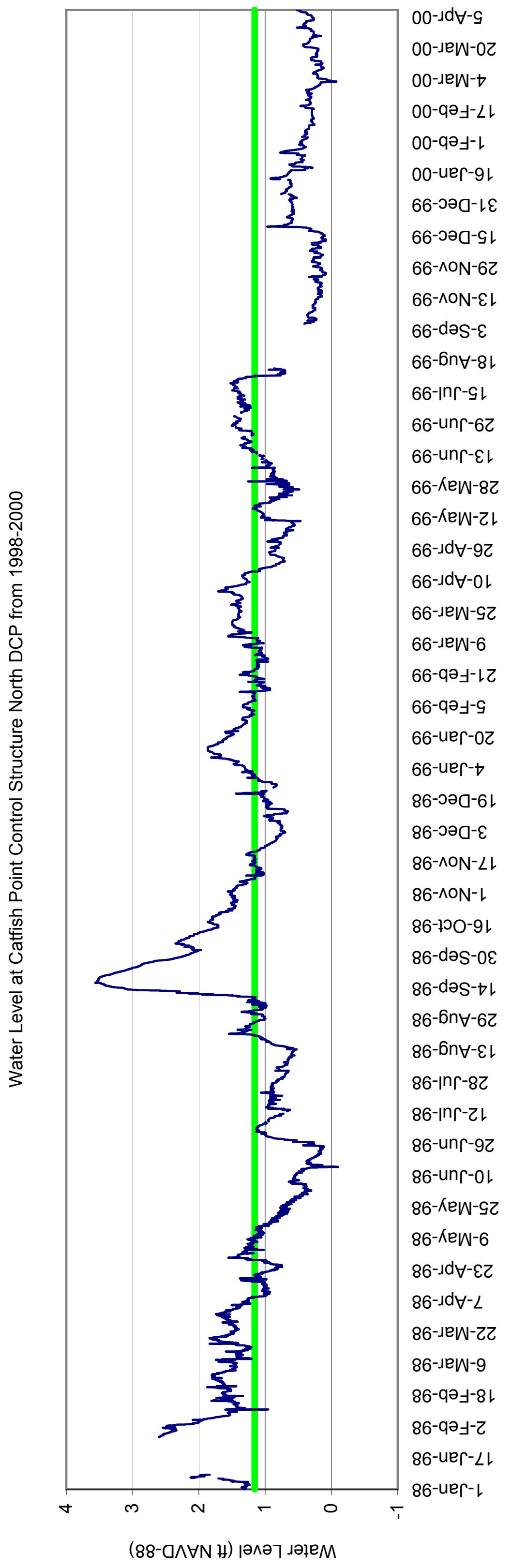
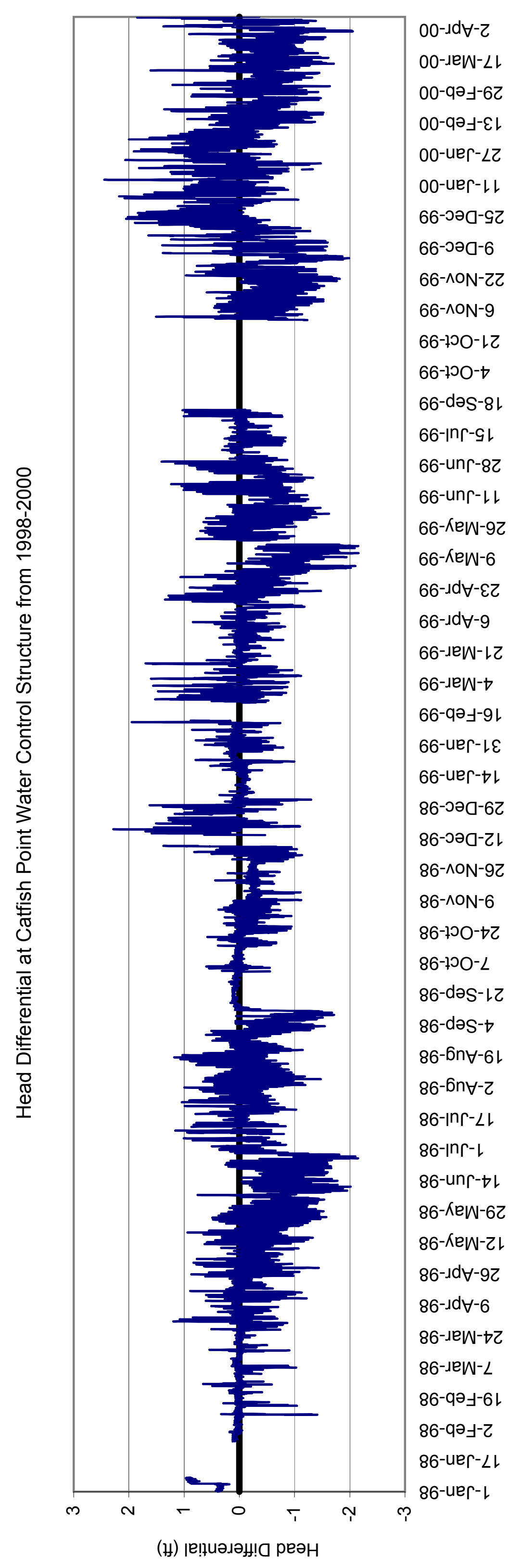
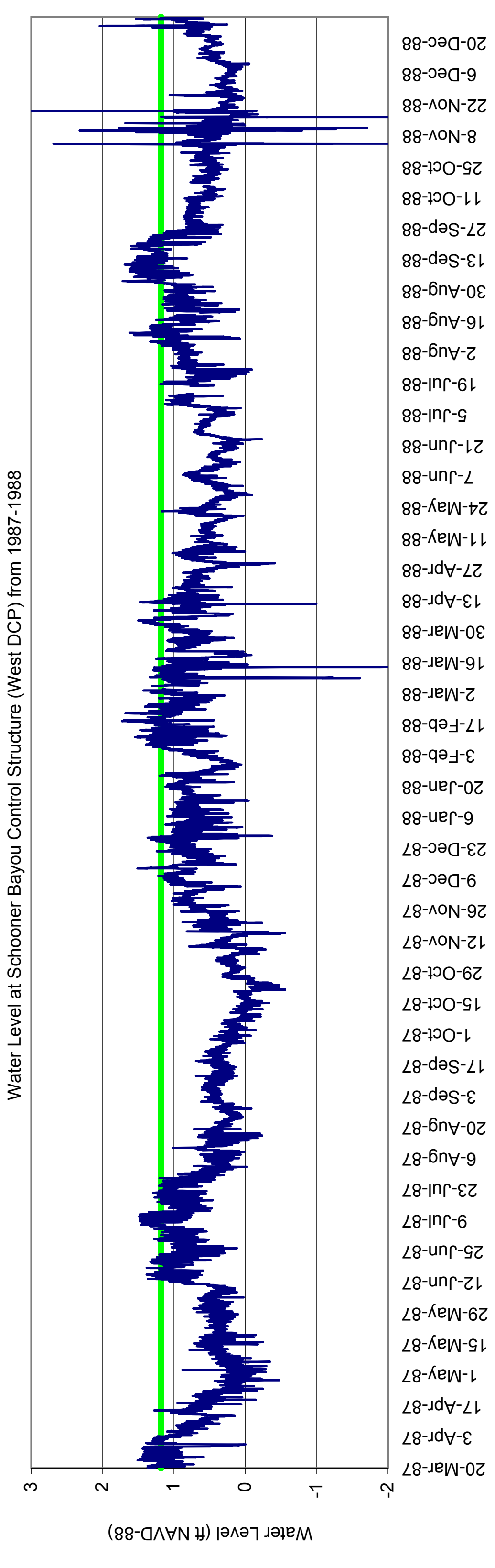
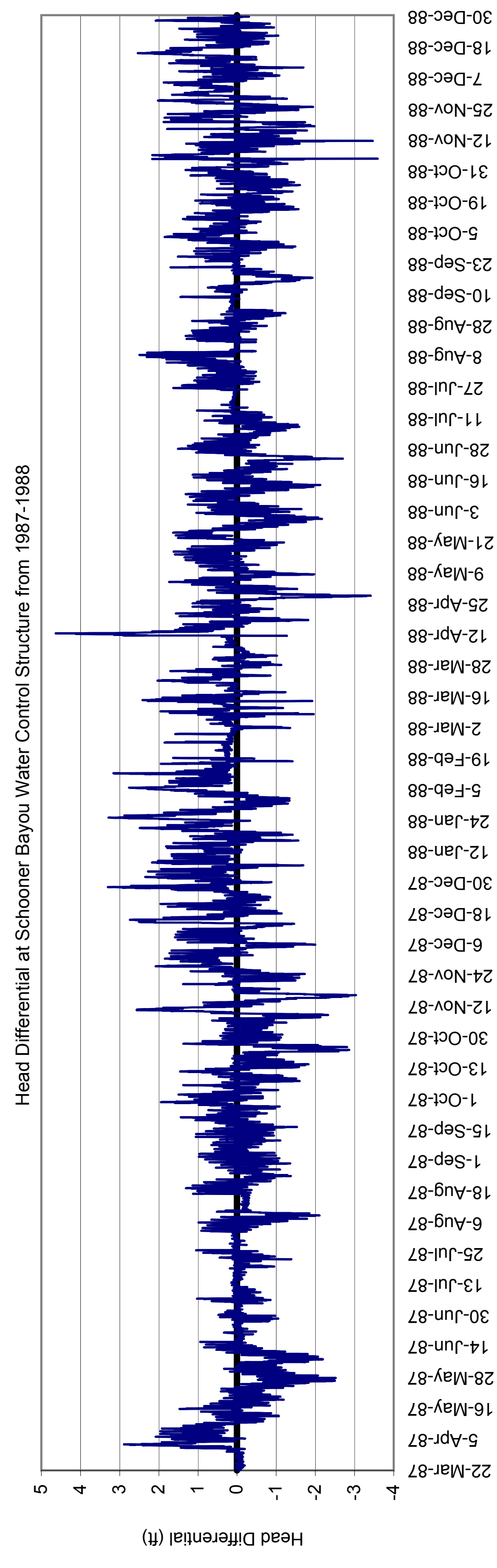
23-Oct-97
7-Nov-97
22-Nov-97
8-Dec-97
23-Dec-97

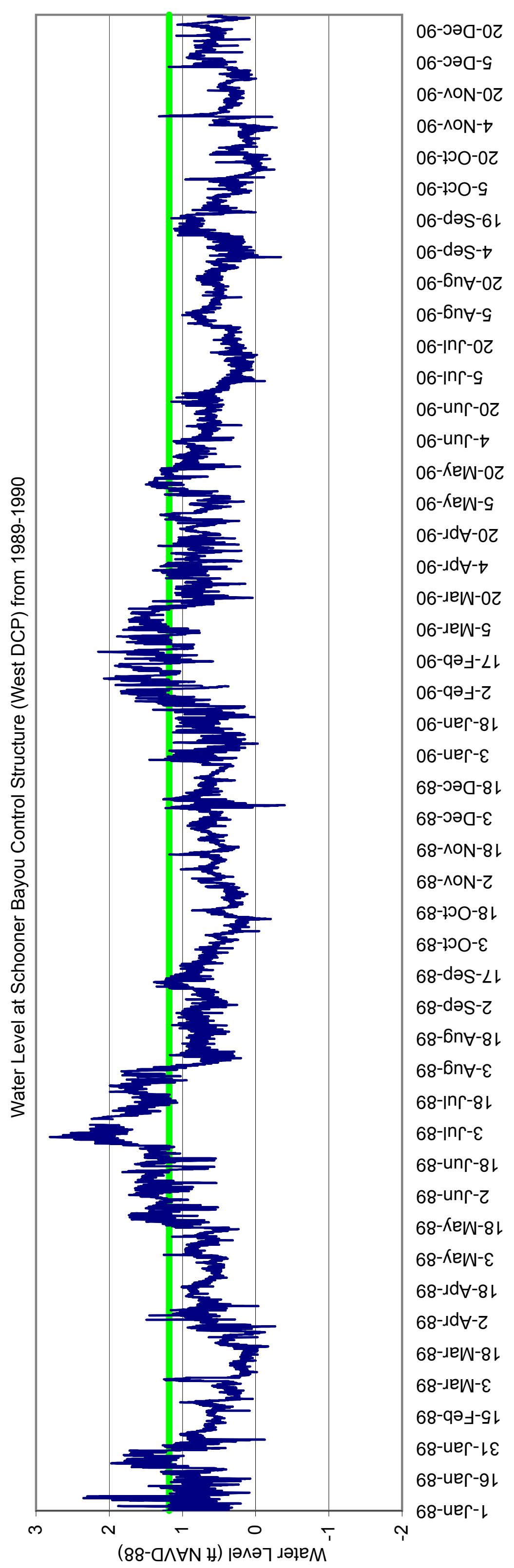

Water Level at Catfish Point Control Structure North DCP from 1998-2000
Water Level (ft NAVD-88)

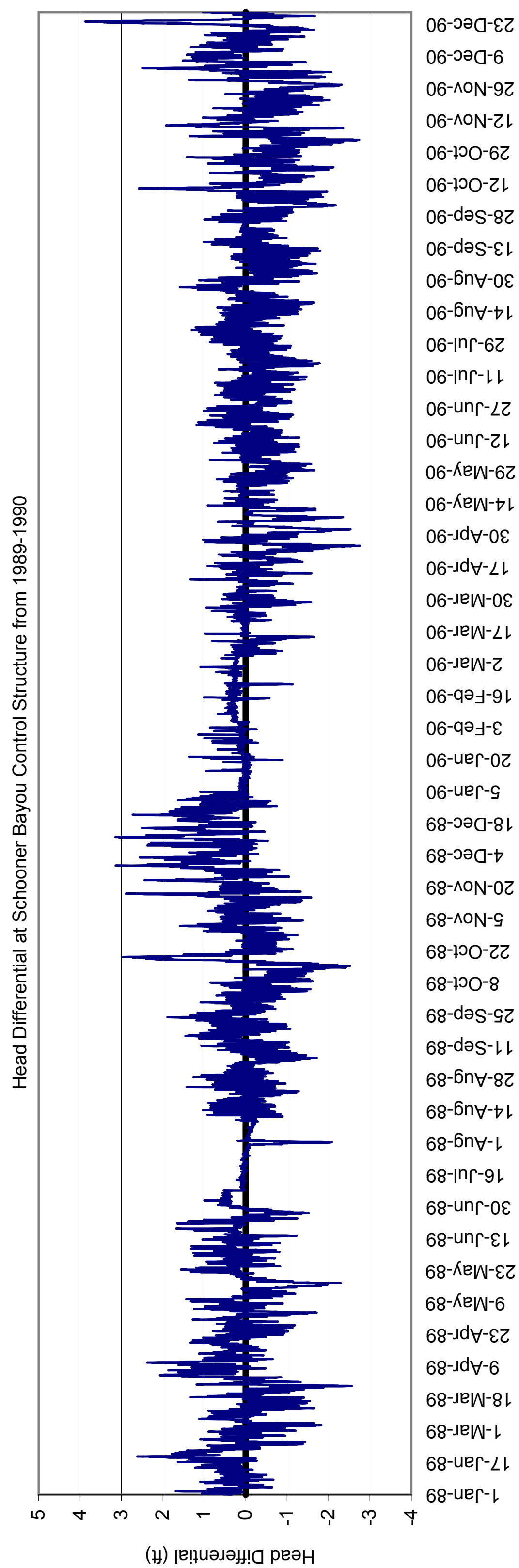

Head Differential at Catfish Point Water Control Structure from 1998-2000
Head Differential (ft)

Schooner Bayou Control Structure 1987-2000


Water Level at Schooner Bayou Control Structure (West DCP) from 1987-1988
Water Level (ft NAVD-88)
3
2
1
0
-1
-2
20-Mar-87
3-Apr-87
17-Apr-87
1-May-87
15-May-87
29-May-87
12-Jun-87
25-Jun-87
9-Jul-87
23-Jul-87
6-Aug-87
20-Aug-87
3-Sep-87
17-Sep-87
1-Oct-87
15-Oct-87
29-Oct-87
12-Nov-87
26-Nov-87
9-Dec-87
23-Dec-87
6-Jan-88
20-Jan-88
3-Feb-88
17-Feb-88
2-Mar-88
16-Mar-88
30-Mar-88
13-Apr-88
27-Apr-88
11-May-88
24-May-88
7-Jun-88
21-Jun-88
5-Jul-88
19-Jul-88
2-Aug-88
16-Aug-88
30-Aug-88
13-Sep-88
27-Sep-88
11-Oct-88
25-Oct-88
8-Nov-88
22-Nov-88
6-Dec-88
20-Dec-88


Head Differential at Schooner Bayou Water Control Structure from 1987-1988
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
22-Mar-87
5-Apr-87
16-May-87
28-May-87
14-Jun-87
30-Jun-87
13-Jul-87
25-Jul-87
6-Aug-87
18-Aug-87
1-Sep-87
15-Sep-87
1-Oct-87
13-Oct-87
30-Oct-87
12-Nov-87
24-Nov-87
6-Dec-87
18-Dec-87
30-Dec-87
12-Jan-88
24-Jan-88
5-Feb-88
19-Feb-88
2-Mar-88
16-Mar-88
28-Mar-88
12-Apr-88
25-Apr-88
9-May-88
21-May-88
3-Jun-88
16-Jun-88
28-Jun-88
11-Jul-88
27-Jul-88
8-Aug-88
28-Aug-88
10-Sep-88
23-Sep-88
5-Oct-88
19-Oct-88
31-Oct-88
12-Nov-88
25-Nov-88
7-Dec-88
18-Dec-88
30-Dec-88


Water Level at Schooner Bayou Control Structure (West DCP) from 1989-1990
Water Level (ft NAVD-88)
3
2
1
0
-1
-2
1-Jan-89
16-Jan-89
31-Jan-89
15-Feb-89
3-Mar-89
18-Mar-89
2-Apr-89
18-Apr-89
3-May-89
18-May-89
2-Jun-89
18-Jun-89
3-Jul-89
18-Jul-89
3-Aug-89
18-Aug-89
2-Sep-89
17-Sep-89
3-Oct-89
18-Oct-89
2-Nov-89
18-Nov-89
3-Dec-89
18-Dec-89
3-Jan-90
18-Jan-90
2-Feb-90
17-Feb-90
5-Mar-90
20-Mar-90
4-Apr-90
20-Apr-90
5-May-90
20-May-90
4-Jun-90
20-Jun-90
5-Jul-90
20-Jul-90
5-Aug-90
20-Aug-90
4-Sep-90
19-Sep-90
5-Oct-90
20-Oct-90
4-Nov-90
20-Nov-90
5-Dec-90
20-Dec-90


Head Differential at Schooner Bayou Control Structure from 1989-1990
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
1-Jan-89
17-Jan-89
1-Mar-89
18-Mar-89
9-Apr-89
23-Apr-89
9-May-89
23-May-89
13-Jun-89
30-Jun-89
16-Jul-89
1-Aug-89
14-Aug-89
28-Aug-89
11-Sep-89
25-Sep-89
8-Oct-89
22-Oct-89
5-Nov-89
20-Nov-89
4-Dec-89
18-Dec-89
5-Jan-90
20-Jan-90
3-Feb-90
16-Feb-90
2-Mar-90
17-Mar-90
30-Mar-90
17-Apr-90
30-Apr-90
14-May-90
29-May-90
12-Jun-90
27-Jun-90
11-Jul-90
29-Jul-90
14-Aug-90
30-Aug-90
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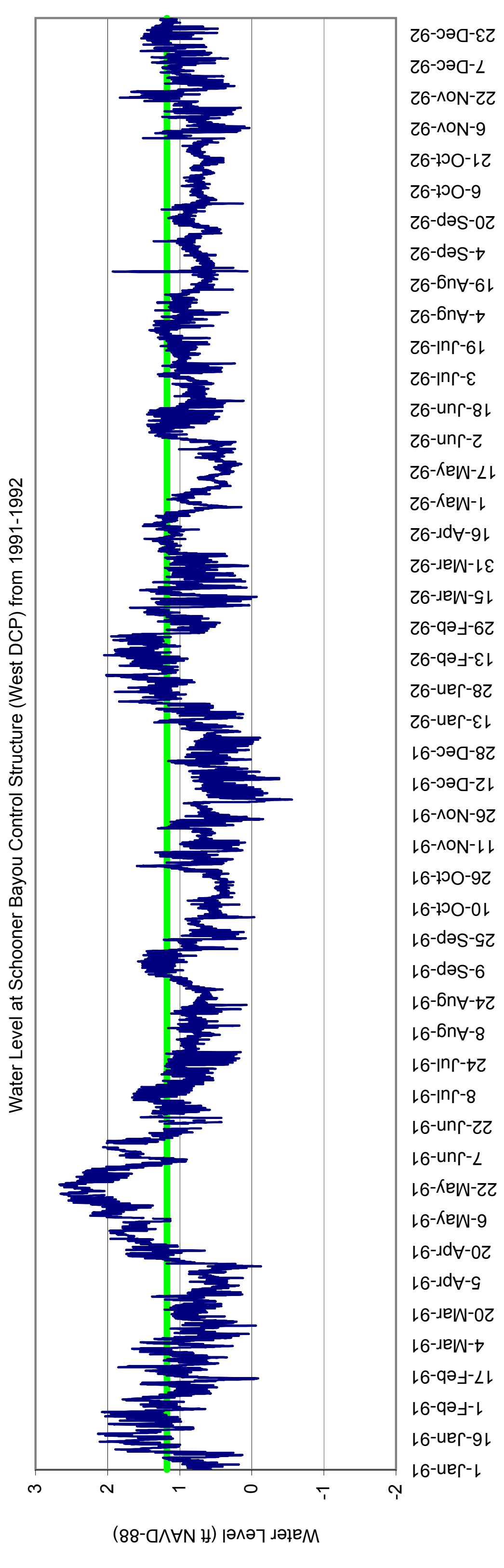
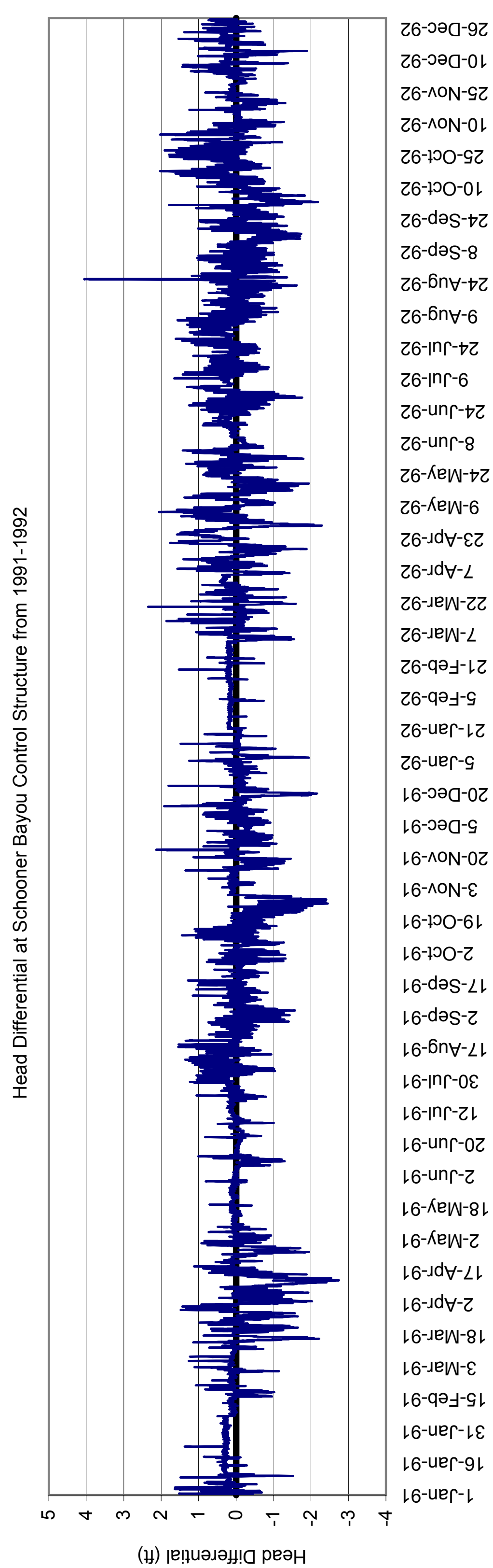
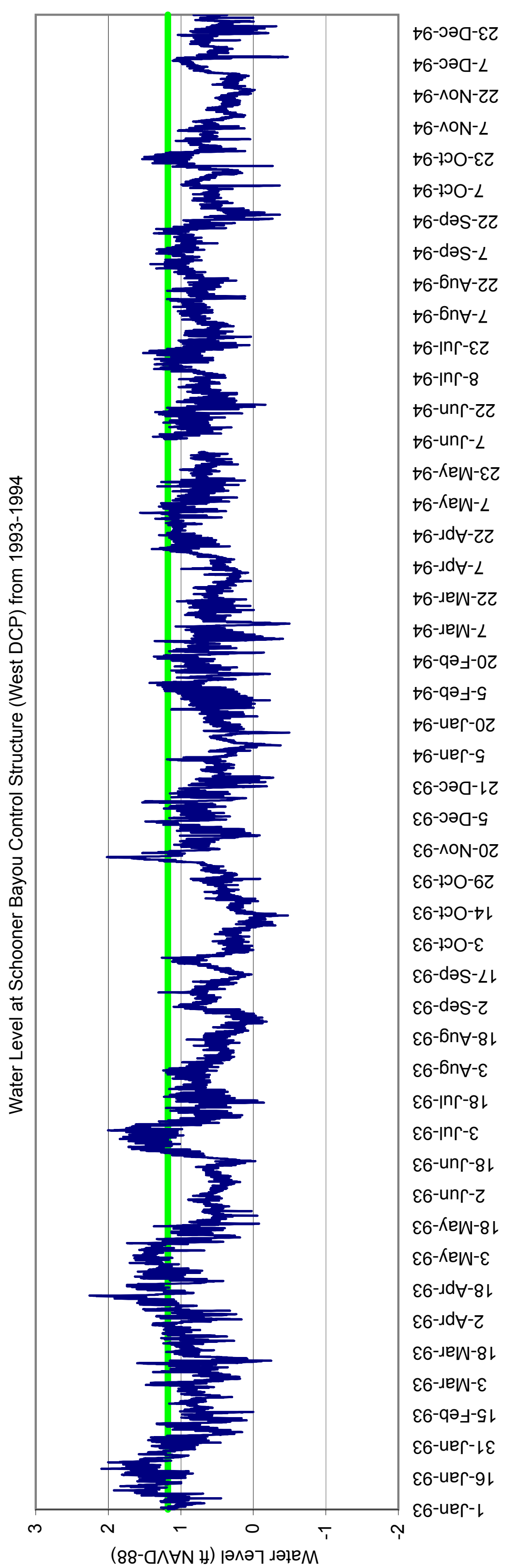
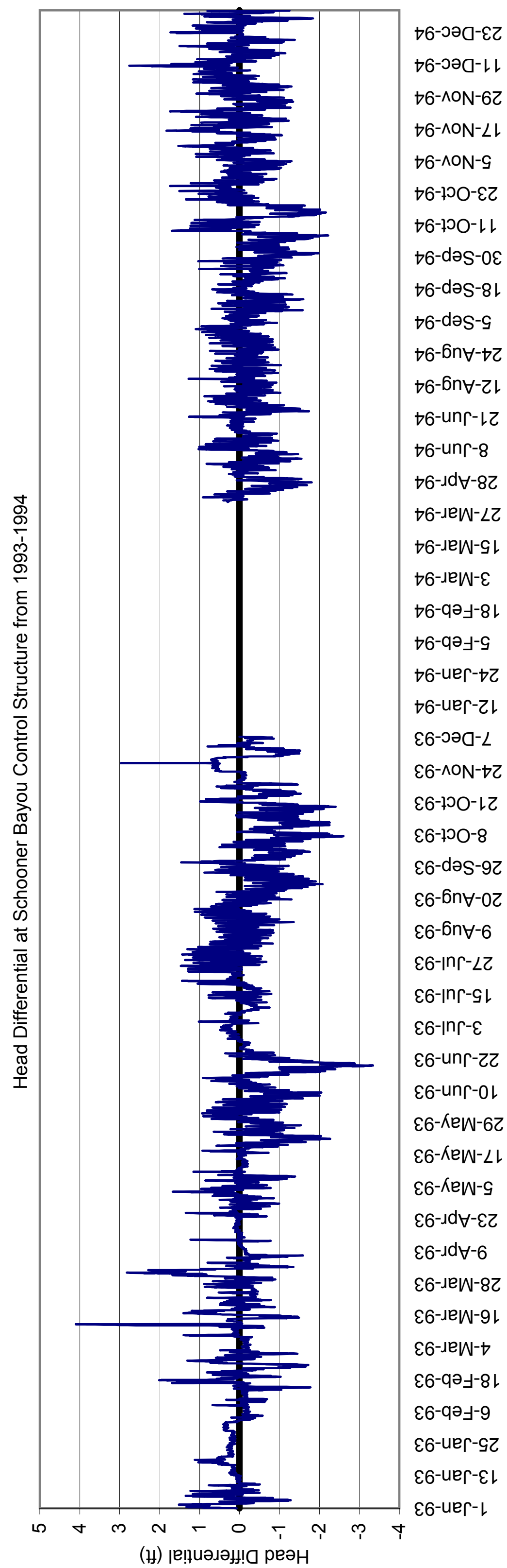
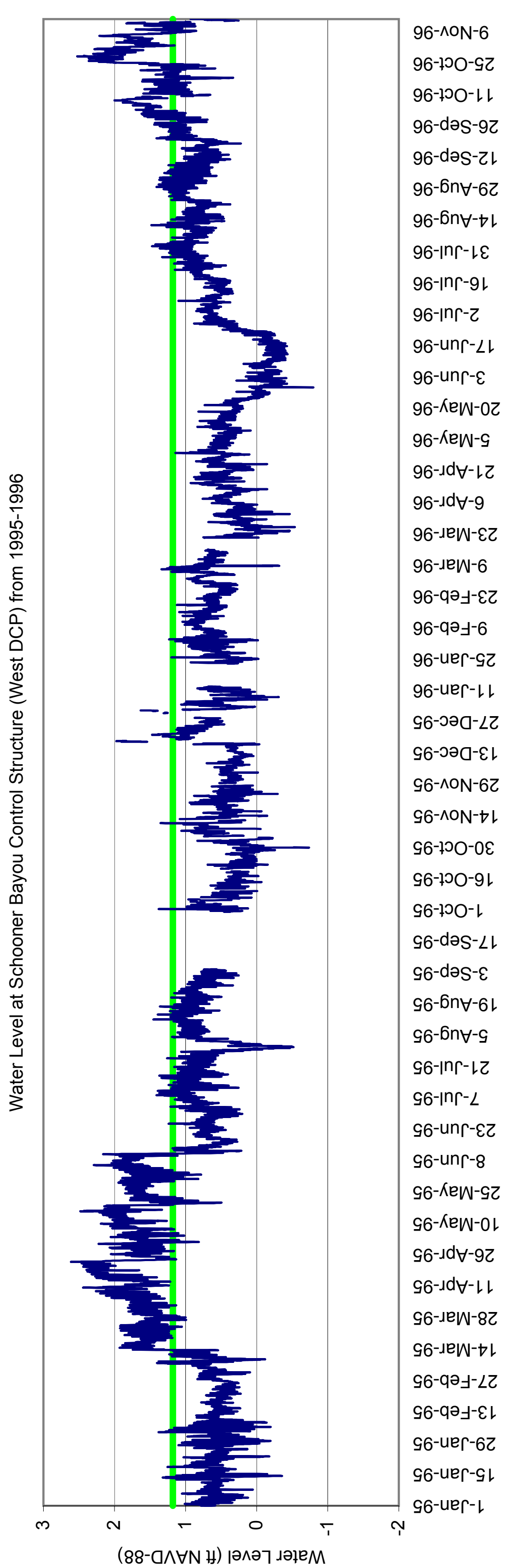
29-Oct-90
12-Nov-90
26-Nov-90
9-Dec-90
23-Dec-90

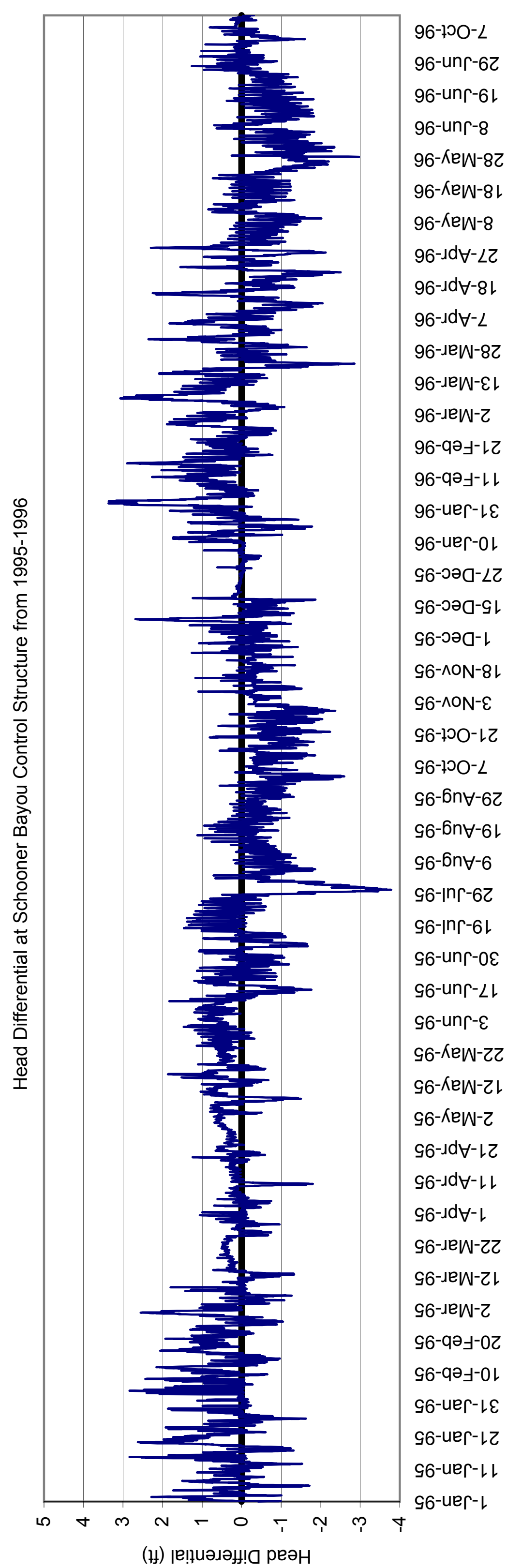

Water Level at Schooner Bayou Control Structure (West DCP) from 1991-1992
Water Level (ft NAVD-88)

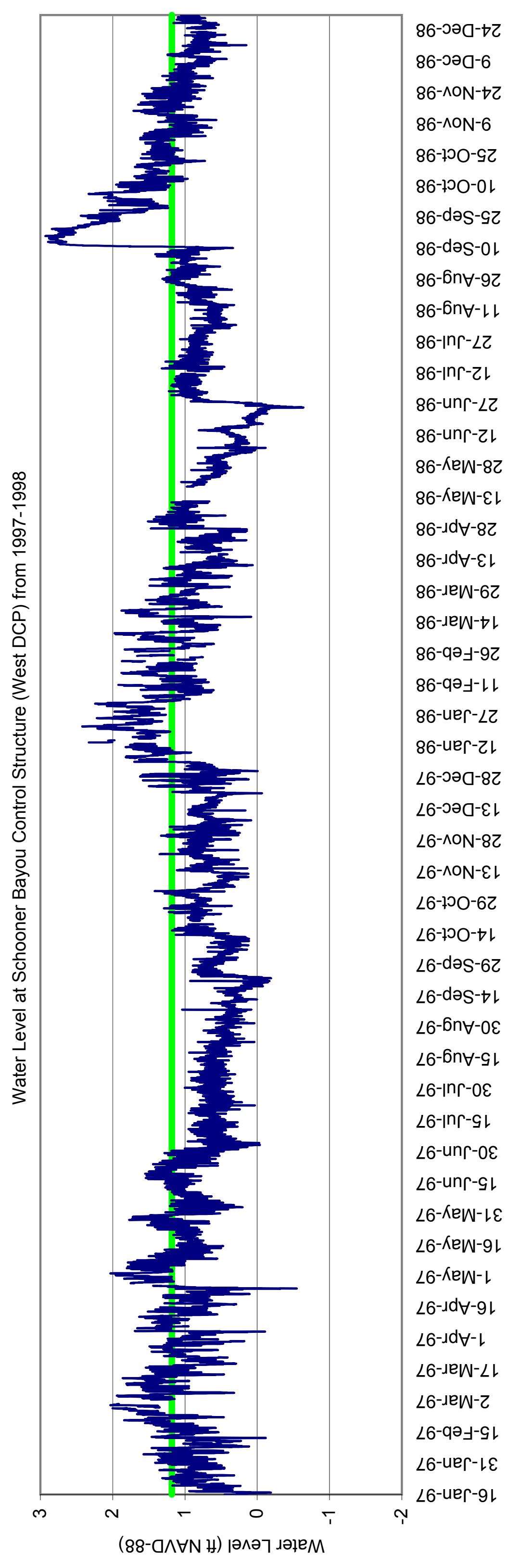

Head Differential at Schooner Bayou Control Structure from 1991-1992
Head Differential (ft)

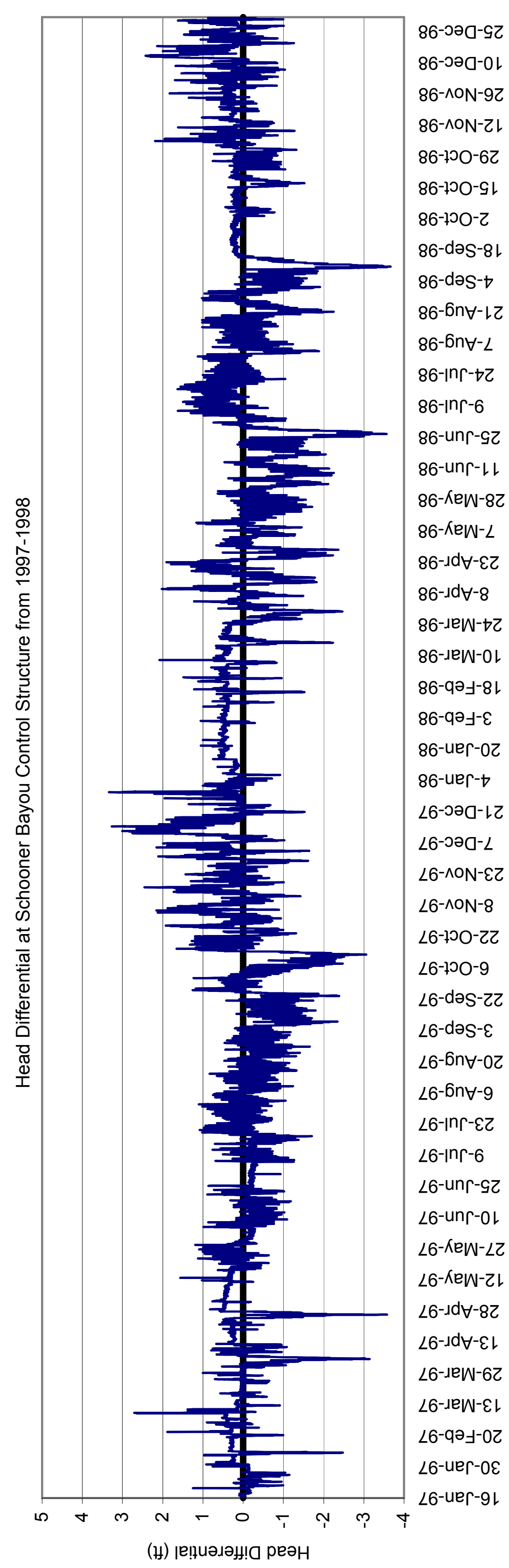

Water Level at Schooner Bayou Control Structure (West DCP) from 1993-1994
Water Level (ft NAVD-88)

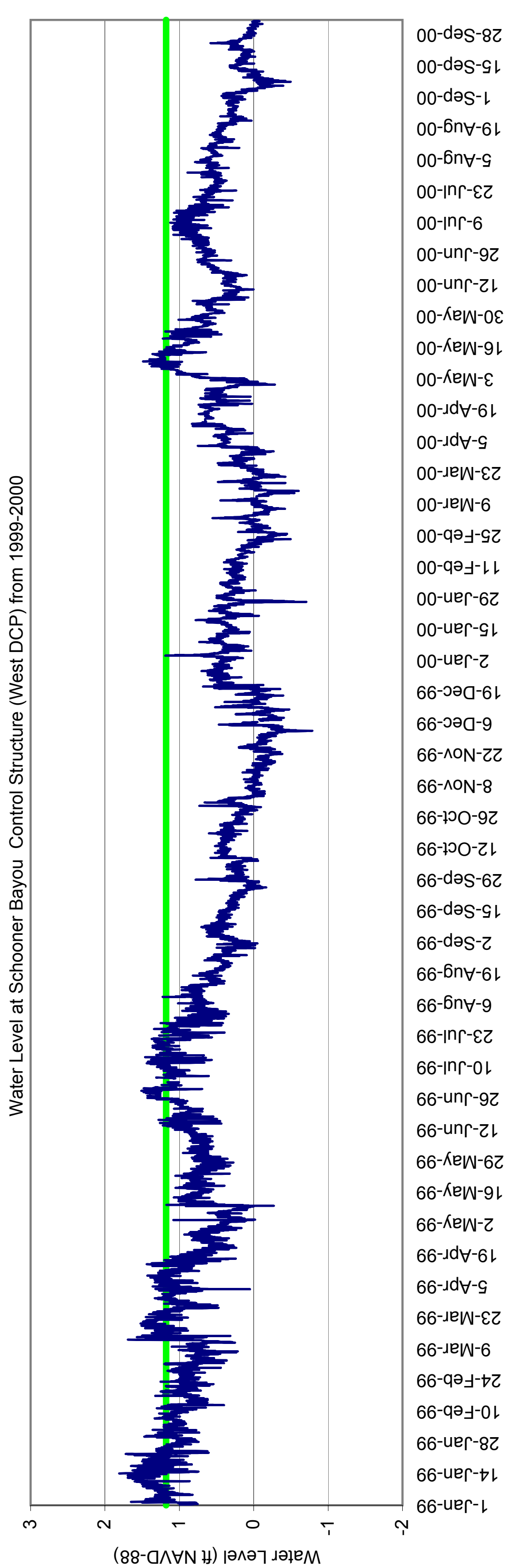

Head Differential at Schooner Bayou Control Structure from 1993-1994
Head Differential (ft)

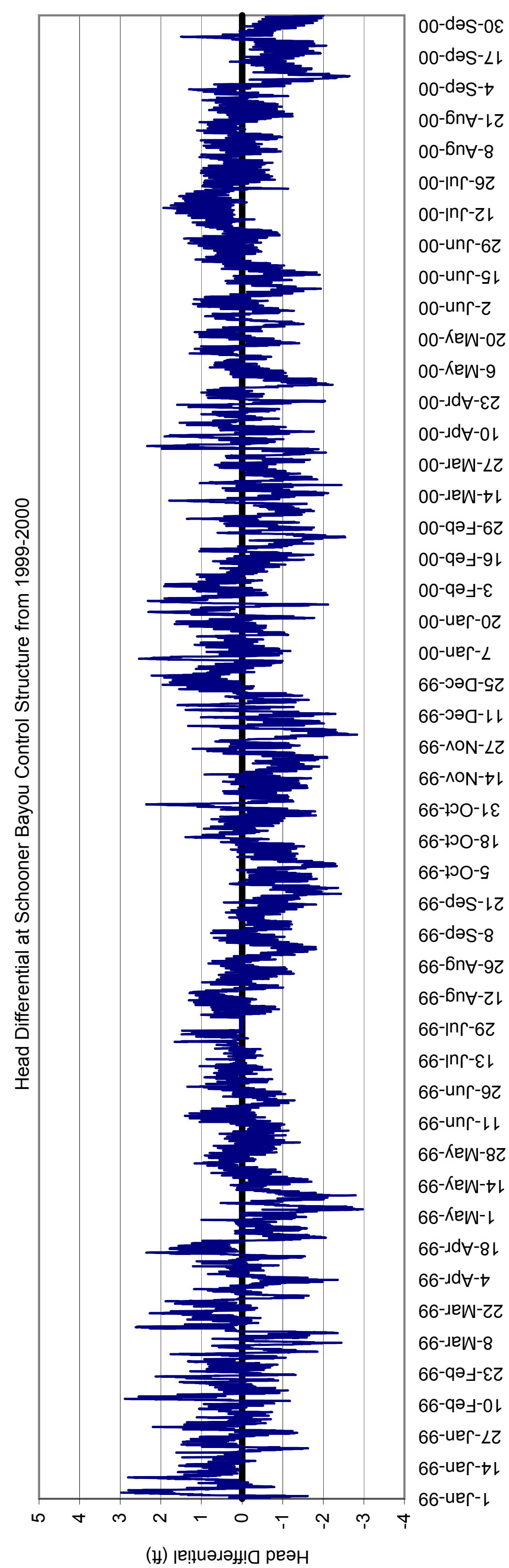

Water Level at Schooner Bayou Control Structure (West DCP) from 1995-1996
Water Level (ft NAVD-88)
3
2
1
0
-1
-2
1-Jan-95
15-Jan-95
29-Jan-95
13-Feb-95
27-Feb-95
14-Mar-95
28-Mar-95
11-Apr-95
26-Apr-95
10-May-95
25-May-95
8-Jun-95
23-Jun-95
7-Jul-95
21-Jul-95
5-Aug-95
19-Aug-95
3-Sep-95
17-Sep-95
1-Oct-95
16-Oct-95
30-Oct-95
14-Nov-95
29-Nov-95
13-Dec-95
27-Dec-95
11-Jan-96
25-Jan-96
9-Feb-96
23-Feb-96
9-Mar-96
23-Mar-96
6-Apr-96
21-Apr-96
5-May-96
20-May-96
3-Jun-96
17-Jun-96
2-Jul-96
16-Jul-96
31-Jul-96
14-Aug-96
29-Aug-96
12-Sep-96
26-Sep-96
11-Oct-96
25-Oct-96
9-Nov-96


Head Differential at Schooner Bayou Control Structure from 1995-1996
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
1-Jan-95
11-Jan-95
21-Jan-95
31-Jan-95
10-Feb-95
20-Feb-95
2-Mar-95
12-Mar-95
22-Mar-95
1-Apr-95
11-Apr-95
21-Apr-95
2-May-95
12-May-95
22-May-95
3-Jun-95
17-Jun-95
30-Jun-95
19-Jul-95
29-Jul-95
9-Aug-95
19-Aug-95
29-Aug-95
7-Oct-95
21-Oct-95
3-Nov-95
18-Nov-95
1-Dec-95
15-Dec-95
27-Dec-95
10-Jan-96
31-Jan-96
11-Feb-96
21-Feb-96
2-Mar-96
13-Mar-96
28-Mar-96
7-Apr-96
18-Apr-96
27-Apr-96
8-May-96
18-May-96
28-May-96
8-Jun-96
19-Jun-96
29-Jun-96
7-Oct-96

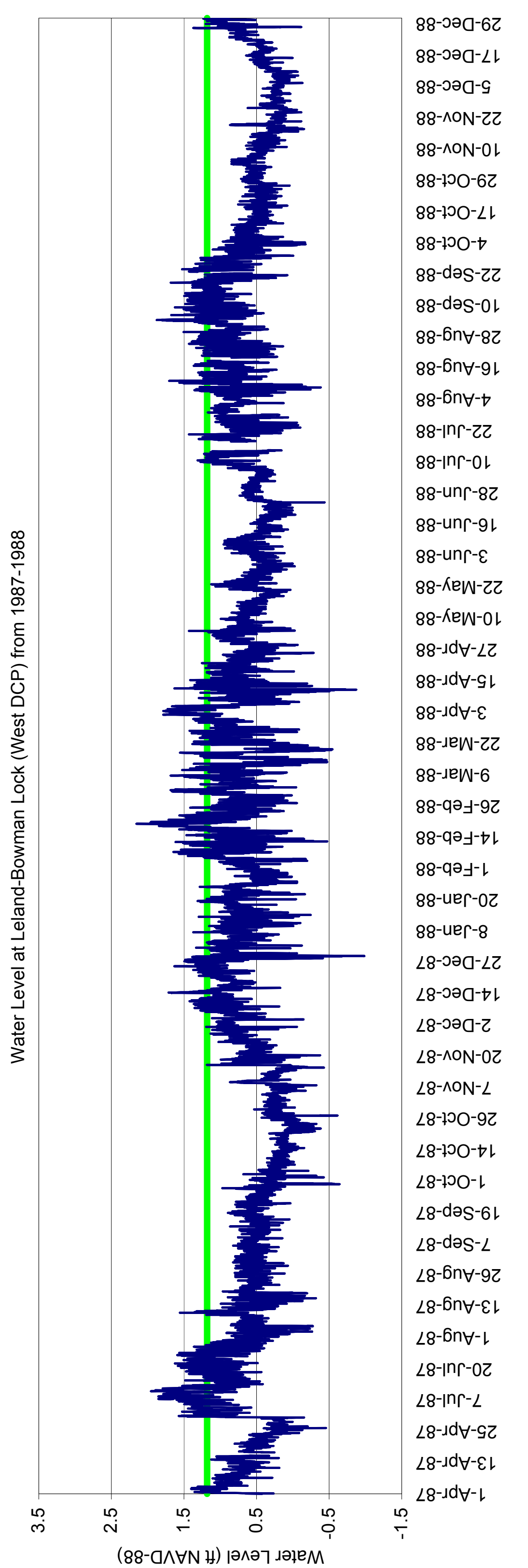

Water Level at Schooner Bayou Control Structure (West DCP) from 1997-1998
Water Level (ft NAVD-88)
3
2
1
0
-1
-2
16-Jan-97
31-Jan-97
15-Feb-97
2-Mar-97
17-Mar-97
1-Apr-97
16-Apr-97
1-May-97
16-May-97
31-May-97
15-Jun-97
30-Jun-97
15-Jul-97
30-Jul-97
15-Aug-97
30-Aug-97
14-Sep-97
29-Sep-97
14-Oct-97
29-Oct-97
13-Nov-97
28-Nov-97
13-Dec-97
28-Dec-97
12-Jan-98
27-Jan-98
11-Feb-98
26-Feb-98
14-Mar-98
29-Mar-98
13-Apr-98
28-Apr-98
13-May-98
28-May-98
12-Jun-98
27-Jun-98
12-Jul-98
27-Jul-98
11-Aug-98
26-Aug-98
10-Sep-98
25-Sep-98
10-Oct-98
25-Oct-98
9-Nov-98
24-Nov-98
9-Dec-98
24-Dec-98

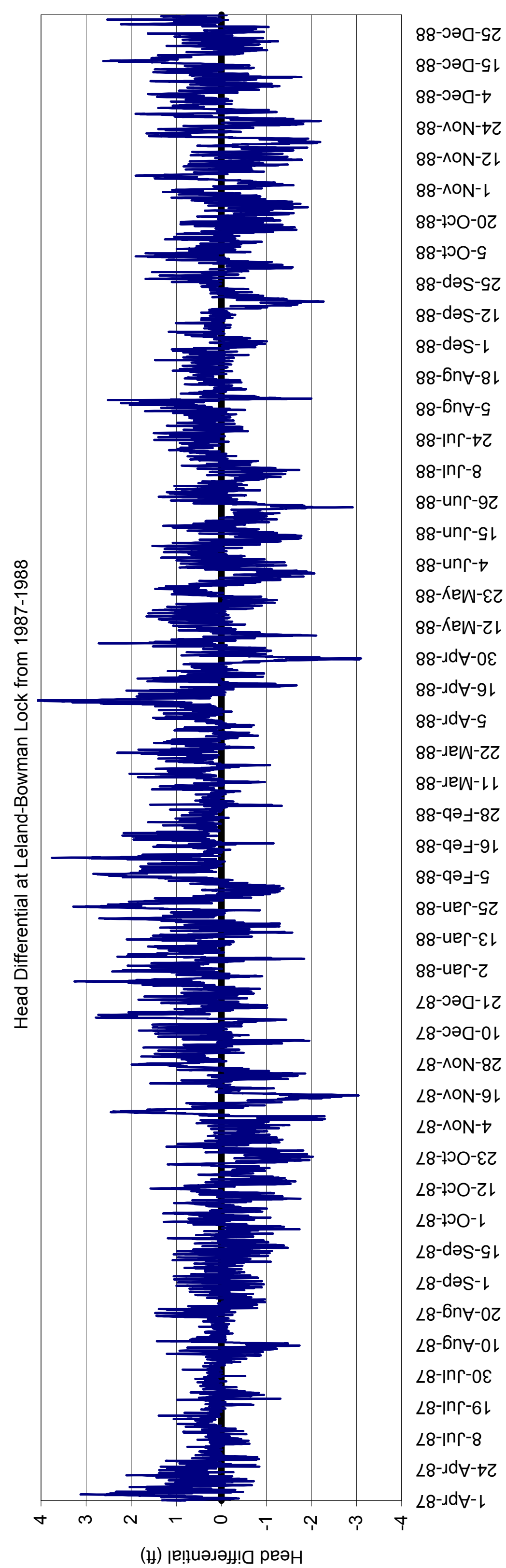

Head Differential at Schooner Bayou Control Structure from 1997-1998
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
16-Jan-97
30-Jan-97
20-Feb-97
13-Mar-97
29-Mar-97
13-Apr-97
28-Apr-97
12-May-97
27-May-97
10-Jun-97
25-Jun-97
9-Jul-97
23-Jul-97
6-Aug-97
20-Aug-97
3-Sep-97
22-Sep-97
6-Oct-97
22-Oct-97
8-Nov-97
23-Nov-97
7-Dec-97
21-Dec-97
4-Jan-98
20-Jan-98
3-Feb-98
18-Feb-98
10-Mar-98
24-Mar-98
8-Apr-98
23-Apr-98
7-May-98
28-May-98
11-Jun-98
25-Jun-98
9-Jul-98
24-Jul-98
7-Aug-98
21-Aug-98
4-Sep-98
18-Sep-98
2-Oct-98
15-Oct-98
29-Oct-98
12-Nov-98
26-Nov-98
10-Dec-98
25-Dec-98

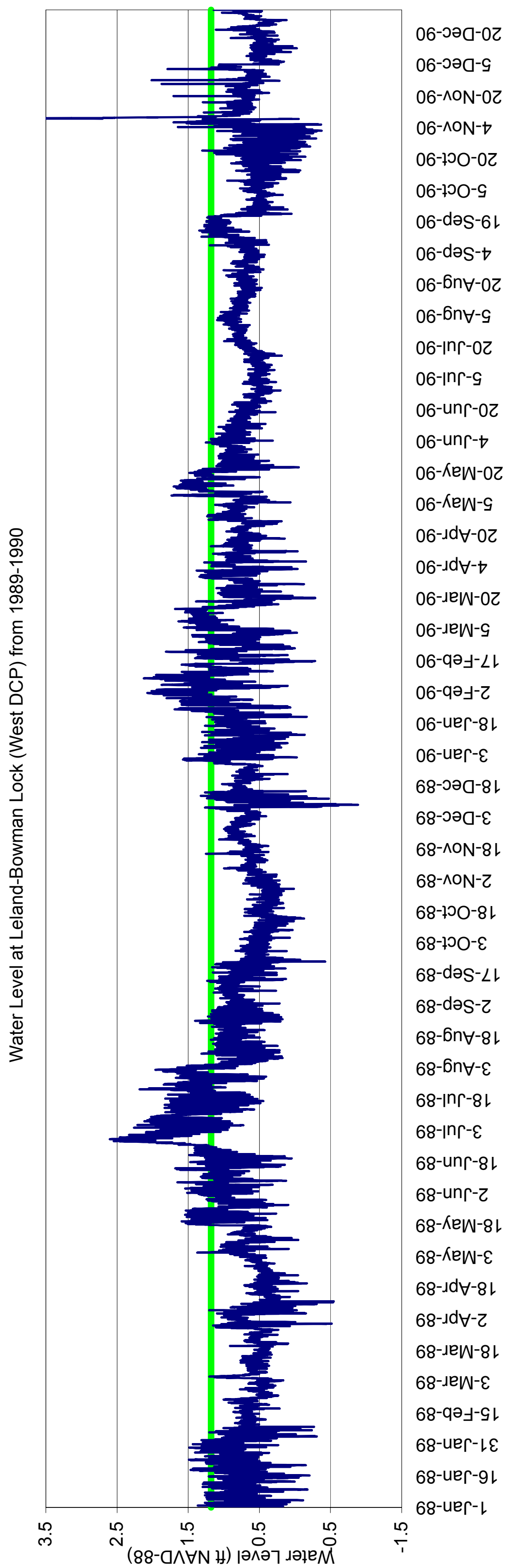

Water Level at Schooner Bayou Control Structure (West DCP) from 1999-2000
Water Level (ft NAVD-88)

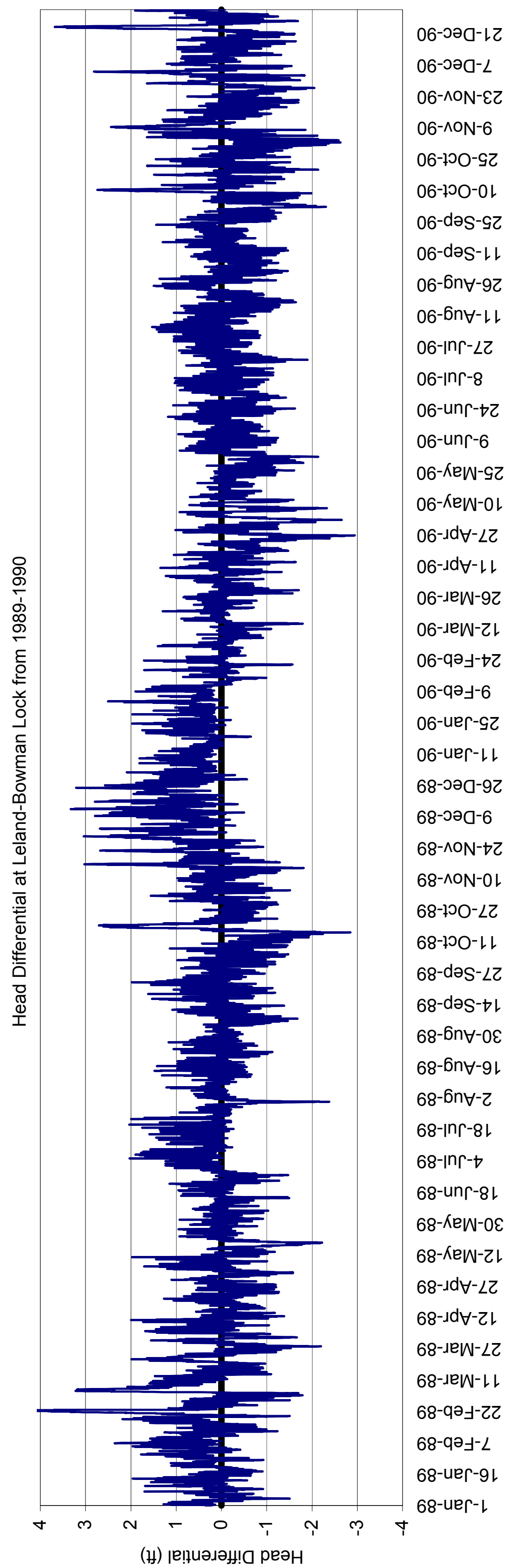

Head Differential at Schooner Bayou Control Structure from 1999-2000
Head Differential (ft)

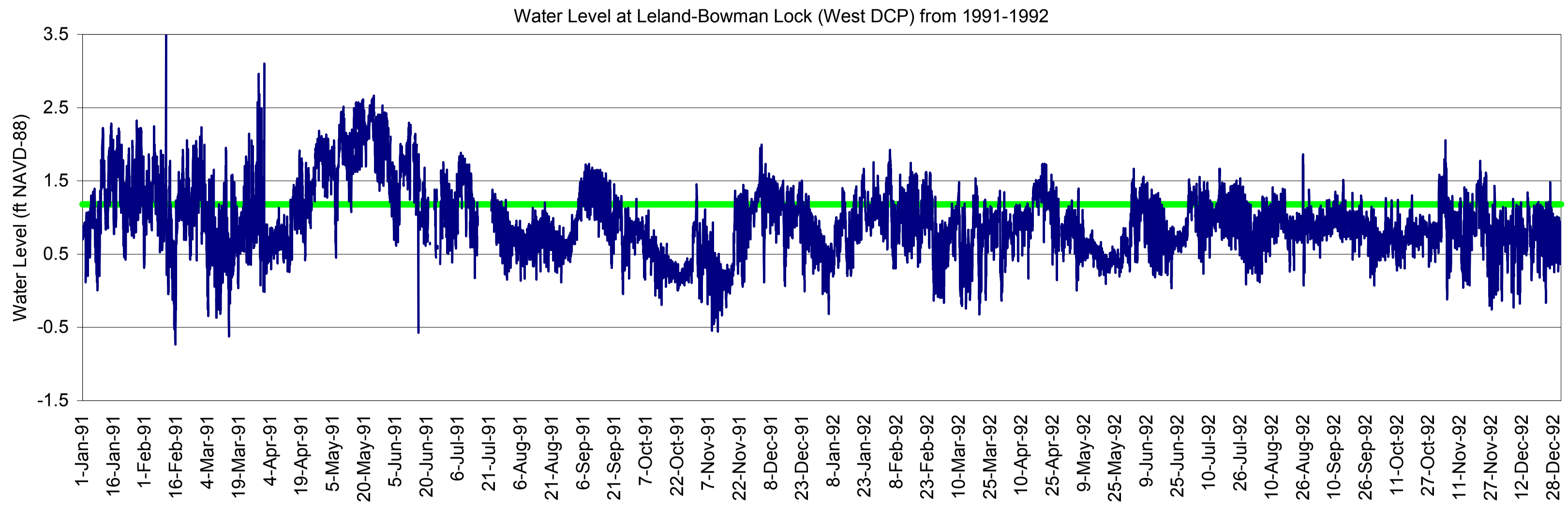
Leland Bowman Lock
1987-2000

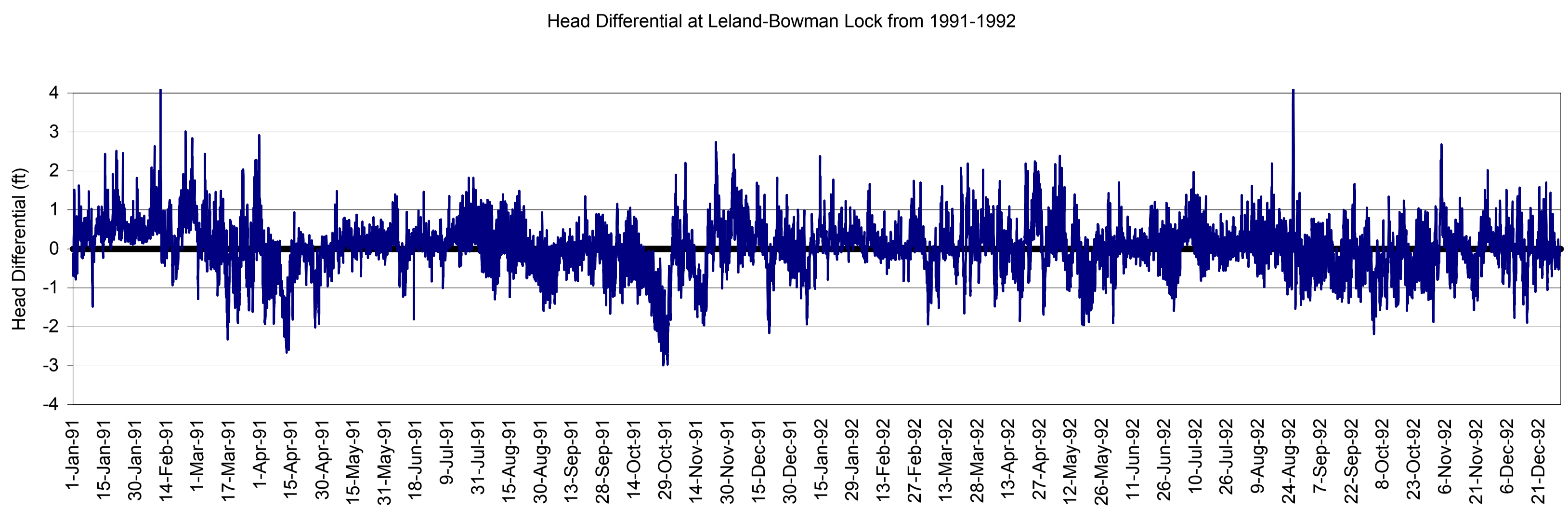

Water Level at Leland-Bowman Lock (West DCP) from 1987-1988
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
-1.5
1-Apr-87
13-Apr-87
25-Apr-87
7-Jul-87
20-Jul-87
1-Aug-87
13-Aug-87
26-Aug-87
7-Sep-87
19-Sep-87
1-Oct-87
14-Oct-87
26-Oct-87
7-Nov-87
20-Nov-87
2-Dec-87
14-Dec-87
27-Dec-87
8-Jan-88
20-Jan-88
1-Feb-88
14-Feb-88
26-Feb-88
9-Mar-88
22-Mar-88
3-Apr-88
15-Apr-88
27-Apr-88
10-May-88
22-May-88
3-Jun-88
16-Jun-88
28-Jun-88
10-Jul-88
22-Jul-88
4-Aug-88
16-Aug-88
28-Aug-88
10-Sep-88
22-Sep-88
4-Oct-88
17-Oct-88
29-Oct-88
10-Nov-88
22-Nov-88
5-Dec-88
17-Dec-88
29-Dec-88

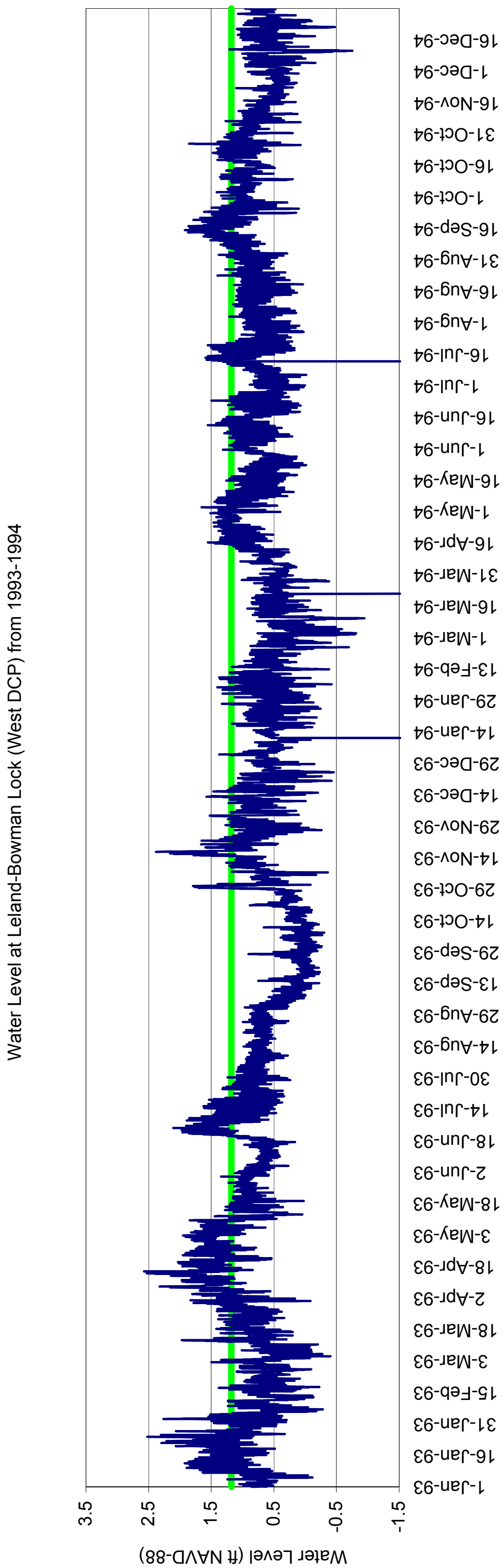

Head Differential at Leland-Bowman Lock from 1987-1988
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
-4
1-Apr-87
24-Apr-87
8-Jul-87
19-Jul-87
30-Jul-87
10-Aug-87
20-Aug-87
1-Sep-87
15-Sep-87
1-Oct-87
12-Oct-87
23-Oct-87
4-Nov-87
16-Nov-87
28-Nov-87
10-Dec-87
21-Dec-87
2-Jan-88
13-Jan-88
25-Jan-88
5-Feb-88
16-Feb-88
28-Feb-88
11-Mar-88
22-Mar-88
5-Apr-88
16-Apr-88
30-Apr-88
12-May-88
23-May-88
4-Jun-88
15-Jun-88
26-Jun-88
8-Jul-88
24-Jul-88
5-Aug-88
18-Aug-88
1-Sep-88
12-Sep-88
25-Sep-88
5-Oct-88
20-Oct-88
1-Nov-88
12-Nov-88
24-Nov-88
4-Dec-88
15-Dec-88
25-Dec-88

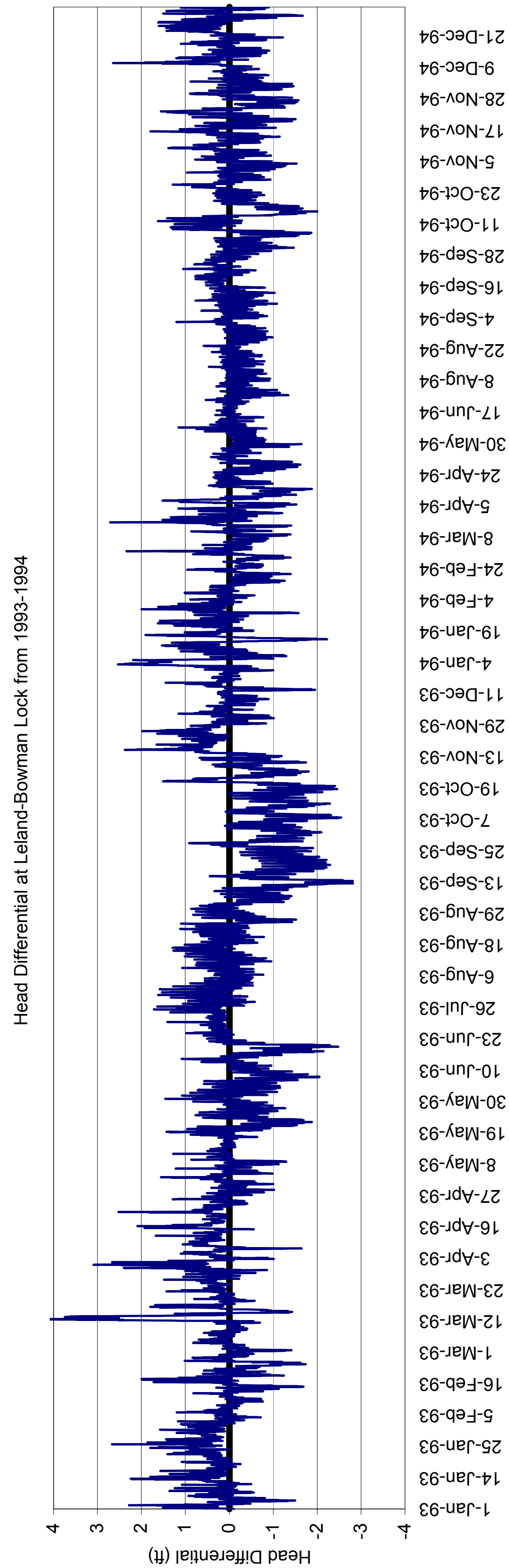

Water Level at Leland-Bowman Lock (West DCP) from 1989-1990
Water Level (ft NAVD-88)

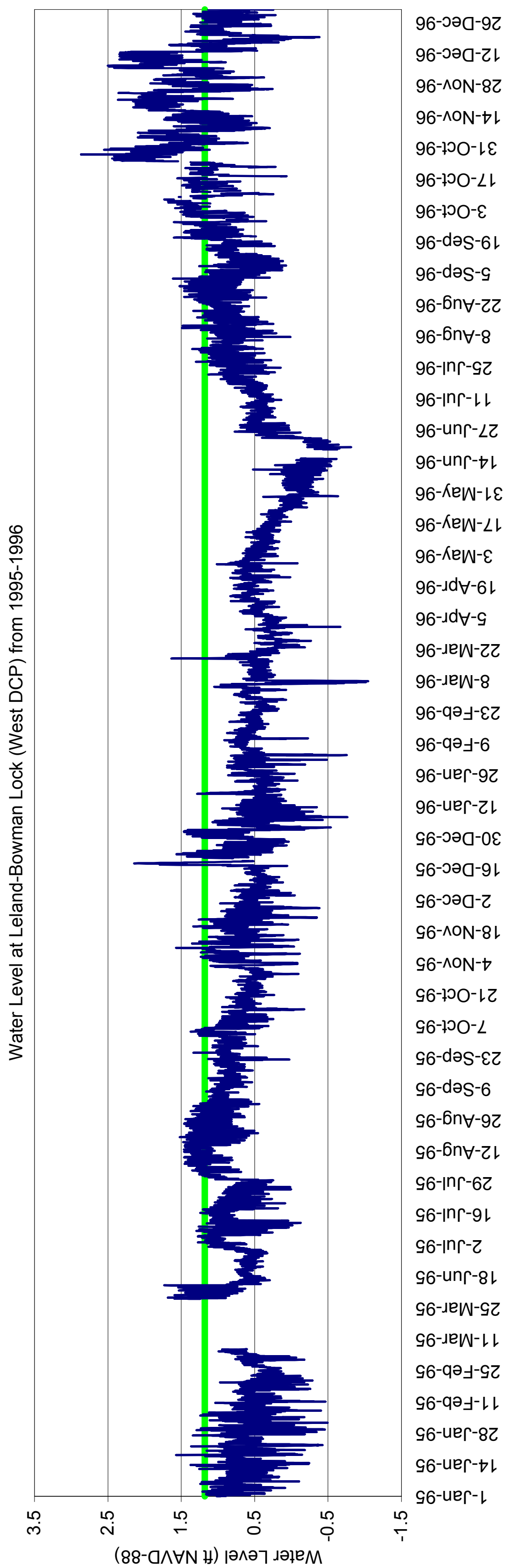

Head Differential at Leland-Bowman Lock from 1989-1990
Head Differential (ft)

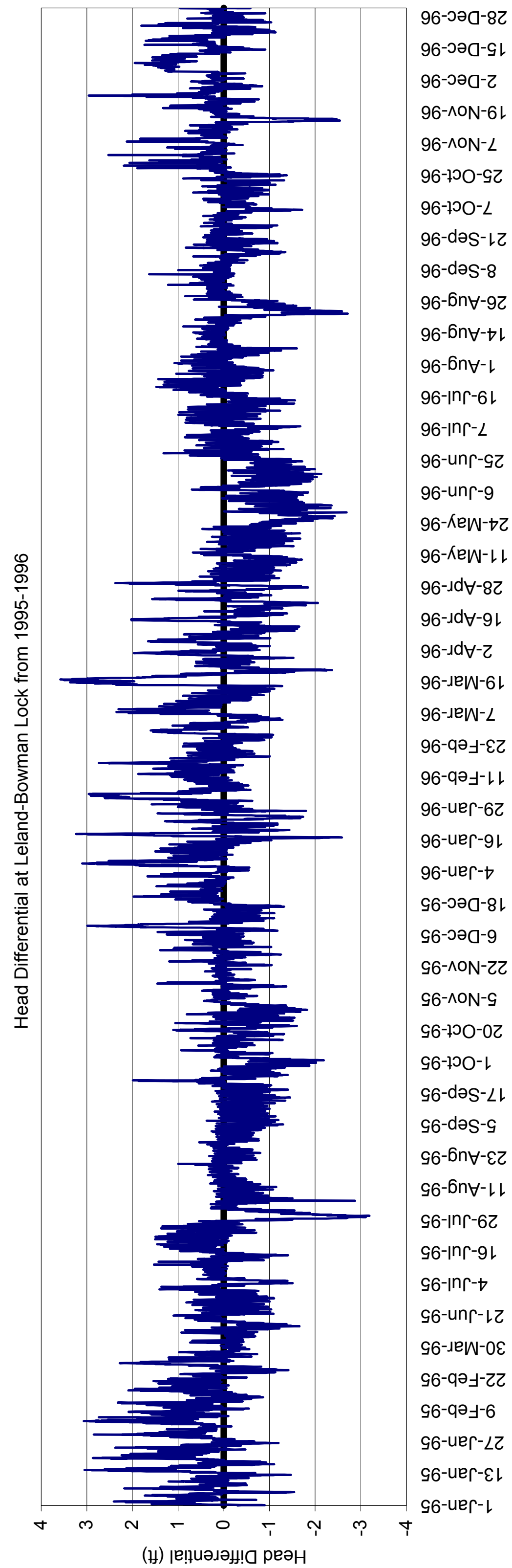

Water Level at Leland-Bowman Lock (West DCP) from 1991-1992
Water Level (ft NAVD-88)

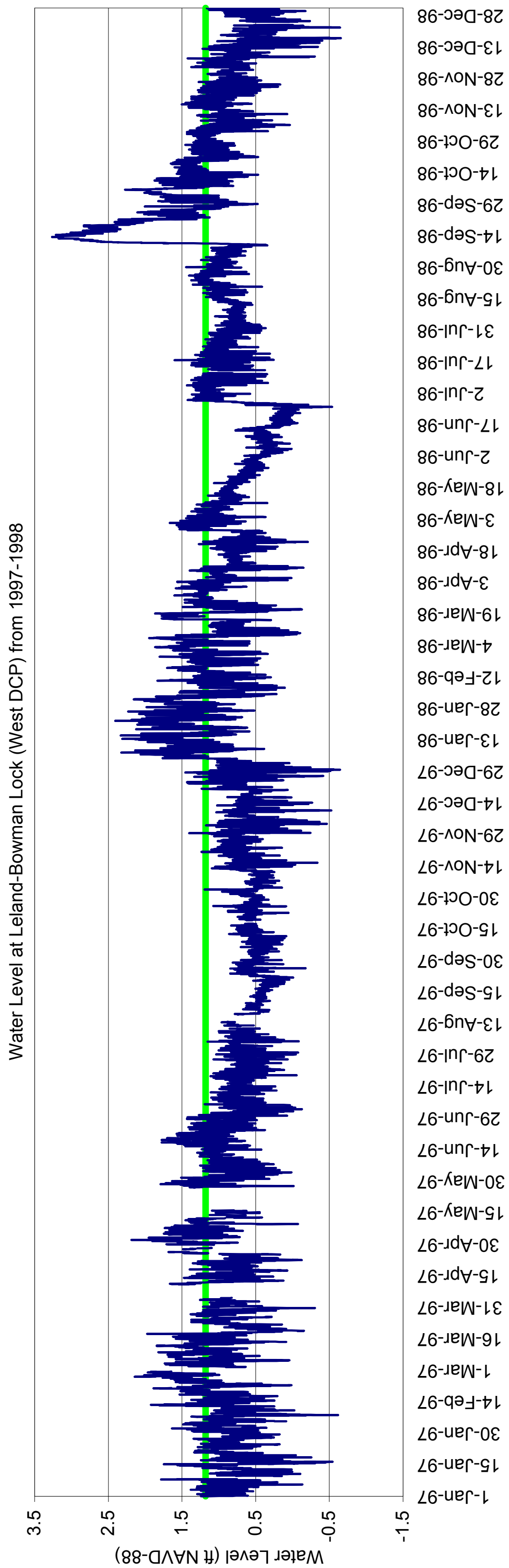

Head Differential at Leland-Bowman Lock from 1991-1992
Head Differential (ft)

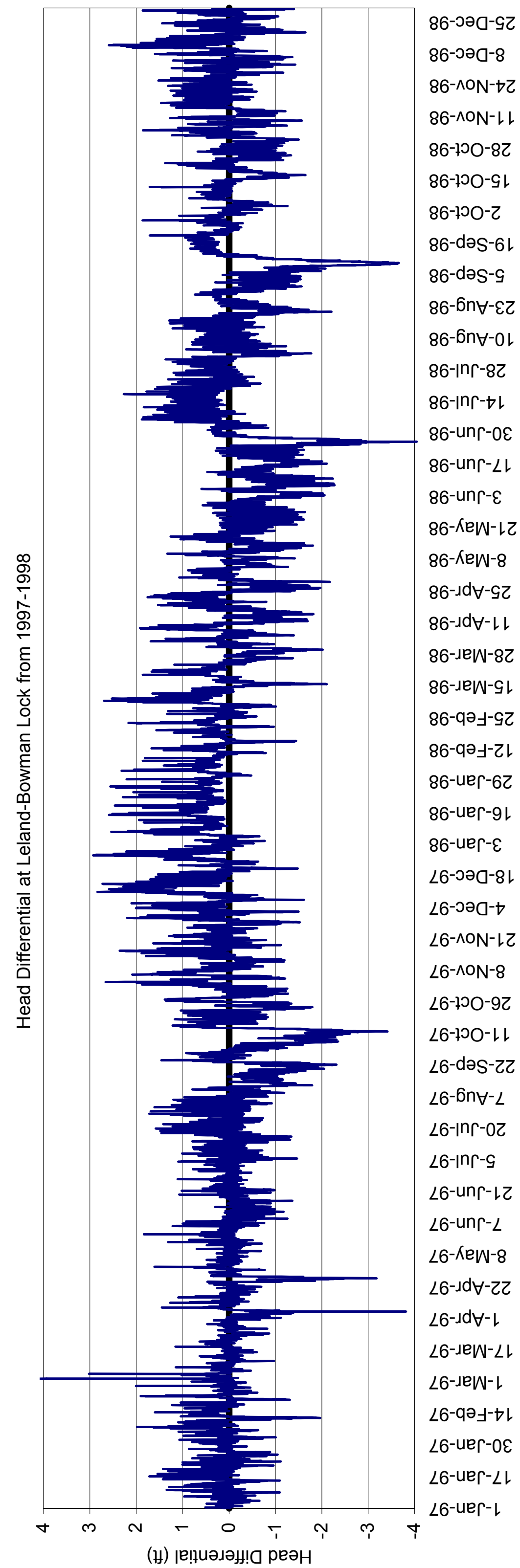

Water Level at Leland-Bowman Lock (West DCP) from 1993-1994
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
-1.5
1-Jan-93
16-Jan-93
31-Jan-93
15-Feb-93
3-Mar-93
18-Mar-93
2-Apr-93
18-Apr-93
3-May-93
18-May-93
2-Jun-93
18-Jun-93
14-Jul-93
30-Jul-93
14-Aug-93
29-Aug-93
13-Sep-93
29-Sep-93
14-Oct-93
29-Oct-93
14-Nov-93
29-Nov-93
14-Dec-93
29-Dec-93
14-Jan-94
29-Jan-94
13-Feb-94
1-Mar-94
16-Mar-94
31-Mar-94
16-Apr-94
1-May-94
16-May-94
1-Jun-94
16-Jun-94
1-Jul-94
16-Jul-94
1-Aug-94
16-Aug-94
31-Aug-94
16-Sep-94
1-Oct-94
16-Oct-94
31-Oct-94
16-Nov-94
1-Dec-94
16-Dec-94

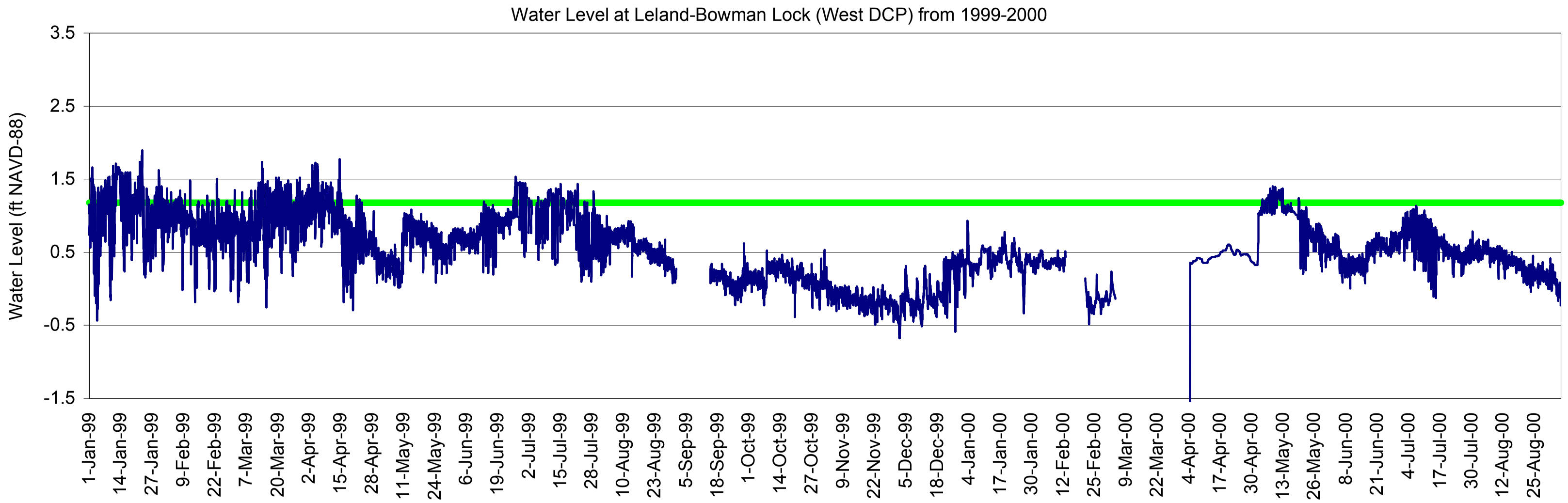

Head Differential at Leland-Bowman Lock from 1993-1994
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-93
14-Jan-93
25-Jan-93
5-Feb-93
16-Feb-93
1-Mar-93
12-Mar-93
23-Mar-93
3-Apr-93
16-Apr-93
27-Apr-93
8-May-93
19-May-93
30-May-93
10-Jun-93
23-Jun-93
26-Jul-93
6-Aug-93
18-Aug-93
29-Aug-93
13-Sep-93
25-Sep-93
7-Oct-93
19-Oct-93
13-Nov-93
29-Nov-93
11-Dec-93
4-Jan-94
19-Jan-94
4-Feb-94
24-Feb-94
8-Mar-94
5-Apr-94
24-Apr-94
30-May-94
17-Jun-94
8-Aug-94
22-Aug-94
4-Sep-94
16-Sep-94
28-Sep-94
11-Oct-94
23-Oct-94
5-Nov-94
17-Nov-94
28-Nov-94
9-Dec-94
21-Dec-94

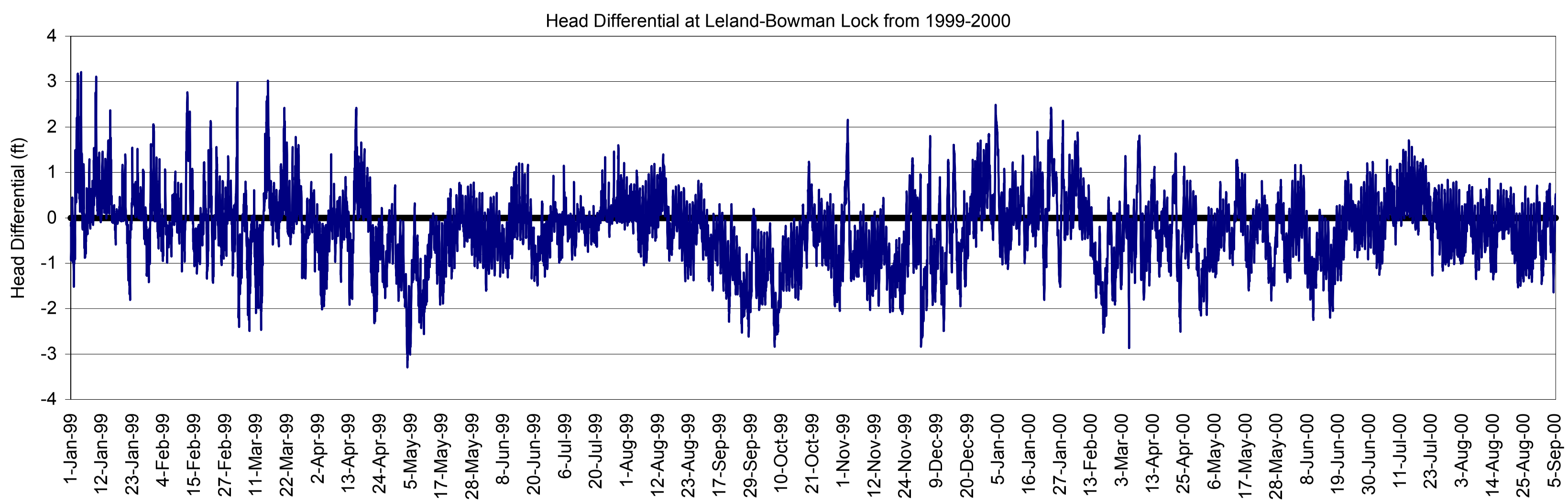

Water Level at Leland-Bowman Lock (West DCP) from 1995-1996
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
-1.5
1-Jan-95
14-Jan-95
28-Jan-95
11-Feb-95
25-Feb-95
11-Mar-95
25-Mar-95
18-Jun-95
2-Jul-95
16-Jul-95
29-Jul-95
12-Aug-95
26-Aug-95
9-Sep-95
23-Sep-95
7-Oct-95
21-Oct-95
4-Nov-95
18-Nov-95
2-Dec-95
16-Dec-95
30-Dec-95
12-Jan-96
26-Jan-96
9-Feb-96
23-Feb-96
8-Mar-96
22-Mar-96
5-Apr-96
19-Apr-96
3-May-96
17-May-96
31-May-96
14-Jun-96
27-Jun-96
11-Jul-96
25-Jul-96
8-Aug-96
22-Aug-96
5-Sep-96
19-Sep-96
3-Oct-96
17-Oct-96
31-Oct-96
14-Nov-96
28-Nov-96
12-Dec-96
26-Dec-96


Head Differential at Leland-Bowman Lock from 1995-1996
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-95
13-Jan-95
27-Jan-95
9-Feb-95
22-Feb-95
30-Mar-95
21-Jun-95
4-Jul-95
16-Jul-95
29-Jul-95
11-Aug-95
23-Aug-95
5-Sep-95
17-Sep-95
1-Oct-95
20-Oct-95
5-Nov-95
22-Nov-95
6-Dec-95
18-Dec-95
4-Jan-96
16-Jan-96
29-Jan-96
11-Feb-96
23-Feb-96
7-Mar-96
19-Mar-96
2-Apr-96
16-Apr-96
28-Apr-96
11-May-96
24-May-96
6-Jun-96
25-Jun-96
7-Jul-96
19-Jul-96
1-Aug-96
14-Aug-96
26-Aug-96
8-Sep-96
21-Sep-96
7-Oct-96
25-Oct-96
7-Nov-96
19-Nov-96
2-Dec-96
15-Dec-96
28-Dec-96

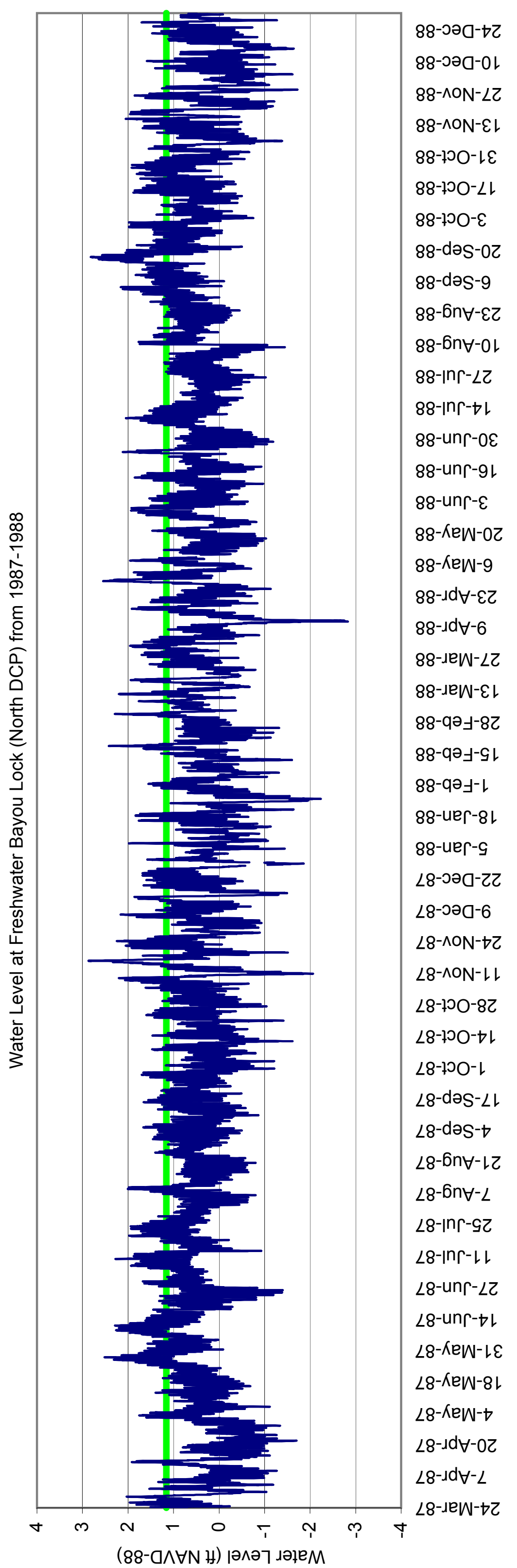

Water Level at Leland-Bowman Lock (West DCP) from 1997-1998
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
-1.5
1-Jan-97
15-Jan-97
30-Jan-97
14-Feb-97
1-Mar-97
16-Mar-97
31-Mar-97
15-Apr-97
30-Apr-97
15-May-97
30-May-97
14-Jun-97
29-Jun-97
14-Jul-97
29-Jul-97
13-Aug-97
15-Sep-97
30-Sep-97
15-Oct-97
30-Oct-97
14-Nov-97
29-Nov-97
14-Dec-97
29-Dec-97
13-Jan-98
28-Jan-98
12-Feb-98
4-Mar-98
19-Mar-98
3-Apr-98
18-Apr-98
3-May-98
18-May-98
2-Jun-98
17-Jun-98
2-Jul-98
17-Jul-98
31-Jul-98
15-Aug-98
30-Aug-98
14-Sep-98
29-Sep-98
14-Oct-98
29-Oct-98
13-Nov-98
28-Nov-98
13-Dec-98
28-Dec-98

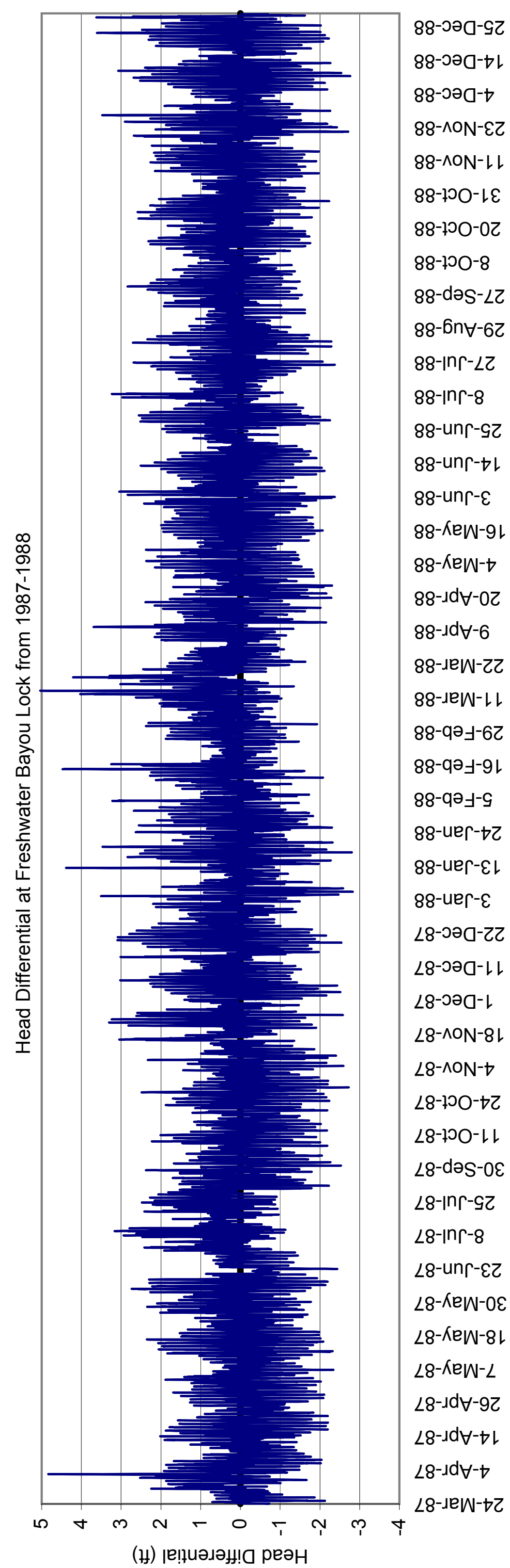

Head Differential at Leland-Bowman Lock from 1997-1998
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-97
17-Jan-97
30-Jan-97
14-Feb-97
1-Mar-97
17-Mar-97
1-Apr-97
22-Apr-97
8-May-97
7-Jun-97
21-Jun-97
5-Jul-97
20-Jul-97
7-Aug-97
22-Sep-97
11-Oct-97
26-Oct-97
8-Nov-97
21-Nov-97
4-Dec-97
18-Dec-97
3-Jan-98
16-Jan-98
29-Jan-98
12-Feb-98
25-Feb-98
15-Mar-98
28-Mar-98
11-Apr-98
25-Apr-98
8-May-98
21-May-98
3-Jun-98
17-Jun-98
30-Jun-98
14-Jul-98
28-Jul-98
10-Aug-98
23-Aug-98
5-Sep-98
19-Sep-98
2-Oct-98
15-Oct-98
28-Oct-98
11-Nov-98
24-Nov-98
8-Dec-98
25-Dec-98

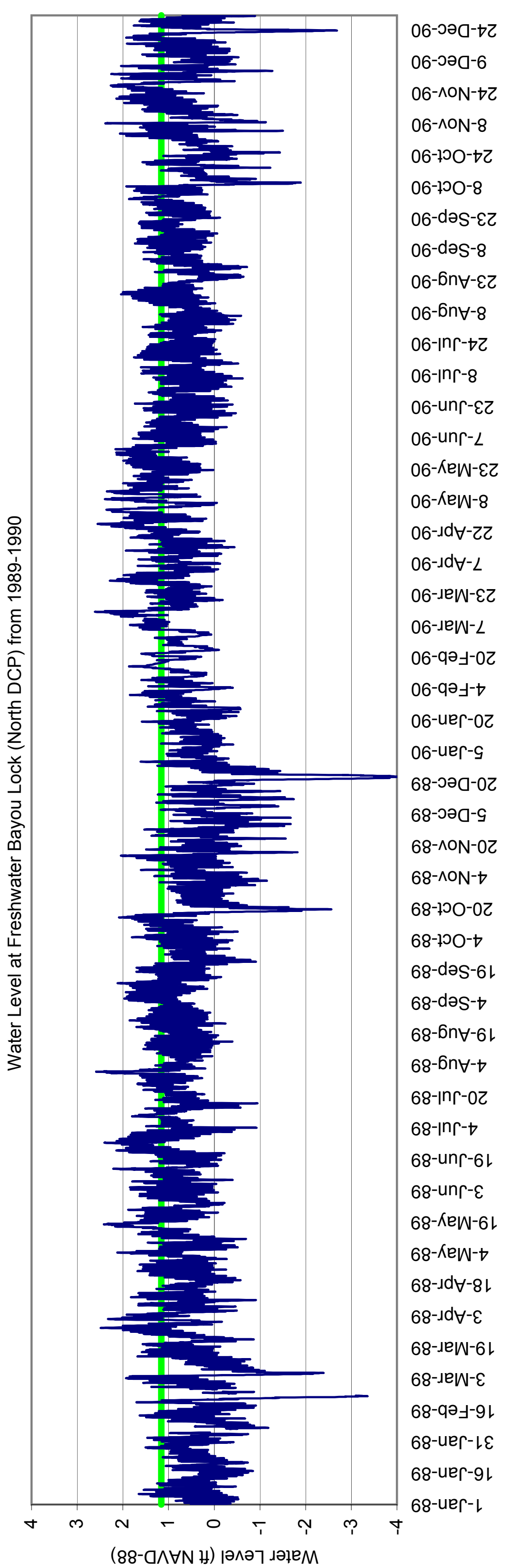

Water Level at Leland-Bowman Lock (West DCP) from 1999-2000
Water Level (ft NAVD-88)
3.5
2.5
1.5
0.5
-0.5
-1.5
1-Jan-99
14-Jan-99
27-Jan-99
9-Feb-99
22-Feb-99
7-Mar-99
20-Mar-99
2-Apr-99
15-Apr-99
28-Apr-99
11-May-99
24-May-99
6-Jun-99
19-Jun-99
2-Jul-99
15-Jul-99
28-Jul-99
10-Aug-99
23-Aug-99
5-Sep-99
18-Sep-99
1-Oct-99
14-Oct-99
27-Oct-99
9-Nov-99
22-Nov-99
5-Dec-99
18-Dec-99
4-Jan-00
17-Jan-00
30-Jan-00
12-Feb-00
25-Feb-00
9-Mar-00
22-Mar-00
4-Apr-00
17-Apr-00
30-Apr-00
13-May-00
26-May-00
8-Jun-00
21-Jun-00
4-Jul-00
17-Jul-00
30-Jul-00
12-Aug-00
25-Aug-00

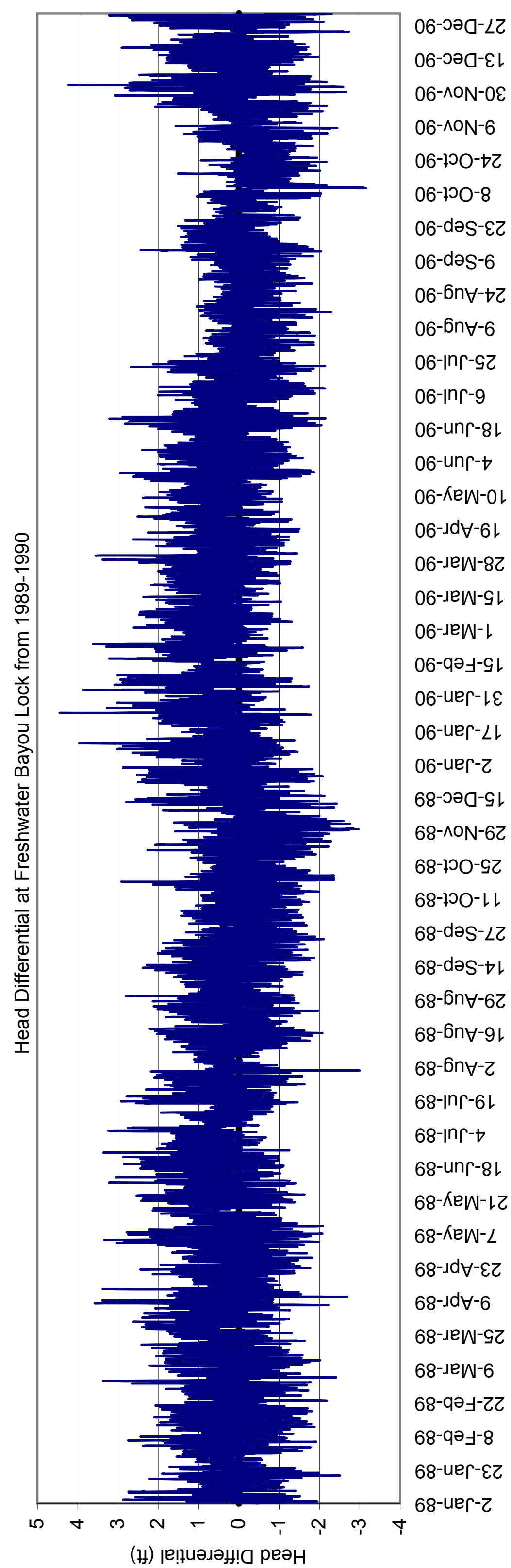

Head Differential at Leland-Bowman Lock from 1999-2000
Head Differential (ft)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-99
12-Jan-99
23-Jan-99
4-Feb-99
15-Feb-99
27-Feb-99
11-Mar-99
22-Mar-99
2-Apr-99
13-Apr-99
24-Apr-99
5-May-99
17-May-99
28-May-99
8-Jun-99
20-Jun-99
6-Jul-99
20-Jul-99
1-Aug-99
12-Aug-99
23-Aug-99
17-Sep-99
29-Sep-99
10-Oct-99
21-Oct-99
1-Nov-99
12-Nov-99
24-Nov-99
9-Dec-99
20-Dec-99
5-Jan-00
16-Jan-00
27-Jan-00
13-Feb-00
3-Mar-00
13-Apr-00
25-Apr-00
6-May-00
17-May-00
28-May-00
8-Jun-00
19-Jun-00
30-Jun-00
11-Jul-00
23-Jul-00
3-Aug-00
14-Aug-00
25-Aug-00
5-Sep-00

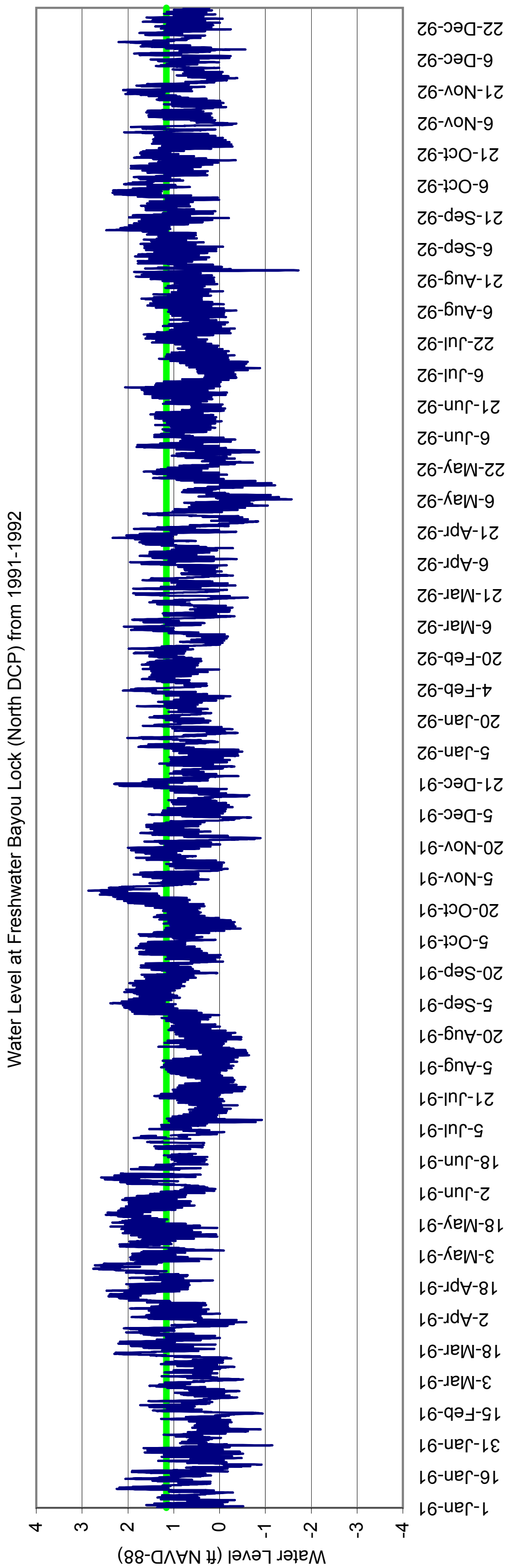
Freshwater Bayou Lock
1987-2000


Water Level at Freshwater Bayou Lock (North DCP) from 1987-1988
Water Level (ft NAVD-88)


Head Differential at Freshwater Bayou Lock from 1987-1988
Head Differential (ft)


Water Level at Freshwater Bayou Lock (North DCP) from 1989-1990
Water Level (ft NAVD-88)


Head Differential at Freshwater Bayou Lock from 1989-1990
Head Differential (ft)


Water Level at Freshwater Bayou Lock (North DCP) from 1991-1992
Water Level (ft NAVD-88)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-91
16-Jan-91
31-Jan-91
15-Feb-91
3-Mar-91
18-Mar-91
2-Apr-91
18-Apr-91
3-May-91
18-May-91
2-Jun-91
18-Jun-91
5-Jul-91
21-Jul-91
5-Aug-91
20-Aug-91
5-Sep-91
20-Sep-91
5-Oct-91
20-Oct-91
5-Nov-91
20-Nov-91
5-Dec-91
21-Dec-91
5-Jan-92
20-Jan-92
4-Feb-92
20-Feb-92
6-Mar-92
21-Mar-92
6-Apr-92
21-Apr-92
6-May-92
22-May-92
6-Jun-92
21-Jun-92
6-Jul-92
22-Jul-92
6-Aug-92
21-Aug-92
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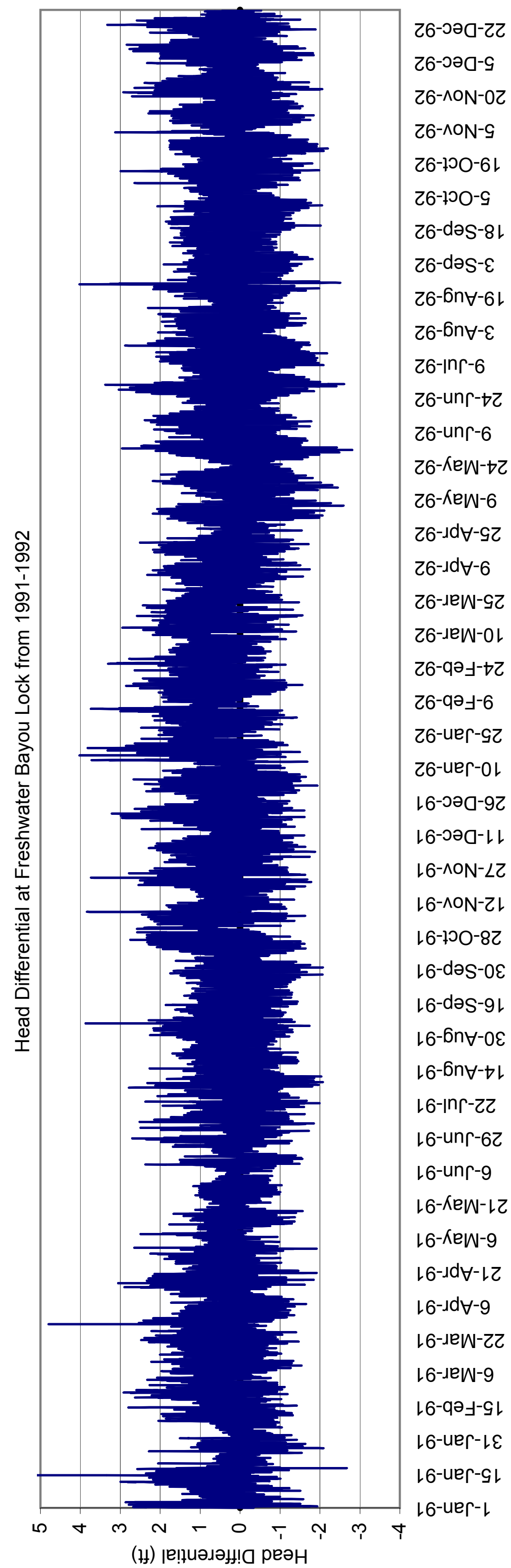
21-Nov-92
6-Dec-92
22-Dec-92


Head Differential at Freshwater Bayou Lock from 1991-1992
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
1-Jan-91
15-Jan-91
31-Jan-91
15-Feb-91
6-Mar-91
22-Mar-91
6-Apr-91
21-Apr-91
6-May-91
21-May-91
6-Jun-91
29-Jun-91
22-Jul-91
14-Aug-91
30-Aug-91
16-Sep-91
30-Sep-91
28-Oct-91
12-Nov-91
27-Nov-91
11-Dec-91
26-Dec-91
10-Jan-92
25-Jan-92
9-Feb-92
24-Feb-92
10-Mar-92
25-Mar-92
9-Apr-92
25-Apr-92
9-May-92
24-May-92
9-Jun-92
24-Jun-92
9-Jul-92
3-Aug-92
19-Aug-92
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18-Sep-92
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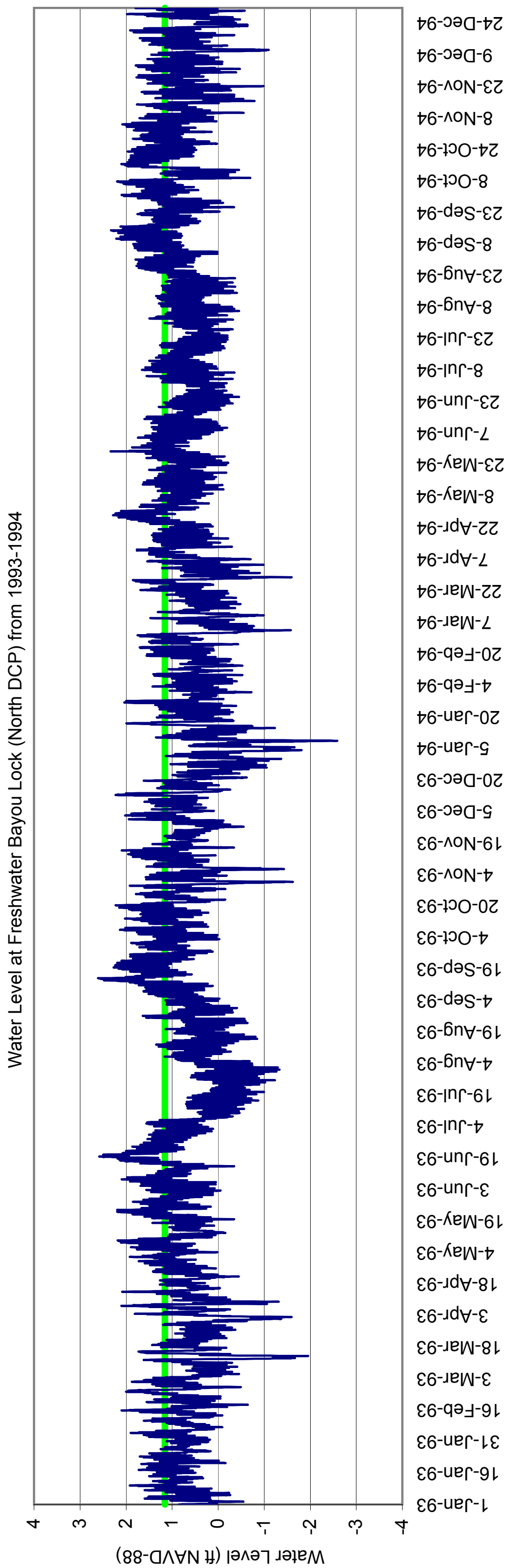
19-Oct-92
5-Nov-92
20-Nov-92
5-Dec-92
22-Dec-92


Water Level at Freshwater Bayou Lock (North DCP) from 1993-1994
Water Level (ft NAVD-88)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-93
16-Jan-93
31-Jan-93
16-Feb-93
3-Mar-93
18-Mar-93
3-Apr-93
18-Apr-93
4-May-93
19-May-93
3-Jun-93
19-Jun-93
4-Jul-93
19-Jul-93
4-Aug-93
19-Aug-93
4-Sep-93
19-Sep-93
4-Oct-93
20-Oct-93
4-Nov-93
19-Nov-93
5-Dec-93
20-Dec-93
5-Jan-94
20-Jan-94
4-Feb-94
20-Feb-94
7-Mar-94
22-Mar-94
7-Apr-94
22-Apr-94
8-May-94
23-May-94
7-Jun-94
23-Jun-94
8-Jul-94
23-Jul-94
8-Aug-94
23-Aug-94
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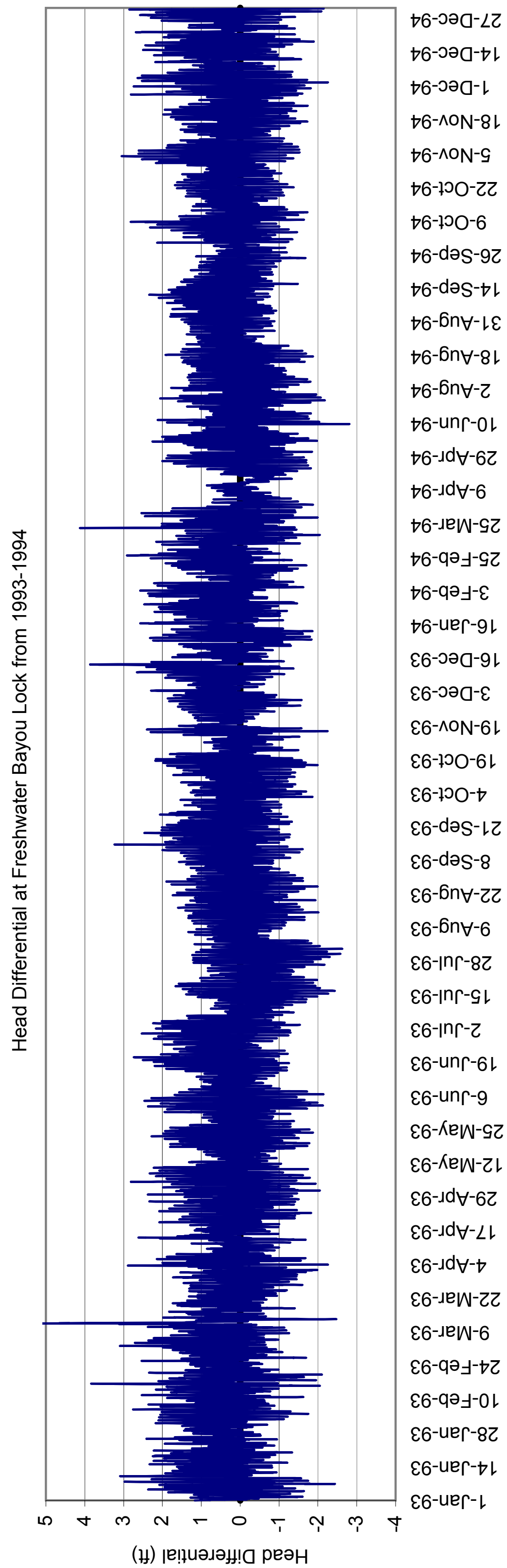
24-Oct-94
8-Nov-94
23-Nov-94
9-Dec-94
24-Dec-94


Head Differential at Freshwater Bayou Lock from 1993-1994
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
1-Jan-93
14-Jan-93
28-Jan-93
10-Feb-93
24-Feb-93
9-Mar-93
22-Mar-93
4-Apr-93
17-Apr-93
29-Apr-93
12-May-93
25-May-93
6-Jun-93
19-Jun-93
2-Jul-93
15-Jul-93
28-Jul-93
9-Aug-93
22-Aug-93
8-Sep-93
21-Sep-93
4-Oct-93
19-Oct-93
19-Nov-93
3-Dec-93
16-Dec-93
16-Jan-94
3-Feb-94
25-Feb-94
25-Mar-94
9-Apr-94
29-Apr-94
10-Jun-94
2-Aug-94
18-Aug-94
31-Aug-94
14-Sep-94
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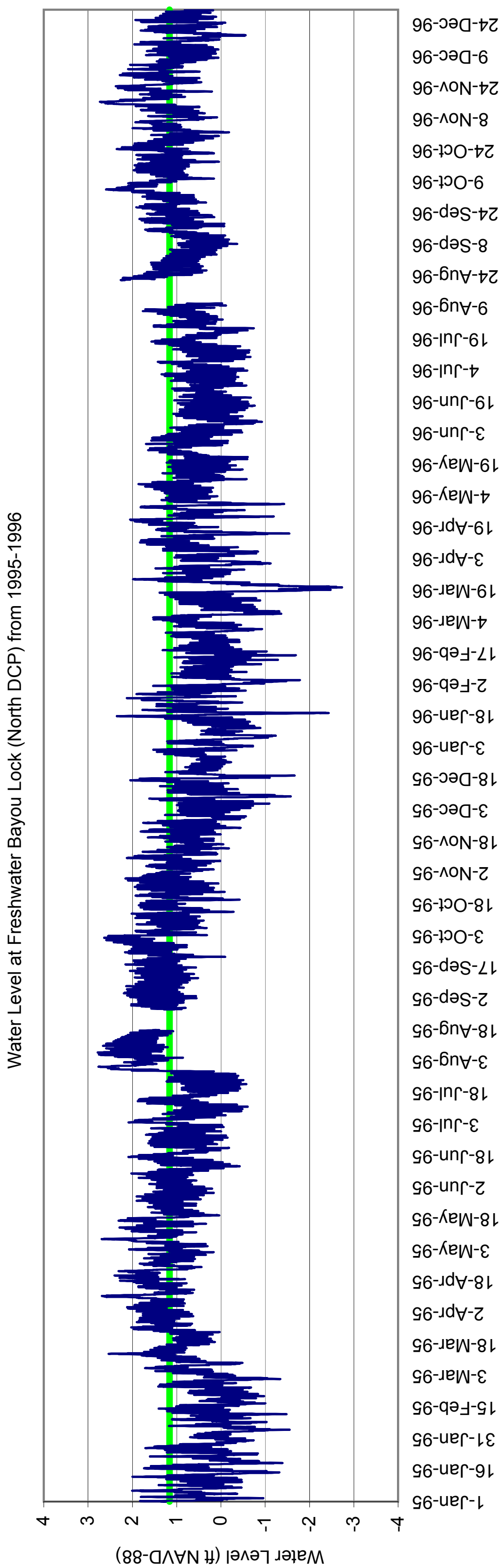
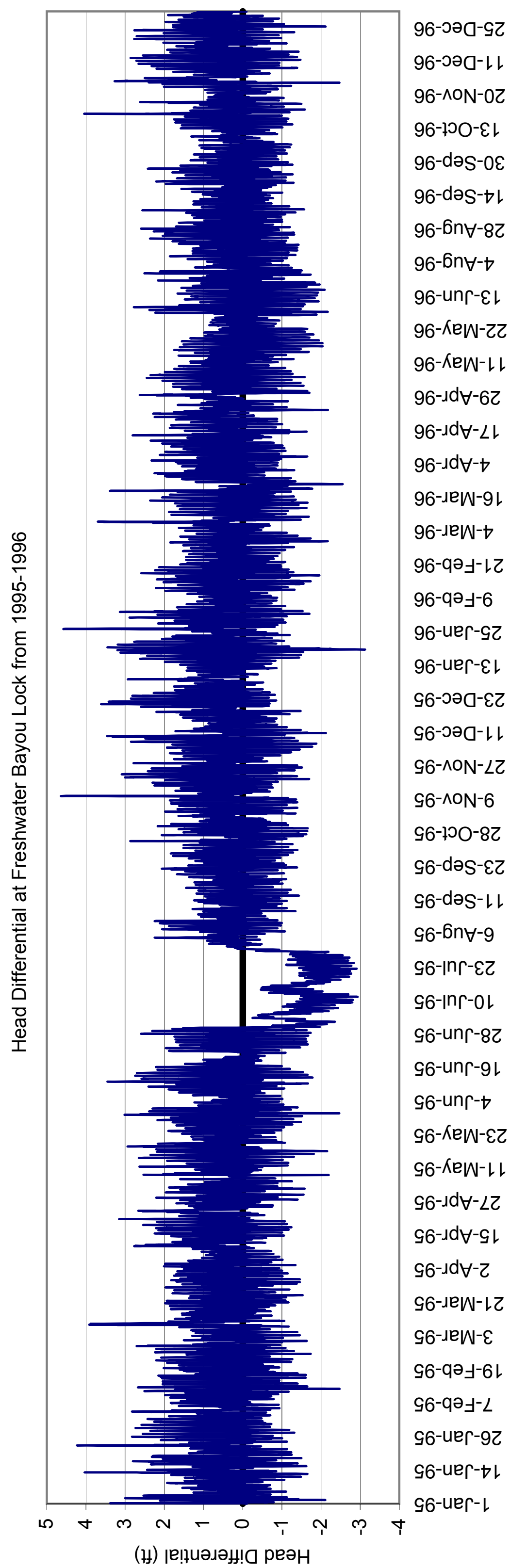
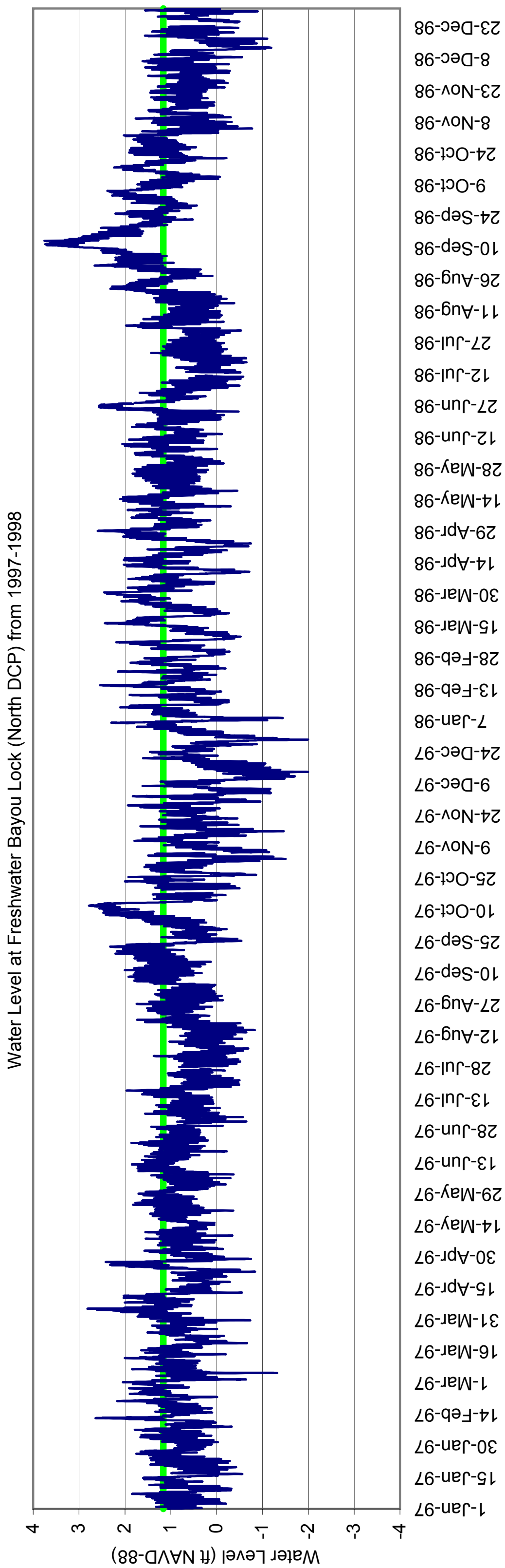
5-Nov-94
18-Nov-94
1-Dec-94
14-Dec-94
27-Dec-94


Water Level at Freshwater Bayou Lock (North DCP) from 1995-1996
Water Level (ft NAVD-88)
4 3 2 1 0 -1 -2 -3 -4
1-Jan-95 16-Jan-95 31-Jan-95 15-Feb-95 3-Mar-95 18-Mar-95 2-Apr-95 18-Apr-95 3-May-95 18-May-95 2-Jun-95 18-Jun-95 3-Jul-95 18-Jul-95 3-Aug-95 18-Aug-95 2-Sep-95 17-Sep-95 3-Oct-95 18-Oct-95 2-Nov-95 18-Nov-95 3-Dec-95 18-Dec-95 3-Jan-96 18-Jan-96 2-Feb-96 17-Feb-96 4-Mar-96 19-Mar-96 3-Apr-96 19-Apr-96 4-May-96 19-May-96 3-Jun-96 19-Jun-96 4-Jul-96 19-Jul-96 9-Aug-96 24-Aug-96 8-Sep-96 24-Sep-96 9-Oct-96 24-Oct-96 8-Nov-96 24-Nov-96 9-Dec-96 24-Dec-96


Head Differential at Freshwater Bayou Lock from 1995-1996
Head Differential (ft)
5 4 3 2 1 0 -1 -2 -3 -4
1-Jan-95 14-Jan-95 26-Jan-95 7-Feb-95 19-Feb-95 3-Mar-95 21-Mar-95 2-Apr-95 15-Apr-95 27-Apr-95 11-May-95 23-May-95 4-Jun-95 16-Jun-95 28-Jun-95 10-Jul-95 23-Jul-95 6-Aug-95 11-Sep-95 23-Sep-95 28-Oct-95 9-Nov-95 27-Nov-95 11-Dec-95 23-Dec-95 13-Jan-96 25-Jan-96 9-Feb-96 21-Feb-96 4-Mar-96 16-Mar-96 4-Apr-96 17-Apr-96 29-Apr-96 11-May-96 22-May-96 13-Jun-96 4-Aug-96 28-Aug-96 14-Sep-96 30-Sep-96 13-Oct-96 20-Nov-96 11-Dec-96 25-Dec-96


Water Level at Freshwater Bayou Lock (North DCP) from 1997-1998
Water Level (ft NAVD-88)
4
3
2
1
0
-1
-2
-3
-4
1-Jan-97
15-Jan-97
30-Jan-97
14-Feb-97
1-Mar-97
16-Mar-97
31-Mar-97
15-Apr-97
30-Apr-97
14-May-97
29-May-97
13-Jun-97
28-Jun-97
13-Jul-97
28-Jul-97
12-Aug-97
27-Aug-97
10-Sep-97
25-Sep-97
10-Oct-97
25-Oct-97
9-Nov-97
24-Nov-97
9-Dec-97
24-Dec-97
7-Jan-98
13-Feb-98
28-Feb-98
15-Mar-98
30-Mar-98
14-Apr-98
29-Apr-98
14-May-98
28-May-98
12-Jun-98
27-Jun-98
12-Jul-98
27-Jul-98
11-Aug-98
26-Aug-98
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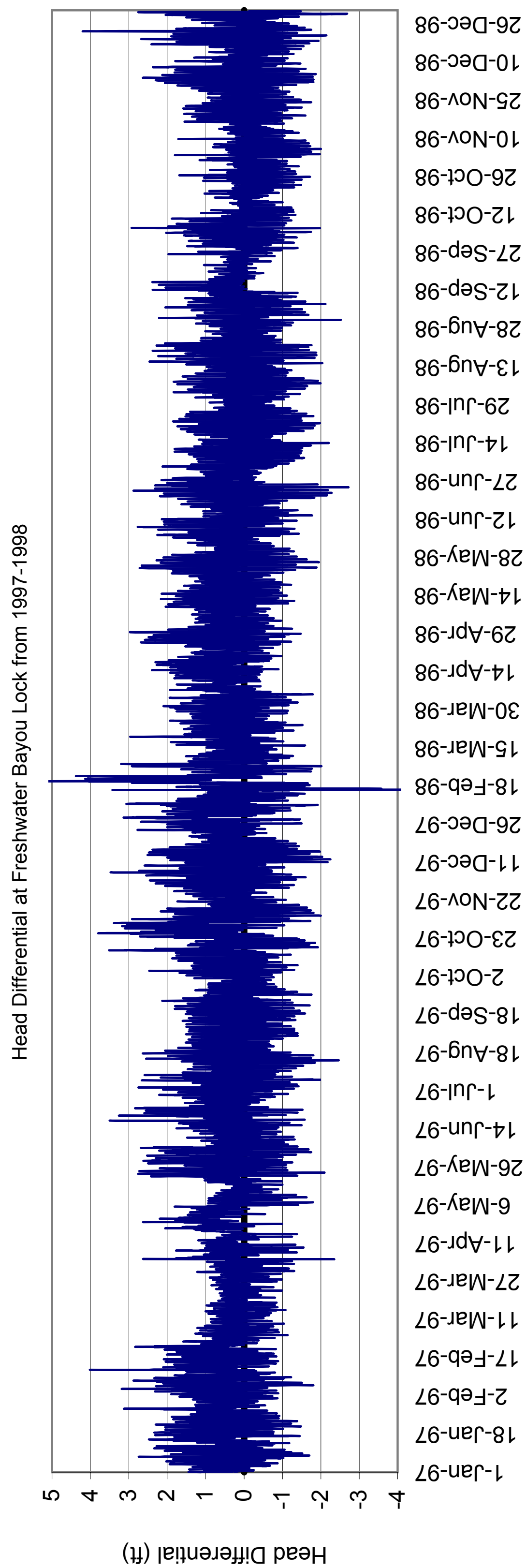
24-Oct-98
8-Nov-98
23-Nov-98
8-Dec-98
23-Dec-98


Head Differential at Freshwater Bayou Lock from 1997-1998
Head Differential (ft)
5
4
3
2
1
0
-1
-2
-3
-4
1-Jan-97
18-Jan-97
2-Feb-97
17-Feb-97
11-Mar-97
27-Mar-97
11-Apr-97
6-May-97
26-May-97
14-Jun-97
1-Jul-97
18-Aug-97
18-Sep-97
2-Oct-97
23-Oct-97
22-Nov-97
11-Dec-97
26-Dec-97
18-Feb-98
15-Mar-98
30-Mar-98
14-Apr-98
29-Apr-98
14-May-98
28-May-98
12-Jun-98
27-Jun-98
14-Jul-98
29-Jul-98
13-Aug-98
28-Aug-98
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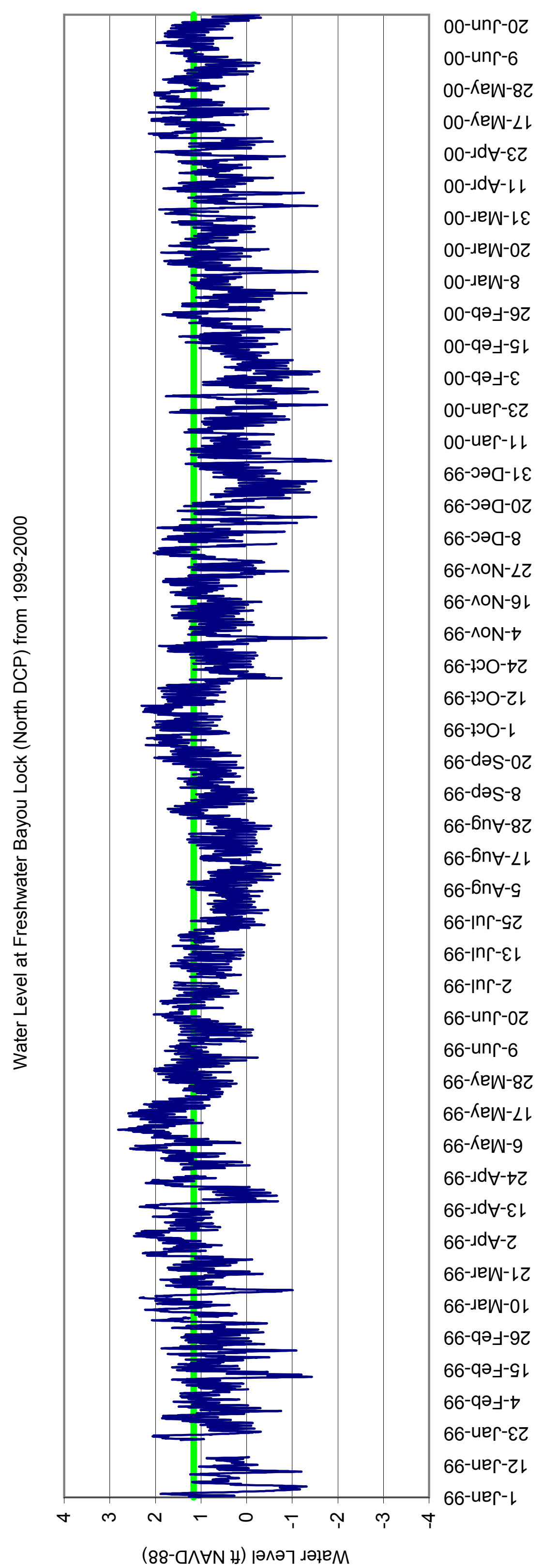
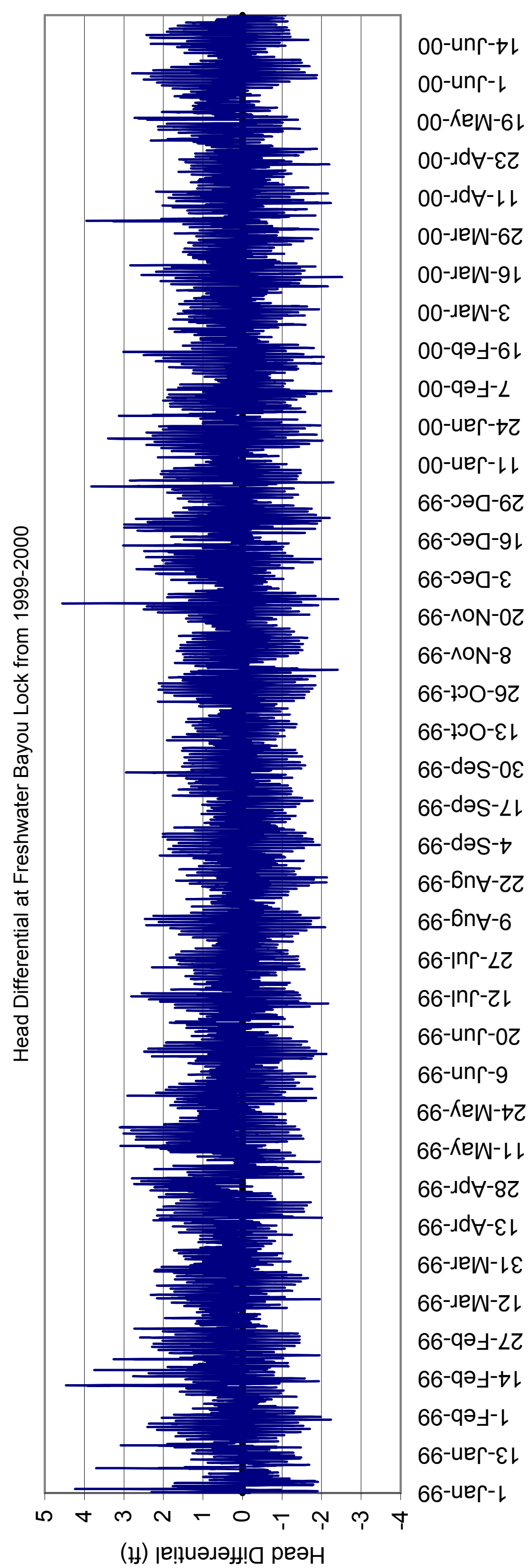
26-Oct-98
10-Nov-98
25-Nov-98
10-Dec-98
26-Dec-98


Water Level at Freshwater Bayou Lock (North DCP) from 1999-2000
Water Level (ft NAVD-88)


Head Differential at Freshwater Bayou Lock from 1999-2000
Head Differential (ft)

APPENDIX B

Mermentau Basin Coastal Change Analysis Program Methodology

Mermentau Basin Coastal Change Analysis Program

Under funding from the National Oceanic Atmospheric Administration, the Spatial Analysis Branch of the U.S. Geological Survey National Wetlands Research Center conducted a Coastal Change Analysis Program (C-CAP). Landsat Thematic Mapper (TM) images and collateral data sources were used to classify the land cover of the Mermentau Basin within the Chenier Plain of coastal Louisiana.

Methods

Cloud-free TM images were acquired of the Mermentau Basin between the fall and winter months (October-February) for the years 1990-96. Two scenes were required to cover the basin in 1990 and three scenes in 1993 and 1996. Of the three winter scenes used in the 1993 classification, one was from the 1992-93 winter season. Similarly, a 1995-96 winter scene was used in the 1996 classification. As in the use of the 1990 fall scenes, the earlier collections were used because of the lack of cloud-free images. The scenes were georeferenced and subsequently mosaiced to a UTM coordinate system by using a nearest neighbor resampling method and a spatial resolution of 25 m by 25 m. Visual inspection and the reported root-mean-square error indicated +/- 0.5 pixels registration accuracy among all images. After georeferencing, all compiled raster and vector data were entered into a common database. We performed TM image classification based on methods outlined in Dobson et al. (1995). Final classification contained 16 classes, including nine upland, five wetland, and two water classes.

The basin was separated into subregions and progressive clustering was used to classify the TM images. Separation into subregions permitted a more detailed analysis within regions that were defined by different groupings of land covers. For example, many rice fields were saturated with water and were indistinguishable from water and emergent marsh located in the wetland areas. Separating the basin into regions dominated by agriculture and by coastal wetlands reduced misclassifications and allowed the majority of rice fields to be correctly classified as cultivated land. Another technique based on the use of the multiple classifications identified and corrected misclassifications that were associated with very unlikely land cover transitions. This technique proved highly successful in uncovering misclassified burned marsh and misclassified upland and wetland forests. The ultimate advantage of the masking and post-classification correction techniques was to reduce human intervention during the classification process that is often necessary to recode incorrectly classified land covers.

Classification accuracy assessment in all years used a class-stratified, random-sample design to select over 30 points per land cover class. Existing points were then verified with color infrared high-resolution photography from approximately the same time period as the TM collection. In 1990 and 1993, photography covered only the lower half and lower third, respectively, of the Basin. In areas and at times outside the photographic coverage, inspection of available images and the closest photographic source was used to verify the land cover type. In 1996, additional classification assessment points were selected with a stratified random sample design within a 16-pixel buffer area around land transportation routes. Road networks were displayed over a raster image of the classified data as well as a display of GPS coordinates. Field verification points were appropriate for classification and change accuracy assessments involving 1996 image data only.

Results

The largest spatial coverages for the entire study area in 1996 were associated with cultivated land (34%), grassland (9%), woody land forests (deciduous, evergreen, mixed, scrub shrub, 13%), woody wetland forests (deciduous, scrub shrub, 11%), wetland palustrine (7%) and wetland estuarine (6%) marshes, and water (17%). The remaining 3% was spread mostly between the developed high-intensity and developed low-intensity classes.

Except for scrub shrub, bare land, and unconsolidated shore classes, over 30 points per class were assessed for accuracy in 1990 and 1993. In 1996, over 30 assessment points represented each land cover class. The 1990, 1993, and 1996 classification accuracy percentages were 80%, 78%, and 86%, respectively. When the cultivated and grassland classes and the water and floating vegetation were combined into one class, the accuracies for 1990, 1993, and 1996 increased to 82%, 83%, and 90%, respectively. In the coastal region of the basin, most classification errors were associated with confusion between:

(1) woody wetland deciduous and woody land deciduous and mixed;
(2) woody wetland deciduous and scrub shrub;
(3) bare land and unconsolidated shore;
(4) water and unconsolidated shore;
(5) and, especially in 1993, water and floating vegetation.

APPENDIX C

Sabine National Wildlife Refuge
Annual Narrative Report Notes

Summary

To manage an ecosystem as complex and dynamic as the Calcasieu-Sabine estuary, it is useful to review what is known about the natural variability of the ecosystem and the effects of historical hydrologic alterations. To this end, the annual narrative reports dating back to 1938 from the Sabine National Wildlife Refuge are a tremendous resource. These reports represent an excellent historical record of management activities, climatic events, and natural resource management and utilization on the refuge. The reports began with the establishment of the refuge in 1938 and are continuous through the present with the exception of the years 1994 through 1997. For some time periods the reports were completed tri-annually and for others, on an annual basis. They discuss management and development activities on the refuge and document weather, waterfowl, fur and reptile abundance and harvest, cattle grazing, fishing activities, and tourism on the refuge.

The following is a summary of those events and activities that we found useful, interesting, and sometimes humorous from the perspective of the refuge managers. This record documents a 60-year period during which numerous storms, freezes, droughts, floods, fires, vegetative shifts, and hydrologic alterations occurred that in many ways gave rise to the Sabine National Wildlife Refuge of today. Additional information can be gathered directly from the reports located at the refuge headquarters.

1938 Civilian Conservation Corps (CCC)
The narrative for this period focuses on establishing the refuge headquarters and levee repair.

1939 CCC
This narrative also focuses on the ongoing headquarters construction

1940 CCC
Refuge infrastructure construction is ongoing. Pool 3 levee construction begins

2/8/40 Earl A Chiasson Narrative Report for 12/39 and 1/40.
"Thursday January 18, 1940 marked the beginning of a coast wave that lasted ten days. Sleet, snow and ice with the cold temperature at 12 degrees (Fahrenheit). ....Conditions here at Hackberry were the worst experienced in the past twenty-five years. To make matters worse than stated above, the canals were practically void of water due to the north and northwest winds. A record low was recorded, by the Refuge Manager, of -2.5 ft."

1/18/40
Robert W. Newman, Project Superintendent Narrative Report for October through December.
"56 new enrollees came in October as replacements. These lads will not average over eighteen year of age. They come from farm and trapper homes in Southern Louisiana and have not previous training, which fits them for work in the camp. They not only speak French, but they even DREAM in French."

August - November, 1940.
"During The first nine (9) days of August, 1940, some 14.04 inches of rainfall occurred at Sabine, 9.12 inches of which fell in one twenty-four hour period....Needless to say there were many interesting and instructive observations made during the storm in August. Water levels changed quickly and drastically, subject to the whims of the winds, rainfall and backwaters.

...The high water at Sabine Refuge reached two peaks; the first on August 7 was due to the high winds of the storm itself; and the second from August 12 through the 14 as the result of flood waters coming into Calcasieu Lake from the north. This last peak was slightly higher than during the height of the storm itself. The highest recorded water level was plus 4.0 above mean low gulf level.

Water poured into the canals in large quantities for many days. When the water began to recede, the canals carried it out of the refuge at the rate of more than 500,000 gallons per minute.

During this period salinities of canal water varied considerably, depending upon the source. During the latter part of the storm, salinities varied from 1.08 to 27.16 per cent sea water. In one case (Station No. 1) the top was 9.50 per cent sea water and the bottom water at the same station read 27.19 per cent sea water. Canal water was much fresher water, and in most cases bottom and top water were near or exactly the same.

Water has continued to escape from the refuge through the canals, and is still doing so at this writing despite the small amount of rainfall during the month of October." Harry Adams, Refuge Manager

September 23, 1940.
A storm with winds 60 to 65 mph caused high tides to cover the road between Hackberry and Sulphur.

1941
Infrastructure construction continues on the refuge with the Headquarters mostly complete. The report states that the Calcasieu Shipping Channel is completed.

August - October, 1941
Two hurricanes were recorded in September. The first made landfall closer to New Orleans and the second closer to Port Arthur. There were 70 mph winds in Port Arthur. Tides rose from 2.5 to 4.1 ft overwashing the Gulf ridge.

1942
The Civilian Conservation Corps was terminated.

November 1941 - January 1942, NEWS FLASH
A fine specimen of a Nutria has recently been trapped on the Sabine Refuge much to the surprise of everyone and most of all Offie Buford, local trapper. The Nutria is a muskrat-like member of the rodent family and was imported from South America into Louisiana marshlands some years ago. Since that time they have spread considerably from their original North American home near New Iberia, LA and occasional specimens are taken throughout the area. Offie's surprise in seeing the animal in his 'coon trap is eloquently expressed in his own words:—

"I set my trap juss lik for ottah or mink. I dident know it wass dat ting dat come catch in dat trap, no. Dat morning I pass in pirogue on canal. De first trap don't have nothing. I have two trap 'fore I get there. I stop in my pirogue and I'm see dat ting. I can see dat ting 'fore I get down from my pirogue. It wass right to da watah and juss 'nether side of dump I had ottah. I kill dat "battie" first, I say, Offie 'fite gaus'" (scuse, pless, dat is suprise cuss, I can't help dat.)

"I sorry I kill dat ting. Den I go and kill ottah. I take ottah out of de trap first. Dat is de first time I see someting like dat, me. I put de "battie" in pirogue. I bring him to Old Bayou. I hid heem in my pirogue in de back and ask Pierre I want bet him dollah he could not say what I had in pirogue, I show de "battie" to Pierre an' he say "dat is de first time I see dat", heem tool. I skin dat "battie" to Old Bayou and stretch heem, "C'est Tout.'"

> Editors note:
> "Battie" or Bete is any strange or new animal.
> "fite gaus"–your guess is as good as ours.

November 6, 1943, Hurricane
"...The marsh is a veritable lake, consequently, we have cattlemen parked at our doorstep, begging for help; but through it all, they have kept their equilibrium and remained gentlemen. The trappers have had to swim their lines and we have all herd their woes. Nevertheless, the geese and ducks continue to brouse and keep us awake and defy anyone to molest them, and after all, our primary purpose in being here is to keep them happy, even though it is hard to see the cattle dying all around us. I am now convinced that it is a poor place to keep cattle and a losing battle insofar as grazing is concerned."

January - April, 1948
The marsh buggy was being used for clearing ponds in the marsh and destroying vegetation to improve waterfowl habitat.

1948
This was a major drought year

May - August, 1948
"Nutria is Louisiana's newest fur resource and one which we wish we had. There are two on the refuge which escaped from traps last winter but whether or not they are alive is a moot question. Every time we get high enough off the ground to gaze out over the vast expanses of southern bulrush in the central portion of the marsh, we are reminded that nutria find this plant sufficiently palatable that they will make extensive clearings in the bulrush stands.

Because of their taste for some of the coarser marsh plants they can be employed as a useful tool in duck management. Being beneficial in this respect and also providing an additional source of fur, adds up to one of those rare cases of "eating your cake and having it too."

October, 1949
Confusing references to a tropical disturbance also described as a hurricane with some damage to refuge facilities. Photos of extensive marsh flooding.

1948-49
Muskrat populations reach all time recorded low.

January -April, 1951
This was a period of exceptionally low water.

May-August, 1951
More low water is recorded on the refuge. Muskrats are coming back and "otter and mink populations are thriving."

September.-December, 1951
Low water continues but is "recovering". The effects of drought on wildlife, particularly furbearers are projected to be "years in healing."

January -April, 1952
Pool 3 is basically complete and with winter rains is looking like a pool.

January -April, 1953
Severe drought conditions are recorded on the refuge. The only fresh area on the refuge is Pool 3. The pool is showing signs of increasing aquatics. The drought ends by mid-May.

August 1953
Work initiated on Pool 1

January -April, 1954
The narrative reports dry conditions (7.74" total rainfall compared with 21.83" in 1952, and 8.10" in 1953 over the same period), with average temperatures. Pool #3 had water over 2.0' so logs were pulled. They were replaced when the water level reached 1.7', and the water level was 1.5' by the end of the period. The pools went from plenty of water to low water by the end of April. In the last week of April a wind event pushed salt water into the canals as far as Pool #3. Levee construction around Pool #3 continued, and the ditch around Pool #1 was cleaned out. About 45,000 acres were burned in the year prior to April 1954, about 35,500 of which was saw grass marsh, which showed good regrowth. A severe drop in mink harvest (457, compared to 1,413 in the previous year) was accompanied by a four-fold increase in nutria.

May-August, 1954
Summer drought sees low water levels equaled in severity to '51. August rainfall helps water level rise.

September - December, 1954
Drought conditions prevailed on the refuge with no water over the marsh except in Pool 3. This report notes one of the best waterfowl seasons in a number of years however, the muskrat and alligator harvest is indicated as the worst on record.

January - April, 1955
This was a wet period (17.44"), with high rainfall in February, but no rain in March. March was one of three months in the last 16 years with no rainfall measured. High winds were recorded on April 23. Sabine Pool #3 started at 0.64', but the early rains raised water levels up to 1.58', and it stayed close to that for the duration. From January 18 to February 15 the logs were removed to lower the water level to 1.2' to work on the levees. The canals and marsh freshened due to the high rains. Levee work continued, and about 51,750 acres were burned in the previous year. The nutria population continued to increase, and some recovery was noted for the mink population. The grey fox appeared for the first time, and was considered a pest.

May - August, 1955
Water conditions were noted as favorable with good rainfall

September -December, 1955
Rainfall below average but well distributed. Water conditions are generally good.

January - April, 1956
Abundant water supply on the refuge. Muskrat and nutria harvest on the rise.

May-August, 1956
Average rainfall this period kept the Pool #3 level at 1.26' (ranged from 1.78' to 1.14'). The marsh was becoming very dry. Several wildfires were started by lightning. Duck forage was not as good this year. Construction continued on the north levee of Pool #3.

September -December, 1956
Began that period following one of the worst summer droughts on record with no surface water and subsurface water down to "an extremely low level." Autumn rains brought a recovery in water levels.

January -April, 1957
Very wet first period (27.19" total), with most of the rain in March and April (11.19" and 13.00", respectively). This was the highest rainfall total for these months in 18 years. Pool #3 started at about 1.80' (MLG) and increased to 2.34' on March 19. The water level stayed at 2.2-2.3'. January and February were unseasonably warm. Management considered the need for nutria management (thinning by any means necessary). Alligator populations were increasing. Levee construction at Pool #3 continued. Put out 300 tons of sand in last two years for the geese to use as grit. About 42,000 acres were burned in the year prior to April 1957.

May - August, 1957
Water conditions reported good to excellent in spite of Hurricane Audrey and Bertha. Audrey brought 7.6 inches of rain and over 7 feet of tide water. Winds in excess over 105 mph. High rainfall year. Reported damage to the marsh was not as bad as expected. With relatively rapid flushing that was helped by 6.15 inches of rain in July and Hurricane Bertha in August that carried an additional 7.55 inches. Saltwater intrusion from the hurricane was diluted enough in Pool 3 that alligator weed was unaffected. Some damage to submerged aquatics from wind and waves was reported in the five lakes area.

The storm killed tens of thousands of nutria and scattered them across the refuge to the extent that "we should be ready for extensive control of them this season."

September -December, 1957
Rainfall was high, with a yearly total of 79.43", which made 1957 total the highest recorded in a calendar year. The muskrat population was up, the mink population was down, and nutria were spreading rapidly. Water levels were too high to conduct marsh burning.

January -April, 1958
Fairly high water period with flooded marshes in the early part of the year. Report of the scouring effect of Hurricane Audrey left large barren areas immediately west of Calcasieu

Lake. Noted as ideal habitat for shore birds in the area. Nutria, mink, otter and muskrat and raccoon populations all reported to have been reduced by Hurricane Audrey.

May - August, 1958
Ideal weather conditions persist. Pool #3 water level stayed at or near 2.0' for the period. Levee construction around Pool #1 was completed, and water levels were kept at 1.0' MLG. About 3,500 acres along the west shore of Calcasieu Lake that were denuded by hurricane Audrey were replaced with *Sesbania exaltata* (coffee weed). Nutria populations continue to increase.

September -December, 1958
Began the period with sufficient rainfall and water on the marsh. Rains during October-December were light but the deeper ponds still had enough water for waterfowl.

January - April, 1959
Wet first period, with a very wet February (9.12", versus average of 4"). Pool #3 was at or higher than 2.00' for the entire period. Mink and otter populations increased, and nutria were still a problem. The spillway in Pool #1b was completed.

May - August, 1959
Plenty of rain kept the marsh fresh with good reported vegetation growth. Pool 3 had plenty of water. First mention of expansion of flats caused presumably by salt influx from Audrey in 1957 and saw grass die-off.

September -December, 1959
Sporadic rain (low, high, low, high) averaged slightly higher than normal. This November was the coldest in years. Water levels were 2.08' to 2.48' throughout the period. The levees around Pools #1a and #1b were completed in December.

January -April, 1960
Rainfall was below average with a dry March. Temperatures were below normal, with 16 freezing episodes. February 11, 1960 experienced 4" of snow, the most since 1895. Pool #3 was > 2.00' until March, when it fell to 1.66'. Pool #1a stayed less than 1.00'. Pool #1b started at 2.46' and dropped to 1.94'. The coot population was one-tenth the level of 1958. Otters and muskrat populations showed increases. Nutria infestations and die-offs resulted in hundreds of acres of loss of saw grass marshes, cordgrass, and bullwhip. A large muskrat die-off may have been due to disease. Nutria hindered the establishment of vegetation on the Pool #1a dike. About 20,000 acres were burned in the year prior to April 1960.

May - August, 1960
There was severe drought during the first three months of the reporting period. Large areas of marsh had dried up completely and the ground was cracked. Frequent heavy rains in late-July ended the drought. The drought was reported to be beneficial to the marsh by eliminating or slowing the growth of many of the undesirable species such as coffee bean. The saw grass marsh in Pool 3 continued to die-off.

September - December, 1960
Rainfall was slightly above average. Water levels were recalibrated and management practices were changed. Pool #1b was kept as high as possible (up to 3.86' MGL), Pool #1a was kept low to prevent dike erosion, and Pool #3 was kept at 2.5' (which was low, based on the new datum). Nutria were still increasing on the refuge.

"Saw grass is almost non-existent." - Kent Meyers, Refuge Manager

January -April, 1961
Mention of bultongue and *Eleocharis* spreading over mudflats that were created by the die-out of saw grass.

May - August, 1961
This was apparently are really good season for waterfowl food in all of the pools and in the East Cove marshes. "The dense growth of millet would be the envy of any flatland rice farmer."

September - December, 1961
Low rainfall in October. On September 9, 1961, Hurricane Carla made landfall, with 35-80 mph winds, and seas 5-9' above normal. Water at Headquarters was 5.3' MGL. The marsh was flooded with salt water for a period of two weeks. Only 2.73" of rain was associated with the hurricane. In Pool #1b, water levels increased to over 4' (4.08' and 4.32' on September 1 and September 12, respectively). In Pool #3, water levels were 2.26' on September 1 (pre-Carla). The storm topped the levees, and water levels were still over 3.3' (gage limit) on September 17. Pool #1a was topped for 12 hours and inflow continued into to pool for one week. Rains didn't came until November 3. Over 80% of the millet was destroyed.

January - April, 1962
A very cold winter coupled with low precipitation during March and April created ideal conditions for millet regrowth but this was not seen. In fact "all vegetation seems to be retarded." Thousands of nutria were killed by Carla and in the January hard freeze. "...they would bed up together in dense stands of grass to keep warm, only to freeze to death." Kent Meyers, Refuge Manager. By this time the economic gains from the nutria harvest now exceed what was once gained from the muskrat harvest.

May - August, 1962
Rainfall was high in August, but drought conditions persisted until then. Two major storms hit in August, including one on August 28 that dropped 24.4" of rain (22" in 24 hour period), with 80-85 mph winds. During the drought, standing water was restricted to the deeper bayous and borrow ditches. Pool #3 went from 0.92' to 2.42' from the August 28 storm. Pool #1b went from 1.12' to 3.24' during the same event. Some of the bultongue marsh died as a result of the drought. "Marcenaux Ridge has not fully recovered from the saltwater tides caused by Hurricane Carla in 1961. The heavy growth of olneyi that covered the area on both sides of Gray's Ditch in prior years has disappeared; this area now supports patens."

The rest of the marsh appears to have recovered from Carla. The alligator population had increased, and was considered too large.

September - December, 1962
The drought ended with heavy rains in late August. Water levels (at least in the pools) appear to be adequate.

Muskrats on the refuge were still declining with only a few accidental catches in the nutria traps.

January - April, 1963
Drought conditions, with half the normal amount of rainfall. Pool #3 decreased to 1.81 ft, which was the lowest level since 1956. Pool #1b was down to 2.68 ft by late April. The unmanaged areas were dry and cracking. Even the alligator holes were dry. A combination of SE winds and the drought resulted in salt water being blown into the canals. The nutria population dropped, either as a result of the drought or from disease.

May - August, 1963
Severe drought continued. The marshes were VERY dry. Pool #1a dropped to -3 inches. Pool #1b dropped to 1.8 ft MGL, and Pool #3 set new record lows. Readings were 0.4 ft, 0.75 ft, and 0.16 ft at Spillways 1, 2, and 3, respectively. The nutria population declined, and lightning fires were common.

September -December, 1963
September 17 and 18 brought Hurricane Cindy with 6.57 inches of rain which "...relieved a drought which was in its second year and believed to be as severe as the one in 1939. ...Hurricane Cindy was most beneficial to coastal marshes as it brought quantities of water that could be gained only through the effects of such a storm." Pool 3 received 18 inches of water.

December brought a hard freeze to all refuge canals. This was the coldest December since 1950. Normal rainfall in November and December. Unmanaged marshes remained flooded most of the period.

"During the waterfowl season tides aided in the utilization of the dwarf spikerush all over the old sawgrass flats by providing surface water for birds to puddle." John Walther, Refuge Manager

Nutria declining following the prolonged droughts.

1964
April was a dry month, but July was wet. Hurricane Hilda hit October 2, 1964, with gale force winds and tides one foot above normal. Little or no rain was recorded. About 2,060 million gallons were released from Pool #1a during the year. Water in the canals was still brackish. "The saw grass die off area in the northeast corner of this pool (#1a) still remains barren due in part to the high soil salts present." The water level reached 2.18 ft in

December, but high external water levels prevented flushing. In Pool #1b water levels reached 4.00 ft in September, and stayed there for the remainder of the year. The water level in Pool #3 started at 2.5 ft, increased to 3.0 ft by the end of March, and dropped to 2.0 ft by the end of summer. Nutria numbers were still low, and about 48,000 acres were burned.

1965
Adequate rainfall, low salinity and excellent weather in early spring made 1965 a very goodyear for the marshes on the refuge from the waterfowl utilization standpoint. As it turned out, it was a good waterfowl year.

Muskrat population seems to still be decreasing. Nutria are declining and were rarely seen on the refuge since 1961-62. The reasons were not understood at that time. (Suspect that the decline was drought related.)

1966
Even rainfall throughout the year prevented drought conditions from developing. Temperatures were mild. Hurricane Inez caused some salt water intrusion in the canals, but no major damage was done. Fishing was the best in years. Pool #1a was managed under drawdown conditions to reduce salinity. Water levels ranged from 1.40' in March to 3.10' in September. The Northline Canal silted in to the point where it was impassible to boats. Pool #1b reached the target level of 4.00' by February, and stayed above that for the rest of the year. Pool #3 took a year to get up to the target level of 3.00' after completion of the levees in June 1965. It reached the target level in August and stayed stable for the rest of the year. Marshes outside the impoundments had good rainfall. Spikerush was growing where sawgrass had died out. Muskrat and nutria populations rebounded. About 17,000 acres were burned.

1967
Nothing particularly remarkable. Generally a good year for brackish marshes but the fresh marshes suffered some due to low rainfall and “salt tides.”

Muskrat population is increasing. Harvesting nutria is increasing in popularity and it is more sought after as a furbearer. Populations of nutria are rising on the refuge.

1968
Adequate rainfall maintained surface water throughout the summer. Overall a good year. Muskrat and nutria populations still increasing. Trapping is ongoing.

1969
Erratic rainfall patterns, with a wet July, but dry August and November, led to drier marshes, particularly in the fall and winter. Pool #3 had high water levels throughout the year (near what was considered optimal). Pool #1b was kept slightly below 4.0' to eliminate *S. patens*. On October 20, 1969, Hurricane Laurie hit, with minimal rain and tides (only 0.31" rain, and normal tides). The unmanaged areas experienced a relatively dry year. In Pool #1a, the water level was about 3.00' until it was reduced to 1.9 on November 4 to draw it down. Phragmites and bullrush were the main vegetation species. Salt water was deliberately

introduced to control these less desirable species. Three-square increased in all units. Muskrats increased, mink and raccoon decreased, and nutria remained stable. A total of 22,000 acres were burned.

1970

Nothing remarkable. Conditions were not favorable for millet production due to salt tides and surface flooding that precludes seed germination for that species. Small increase in muskrat. Mink and otter declined. Nutria were fairly stable but projected to increase. Raccoons declined for the third year in a row.

1971

Rainfall was 10 inches lower this year than average, resulting in drought conditions from March to August. Hurricanes Fern and Edith on September 10 and 16, respectively, brought 8.10 inches of rain. Fern had little rain associated with it, but pushed high tides, which flooded 100,000 acres with salt water. Edith had 75 mph winds and dropped 5.10" rain in less than 12 hours. The high waters from Fern had not subsided before Edith hit. Pool #3 was managed for maximum water levels all year, but low rains caused it to drop from 3.3' in January and February to 2.0' until December. Pool #1a was managed for minimum growth of Phragmites (maximum drawdown). The salt flood from Fern was kept in the pool purposefully to kill off some of the Phragmites, but rain from Edith diluted the salt enough for Phragmites to grow better than average. Muskrat and mink were still low, but the nutria population increased to 20,000. Fishing in the refuge was poor, but the alligator population showed signs of increasing. A total of 28,000 acres were burned.

The EIS for the Cameron-Creole Watershed project was prepared on August 27, 1971. Also, Jake Valentine submitted a report entitled “Some biological aspects of the Cameron-Creole Watershed.”

Malathion was sprayed on July 26 and August 11 at a concentration of 3.0 oz/acre, resulting in the death of all insect life except for ants. Dragonfly populations didn’t start to recover for a year. The mosquito population was back to pre-treatment levels in two weeks.

1972

Adequate rainfall did not result in apparent benefits to the unmanaged marshes. No cause and effect for this was noted but tide gage readings fell below one foot for 3 days (2 in February and 1 in July). During the year over 101 days had readings over 2 feet.

Muskrats declined with some speculation that fire ants in the lodges may play a role in this. Mink still declining. Muskrat and otter stable.

1973 - 1974

Fiscal year calendar. There was no information for the first half of 1973, except that a major freeze in January 1973 killed many birds and cattle. A total of 77.39 inches of rain fell, with 15.72 inches in September 1973. Tropical Storm Delia hit the coast between September 4-6, 1973, dropping 7.73 inches of rain and pushing 4.32 ft tides. The year was wet, with high water levels from September 1973 to January 1974. Headquarters Canal was always greater than 1.0', and was commonly greater than 2.0'. As the refuge manager stated, "this tidal action has had its effects over the past 30 years and as time goes on the deterioration of the marsh is occurring more rapidly. During FY '74 there were 171 days that had tide readings of two feet or higher."

In Pool #1a, water levels were kept high to reduce Phragmites, resulting in a 30% reduction.

In Pool #1b, a drawdown in December was effected to facilitate trapping and to kill dense stands of alligator weed, but no hard freezes happened and the vegetation increased.

In Pool #3, water levels fell to 2.66' in June 1974 from a high of 4.06' in February 1974. Vegetation was disappearing in the Five Lakes area.

1975
Plenty of rain added to the freshwater surplus from 1974. This hurt production of waterfowl foods like Walter's Millet. Black Bayou, Willow Bayou and Sabine Lake were fresh. The Calcasieu Lake marshes continued to be destroyed by salt.

In East Cove, south of Lamberts Bayou the levee was breached allowing a "large area of marsh" to be inundated by salt water. It was noted that several other areas could break any time. The marshes around Hog Island Gully continued to deteriorate.

Muskrat population stable but low. The nutria catch had declined.

1976
Low rainfall during the summer and resulting low water allowed for good germination of millet and low tides kept the saltwater out of the marsh for the most part. The Sabine Lake side stayed fresh throughout the winter but lack of rain allowed an increase during the summer but not so much as to inhibit the growth of *Scirpus olneyi*.

"Calcasieu Lake was more saline this year also. Fortunately the tide levels remained low and there was no significant extension to the marshdamage around Hog Island Gulley. However, no vegetation has returned to the mud flats adjacent to Calcasieu Lake." John Walther, Refuge Manager

1978
Annual report for the calendar year. This was a dry year, with only 46.38 inches total rainfall (20 inches lower than previous year, and 15 inches below normal). Pools #1a and #1b had low water levels, and Pool #3 dropped to about 1.0 ft by late summer. The Calcasieu Shipping Channel was suspected as the cause of marsh loss in unmanaged areas, especially along Highway 27, due to salt water intrusion. The channel moves salt water in too fast on flood events, and then channels the fresh water out quickly, preventing it from mixing and diluting the entrained salt.

1979
This was one of the wettest years ever recorded, with 84.78 inches total rainfall (25 inches above average). September had 14.83 inches. All units were flooded throughout the year. Loss of *S. patens* along Highway 27 continued. Canals were re-dug to 16 ft wide x 6 ft deep. The refuge manager proposed a water control structure to control the salinity intrusion from the Calcasieu Shipping Channel.

1980
An average rainfall year (58 inches total) with wet March and May. March was also particularly cold. A high wind event (49 mph) occurred on January 19, 1980. The third quarter was dry, and the water level in the Roadside Ditch dropped to 1.89 inches. On September 9, 1980 Hurricane Allen caused a high water event (3.3' in the Roadside Ditch) with tides 1.5 ft above normal, and brackish water in the marsh. On October 5, 1980, Tropical Storm Danielle dropped 4.68 inches of rain. After a wet October, the marsh had a dry November and December, and the water in the Roadside Ditch dropped to 0.72 ft. Dredging of canals continued.

"Water levels in Pool #3 have been held high for over 10 years as an aid to area fishermen. The pool had lost all emergent vegetation throughout its lower half. Proposed management for the pool is for continual lower water levels." Pool #1a water levels were held lower, and in August 1980 rotenone was added to Pool #1a to get rid of "rough fish" prior to restocking with 900,000 bluegill and redear and several hundreds of striped bass.

1981
Weirs were installed at Hog Island Gully and West Cove Canals.

Construction of the lake shore levee for the Cameron-Creole Watershed Project started in Lake October, 19 years after it was first proposed.

This was a drought year with only 49.83 inches of rainfall. This was the third time in a 10 year period with less than 50 inches of rain. One third of the annual precipitation fell on five separate days. "Many shallow ponds have dried up and cracked open."

1982
After a dry January, the yearly total rainfall was normal (56.24 inches). On January 17, a low temperature of 13 degrees was recorded. Salinities were low in May and June, and highest in September and October from winds and tides. Heavy rains in December flooded the refuge, topping all the pools with fresh water. About 27,800 acres were burned in the first quarter, and another 10,000 were burned during the rest of the year. Pool #1a was stocked with 87,000 catfish. It was a poor duck year.

1983
Rehabilitation of the refuge headquarters began. The muskrat population had a noticeable increase. Oysters were seeded in Grand Bayou. Cameron-Creole fisheries study is ongoing.

The years average water level of 2.24 ft MLG was higher than both the yearly average of 1978 and 1973. Water levels over 3.00 ft MLG occurred in 1973 which at that time was a record. The ten year high water level of 4.32 ft MLG in 1983 resulted from Tropical Storm Delia. In September of 1983, a staff gage was installed that measures water levels east of Hwy 27 beyond the influence of the water control structures.

1984
An arctic cold front pushed through near Christmas 1983, dropping temperatures to 12 degrees. On January 20 and February 6 temperatures fell to 26 degrees. It was a normal to wet year, with greater than 10 inches of rain in May and October, and less than two inches in March, April, June, and December. The marsh thrived and grew well until July, when southern winds pushed saline water into the refuge and threatened the vegetation with salt burn. Heavy rains prevented this. In Pool #3 the three year dewatering cycle was completed, and it was refilled. The Northline Canal silted back in after being open for only about a year.

It was another poor duck year, and 40,600 acres were burned. Grazing was seen as a means to control cordgrass (a climax species), allowing a sub-climax ecosystem to exist.

The eastern reaches of the refuge experienced high salinity flows than desired, mainly from July to October. Probable sources of salt water include the Calcasieu Shipping Channel, West Cove, and the GIWW. An increase of 147% in the salinity at station BS since a 1980-1982 study shows that salt is moving south into Unit 2.

Fish stocking into Pools #1a and #1b continued (bluegill and redear). Predators were reduced by gill net. The bass stocking apparently did not establish. There were three major fish kills in the refuge. On January 6 extreme cold killed fishes, and on May 7 approximately 3 million menhaden died from low dissolved oxygen levels. On November 4 there was a major die-off after heavy rains in October. It affected fishes, shrimp, and crabs, and lasted for about six weeks.

1985
Hurricane Danny hit Cameron Parish on August 15, 1985, bringing 3.14 inches of rain. Little damage was incurred.

On October 29 Hurricane Juan played along the Louisiana coast for five days bringing 9.45 inches of rain. Only minor damage to the refuge was reported.

190 to 200 acres of marsh was created in near Hog Island Gully from CSC dredged material. The area vegetated naturally.

In 1984 and 1985 the average salinity for the “west refuge” was 7.7 ppt. The salinities in East Cove averaged 11.8 ppt. Report states that averages would have been higher if not for Hurricane Juan having dropped nearly 10 inches of rainfall over 5 days. This lowered salinities from 14.3 on October to 6.2 ppt in November. East Cove salinities fell from 14.7 ppt to 1.2 ppt.

"Salinities in the Ship Channel ranged from 1.7 ppt in March to 40.0 + ppt in August. The unusually high reading in August may be attributed to a reportedly broken brine line located south of the refuge."

1986
This year experiences a drought for most of the year, with only 48.48 inches total rainfall. December received 8.46 inches of rain, while July only received 0.59 inches. Hurricane Bonnie went through Sabine Pass, Texas on June 26, 1986. The majority of the marshes benefitted from the rainfall associated with the hurricane. Because of the drought, this was one of the lowest waterfowl years ever recorded. A fish kill in Pool #1b killed about 5,000 bluegill and redear due to high temperatures and low dissolved oxygen levels.

Mean salinities decreased from east to west. The Calcasieu Shipping Channel had an annual mean salinity of 17.6 ppt, while the East, Central, and West Zones of the refuge averaged 14.3, 6.0, and 5.6 ppt, respectively.

A study conducted by LSU compared standard fixed-crest weirs with vertically slotted weirs. They found that both buffer salinity changes, and both impeded the movement of organisms. Also, larger species used the standard weirs, but biomass and the number of species was reduced behind the standard weirs. They also observed that saltmarsh cordgrass had reduced growth in waterlogged sites.

1987
Climatic conditions were unremarkable. Donald Cahoon of LSU is evaluating sedimentation in the Grand Bayou Marsh noted over a 12 month period 11 mm were accumulated near the mouth of Grand Bayou that were mostly mineral soils.

1988
Total rainfall was 63.13 inches, with a major drought from August to October. Hurricane Gilbert (August 1988) affected tides and pushed salt water in. It started with normal water levels and salinities, but ended with low water and high salinity. Hurricane Debbie (2-4 September) dropped 6.65 inches of rain in three days (4.99 inches in 24 hours), but kept salinities high, which led to fish kills in South and North Prong bayous.

In Pool #1a, water levels were kept high (2 ft above marshes) for more effective catfish stocking. Pool #1b was kept high also (2 ft above marshes) to enhance wildlife viewing (yes, viewing). Pool #3 was kept at levels to support revegetation, but still allow fishing (~6" above marsh level).

Hog Island Gully and West Cove Canal gates were determined to reduce salinity fluctuations in the unmanaged areas of Units 1 and 2. Unit 1 had experienced 40% vegetation loss, and marsh degradation was evident in both Units 1 and 2. Units 4-7 were more influenced by Sabine Lake water, with salinities averaging 3.8-7.1 ppt. At West Cove, the salinities ranged from 1.8 to 29.8 ppt. Five variable crest weirs were constructed at Noname, Mangrove, Peconi, Lambert, and Grand Bayous.

1989
Cameron-Creole Watershed Management Plan put into operation.

Tropical Storm Alison spawns a tornado that hits the community of Hackberry. Hurricane Chantel made landfall at High Island TX on August 1. Minor wind damage to refuge infrastructure.

Hard winter freeze in December took a toll on marsh vegetation, wildlife and waterfowl.

1990
A total of 56.61 inches of rain was recorded, with 8.86 inches in September and 0.95 inches in August. The marshes were on a "fresh cycle" with high water levels and lower salinities than in the previous 10 years. Late winter and early spring rains maintained high fresh water throughout the basin. Areas of marsh were still degrading, but submerged aquatic were expanding., and the diversity of emergent vegetation increased.

An additional 36 salinity stations were added, and water flow data was collected as well. Analysis revealed that saline water from the Calcasieu Shipping Channel enters the refuge through canals and under the Long Point Bayou bridge several miles north of the Hog Island Gully water control structure, rendering it relatively ineffective in regulating salinities. During high tides saline water flows over the fixed-crest portion of the West Cove water control structure and moves westward in a salt wedge more than 4.5 miles. Salinity fluctuations were greatest near the water control structures.

Water levels in the area were high until late summer, when dry conditions caused the water levels to drop. In northeast Unit 4 the marsh appeared to be reverting to freshwater marsh.

A freeze over Christmas killed a lot of above ground foliage as well as some fishes and shrimp. Several minor fish kills were noted this year, but in mid-September a larger kill due to low dissolved oxygen resulted from a high rain event (5.5 inches in 24 hours). Damage was minimized by refuge personnel by opening the control structures to releasing high water levels and provide organisms an escape route to Calcasieu Lake. Additionally , about 12,200 pounds of gar were removed from Pools 1A, 1B, and 3 in January and February with gill nets.

The Sabine Terracing Project was constructed and completed during 1990.

1991
A total of 73.5" rain was recorded. It was a wet year, with a wet January, May, and June, but a dry October. Gates were operated to reduce salt water inflow at Hog Island Gully and West Cove canals. Lots of excess water was in the impoundments, and much effort was expended to drain them. In August, water levels outside the impoundments were low. September through November had high salinities. Large areas of *S. patens* were dying. These areas has 2-4" of water standing on them, with algae growing, indicating water that had been stagnant for some time. It is suspected that the standing water, and not the salinity caused the loss.

Management Conclusions:
• Structures at HIG and WC prevent Unit 1 from draining well.
• Replacement of saw grass with S. patens, which doesn't produce as much below ground biomass, resulted in an accretion, and in increased flooding.
• Drainage of S. patens marsh is by sheet flow, not network, so water stays on the marsh too long.

1992
Hurricane Andrew made landfall near Point Cheveriul, LA on September 6, 1992 but had little impact on Sabine. This was a pretty fresh year with 66 inches of rain (approximately 10 inches more than the thirty year average.

1993-1996
No annual narratives written. Management decision.

1997
Nothing remarkable.

1998
Tropical Storm Frances skirted the coast during the second week of September causing fish die-offs and killing marsh vegetation. Closing Hog Island Gully and West Cove structures had a "trivial" effect on surging tides. Water levels were 2.96' on 8 September, 3.3' (gage topped) on 10 September, and remained greater than 3.3' until 16 September. The storm dropped 5.64" of rain, and had 40 mph winds. Fish kills were caused by organic loading and subsequent drop in dissolved oxygen.

Phase B of terracing was completed, and 16,500 acres were burned.

APPENDIX D

Calcasieu-Sabine Basin
Marsh Elevation Survey

Marsh surface elevation greatly influences the vegetative composition as well as the vulnerability of the marsh to degradation from prolonged flooding and soil anoxia. LDNR contracted with John E. Chance and Associates, Inc., Lafayette, Louisiana, to develop a network of GPS elevational benchmarks and survey marsh elevations at strategically selected locations. In the Calcasieu-Sabine Basin, where land loss relates more to saltwater intrusion than to excessively high water levels, we wanted to gain a better understanding of how marsh elevation may relate to proposed hydrologic alterations of current freshwater inflow regimes of the Sabine River.

Establishing a comprehensive network of GPS elevational benchmarks throughout the Louisiana Chenier Plain will greatly facilitate our understanding of system hydrology. Once the GPS network is established, determining wetland elevation at almost any location in the region will be relatively simple and inexpensive. These data will be critical to future modeling efforts, but more importantly, they will immediately improve our ability to effectively plan, implement, and monitor restoration projects. An added benefit is the establishment of a common datum (NAVD-88) for all future project-level surveys. Over a period of 10-15 years, these benchmarks and elevations will assist in the development of a technically sound estimate of near-surface subsidence in the region.

The purpose of the RTK (Real-Time Kinematic) Survey was to establish accurate horizontal and vertical positions on existing marsh at strategically selected transect and sampling locations previously occupied under the Chabreck and Linscombe (1997) vegetative survey. Ten marsh shots at each sample location were collected using an RTK data collector. These locations were determined in the field by DNR/CRD personnel at the time of survey in accordance with CWPPRA project monitoring protocol (Steyer et al. 1995).

GPS Control Network and Field Survey

We established permanent control monuments in the marshes of Cameron and Vermilion parishes and created a Primary GPS Control Network utilizing existing adjusted National Geodetic Survey (NGS) monuments and High Accuracy Reference Network (HARN) stations. We subsequently established a Secondary GPS Control Network to determine horizontal positions and elevations on permanent reference monuments driven to refusal to be used for DNR projects in the Chenier Plain area utilizing RTK survey methods.

The equipment used to determine X, Y, and Z positions included an RTK Base and Rover Unit consisting of two Trimble Navigation Dual Frequency 4000 SSE GPS receivers along with external Compact L1/L2 antennas, Pacific Crest radio transmitter and receiver, and a Trimble TSC1 Data Collector.

From this GPS network, two adjusted permanent reference monuments were selected as RTK Base Station locations because of their proximity to the sites of interest. The adjusted values for the GPS/RTK reference monument "2000" was used as the base site for this RTK survey. Corrections sent from the base unit to the rover via a radio link resulted in centimeter accuracy, based on QC checks on existing control structures at the site.

With rover in place and data collector in hand, a three-member survey team set out by airboat to "tie in" various marsh shots based on the 1997 coastal vegetative mapping effort locations (Chabreck and Linscombe 1997). The position and elevation of each marsh shot were recorded on the TSC1 Data Collector by holding the point of the fixed height pole with a GPS antenna on the marsh surface and storing the fixed position. The survey collected a total of 177 marsh elevation measurements at 16 locations over a 2-day period in September 1999 (Figure D-1). Average marsh elevation was 1.58 ft NAVD-88 with a standard deviation of 0.17 ft. The highest marsh elevation recorded was 2.09 ft NAVD-88 and the lowest was 1.14 ft NAVD-88.

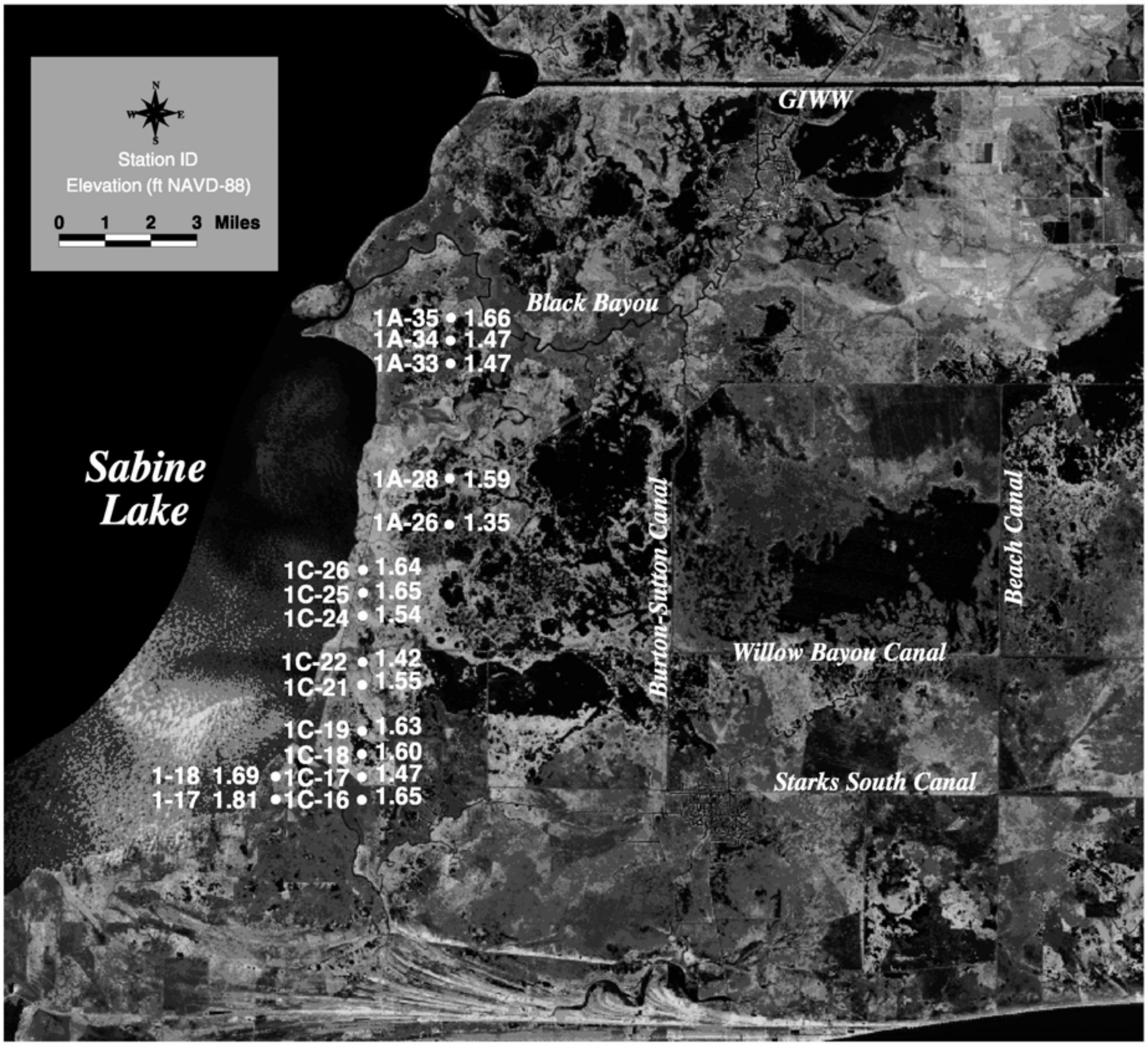


Figure D-1. Marsh elevations at selected locations in the Calcasieu-Sabine Basin. White dots represent the location at which the elevation was acquired. Numbers to the right of the dots represent marsh elevation (NAVD-88). Numbers to the left represent station number.

APPENDIX E

Hydrologic Investigation of the Louisiana Chenier Plain: Annotated Bibliography

Notes

This literature review contains most of the relevant ecology and biology studies that were performed in the Louisiana Chenier Plain, or that contain information that can contribute to knowledge of Chenier Plain ecosystem function. This reference list is not a complete list of all available literature. Further information can be found through following the reference lists in each of these sources. The following should be kept in mind:

- The annotations are interpretations of the aspects of each study most relevant to the hydrologic investigation of the Chenier Plain (HICP), and therefore may not contain summaries of all the information present in the annotated work.
- All attempts were made to keep the key word list short in order to avoid unnecessary proliferation and confusion. Therefore, any reference to fisheries or other fauna was categorized as "ecology," while references relating to vegetation were categorized as "plant processes." Individual species names were not listed in the keyword section.
- To save space, the key word lists do not have the annotations attached to the records. All annotations are found in the complete alphabetical list at the end of the document.
- Suggestions for works not included in this draft but that should be included in further versions will be gratefully accepted, and this document will be revised as circumstances dictate.

Key Word Lists

Calcasieu

Arcement 1988
DeLaune et al. 1983a
DeLaune et al. 1989
Demchek et al. 1990
Fogarty 1965
Herke et al. 1992
Lovelace and Johnson 1996
Marotz 1984
Marotz et al. 1990
Rogers et al. 1992a
USDA 1993
White and Perret 1974

Cameron Parish

Lovelace and Johnson 1996
Turnipseed 1986
USDA 1951
USDA 1995

Canal

Baumann and Turner 1990
Cahoon and Turner 1989
DeLaune et al. 1989
Knaus and Van Gent 1989
Neill and Turner 1987
Stone et al. 1978
Turner 1997
Turner et al. 1994

Ecology

Cahoon and Groat 1990
Chabreck 1972
Gosselink et al. 1979
Gunter and Shell 1958
Herke et al. 1992
Marotz 1984
Marotz et al. 1990
Morton 1973
Neill and Turner 1987
O'Neil 1949
Palmisano 1970
Perry 1978
Rogers et al. 1992a
Rogers et al. 1992b
Turner 1966
USDA 1951
Visser et al. 2000
White 1975
White and Perret 1974
Wicker 1981

Grand Lake

Gunter and Shell 1958
Perry 1978
USACE 1983

Lacassine

Turner 1966

Land Loss

Adams et al. 1978
Baumann et al. 1984
Baumann and Turner 1990
Britsch and Dunbar 1993
Byrnes et al. 1995
Day et al. 1990
DeLaune et al. 1994
Dunbar et al. 1992
Laine and Ramsey 1998
Martin and Serdengecti 1984
Neill and Turner 1987
Nyman et al. 1994
Pezeshki and DeLaune 1996
Templet and Meyer-Arendt 1988
Turner 1990
Turnipseed 1986

Marsh Management

Bryant and Chabreck 1998
Cahoon and Groat 1990
Cowan et al. 1988
Day et al. 1990
LDNR 1998
Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority 1998
Nyman and Chabreck 1995
Reed 1992
Rogers et al. 1992a
Schmalzer and Hinkle 1992
Schroeder 1991

Stone et al. 1978
Templet and Meyer-Arendt 1988
Turner 1997
Turner et al. 1994
USACE 1996
Wicker et al. 1983

Mermentau

Laine and Ramsey 1998
Louisiana Coastal Wetlands Conservation and Restoration Task Force 1993
Lovelace and Johnson 1996
Schroeder 1991
USACE 1976
USACE 1983
USACE 1996
USDA 1997

Plant Processes

Baldwin et al. 1996
Burdick and Mendelssohn 1987
Burdick and Mendelssohn 1990
Burdick et al. 1989
Cahoon and Groat 1990
DeLaune et al. 1979
DeLaune et al. 1993
DeLaune et al. 1983b
Evers et al. 1998
Ewing et al. 1997
Ewing et al. 1995
Flynn et al. 1995
Gough and Grace 1998
Gosselink and Turner 1978
Grace and Ford 1996
Howard and Mendelssohn 1995
Koch and Mendelssohn 1989
Koch et al. 1990
McKee and Mendelssohn 1989
McKee et al. 1989
Mendelssohn and Burdick 1988
Mendelssohn and McKee 1988
Mendelssohn et al. 1981
O'Neil 1949

Palmisano 1970
Pezeshki and DeLaune 1988
Pezeshki and DeLaune 1996b
Pezeshki et al. 1991
Pezeshki et al. 1987a
Pezeshki et al. 1987b
Pezeshki et al. 1987c
Pezeshki et al. 1987d
Pezeshki et al. 1989a
Pezeshki et al. 1989b
Pezeshki et al. 1990
Sasser 1977
Turner 1990
Visser et al. 2000
Webb and Mendelssohn 1996
Wilsey et al. 1992

Regional Geologic Processes

Byrnes et al. 1995
Roberts 1998
Wells and Kemp 1981
Wells and Kemp 1982

Rockefeller Refuge

Bryant and Chabreck 1998
Perry 1978
Wicker et al. 1983

Sabine

Dunn et al. 1997
Fogarty 1965
NOAA-Texas A&M University Sea Grant 1997
Turner 1966
Turnipseed 1986
USDA 1993

Soil Processes

Baumann et al. 1984
Bryant and Chabreck 1998
Cahoon and Groat 1990
Cahoon et al. 1996
Cahoon et al. 1995
Cahoon and Turner 1989
Callaway et al. 1997
Callaway et al. 1996
DeLaune et al. 1983a
DeLaune et al. 1994
DeLaune et al. 1989
Evers et al. 1998
Gambrell et al. 1991
Hatton et al. 1983
Knaus and Van Gent 1989
Morris and Bowden 1986
Nyman and DeLaune 1991
Nyman et al. 1990
Pezeshki and DeLaune 1996a
Reddy and Patrick 1975
Schmalzer and Hinkle 1992
Stephens et al. 1984

White Lake

Evers et al. 1998
Gunter and Shell 1958
Morton 1973
USACE 1983

Combined Reference List: All Key Words

Adams, R. D., P. J. Banas, R. H. Baumann, J. H. Blackmon, and W. G. McIntire. 1978. Shoreline erosion in coastal Louisiana: inventory and assessment. Louisiana Department of Transportation and Development, Baton Rouge. 133 pp. plus appendices.

This report details critical areas of erosion throughout the coast up until the mid 1970s and also makes recommendations on where state dollars would be best spent to curb this erosion. In general, cost-benefit ratios were not favorable for structural solutions to erosion in the Louisiana Chenier Plain where the sediments underlying any potential structures were generally not adequate to sustain them. Lakeshore erosion within the chenier plain was identified as severe, especially on the southern shores, but because these areas are predominantly undeveloped, no structural solutions were warranted.

land loss

Arcement, G. J. 1988. Simulation of flow in the lower Calcasieu River from the saltwater barrier to Burton Landing near Moss Lake, Louisiana. USGS Water-Resources Investigation Report 87-4087. U.S. Geological Survey, Baton Rouge, La. 30 pp.

This report presents a model simulation of the 15 miles of the Calcasieu River immediately north of Calcasieu Lake. Agreement to within ~25 % was found between model runs and actual data.

Calcasieu

Baldwin, A. H., K. L. McKee, and I. A. Mendelssohn. 1996. The influence of vegetation, salinity, and inundation on seed banks of oligohaline coastal marshes. American Journal of Botany 83(4):470-479.

This paper examined the effects of flooding and salt intrusion on seeds and seedlings in oligohaline marsh communities. Decreased abundance and diversity would presumably lead to decreased ability to recover in the face of submergence and saltwater intrusion. *Spartina patens* and *Paspalum vaginatum* marshes had the highest percent cover, which potentially led to a decline in diversity of the seed bank, but overall, the presence of vegetation had very little influence on either type of seeds or diversity in the seed bank. Likewise, salinity pulses, such as those associated with storms, do not have much affect on seedling viability, although in the short term they may be detrimental to existing growth. Sustained increases in salinity and submergence did lower viability of seedlings. The net results are communities that are more reliant on vegetative propagation than on seedling recruitment.

plant processes

Baumann, R. H., J. W. Day, Jr., and C. A. Miller. 1984. Mississippi deltaic wetland survival: sedimentation versus coastal submergence. Science 224:1093-1095.

This report compared seasonal sedimentation rates between deteriorating marshes and stable marshes in the Mississippi River deltaic plain. With the aid of artificial marker horizons, the authors determined that deteriorating marshes accrete at a faster rate than stable marshes. However, because of submergence and eustatic sea-level rise, which were measured by local tide gauges, deteriorating marshes were converting to open water while stable marshes were maintaining elevation. The authors stress the importance of factoring in local variations in submergence and accretion.

land loss/ soil processes

Baumann, R. H., and R. E. Turner. 1990. Direct impacts of outer continental shelf activities on wetland loss in the central Gulf of Mexico. Environmental Geology and Water Science 15(3):189-198.

This article makes use of extensive database and map research to attribute 4.0-4.7% (11,589-13,631 ha) of the total wetland loss in the coastal zone of Louisiana between 1955 and 1978 to oil and gas activities on the outer continental shelf. Habitat changes are also described, and comparisons made of the impact of canals versus pipelines, back-filled versus non-back-filled, and chenier plain versus deltaic plain. In brief, non-back-filled pipeline routes have greater impacts than back-filled, canals have a greater impact than pipelines, and the impacts are greater in the chenier plain than in the deltaic plain. Data are given for impacts of several large navigation canals.

canal/ land loss

Britsch, L. D., and J. B. Dunbar. 1993. Land loss rates: Louisiana coastal plain. Journal of Coastal Research 9(2):324-338.

This paper presents a summary of the land loss trends for all of coastal Louisiana, and also breaks areas of loss down into the deltaic and chenier plains. Land loss over the last 20-30 years has been decreasing in terms of both area and percent loss, and it is expected that the loss will approach a minimum representative of land loss rates before having significant anthropogenic impacts.

land loss

Bryant, J. C., and R. H. Chabreck. 1998. Effects of impoundment on vertical accretion of coastal marsh. Estuaries 21(3):416-422.

This study examined marsh accretion in three stations of the chenier plain, one near Sabine Lake and two in Rockefeller Refuge. ^{137}Cs dating techniques were used along with other methods to determine that impounded areas are lower in elevation and, in general, accretion rates are lower in impounded marshes. This effect is due to isolation from tidal subsidies of sediments and nutrients.

marsh management/ Rockefeller Refuge/ soil processes

Burdick, D. M., and I. A. Mendelssohn. 1987. Waterlogging responses in dune, swale and marsh populations of *Spartina patens* under field conditions. Oecologia 74:321-329.

Metabolic and anatomic responses to waterlogging were studied in dune, swale, and marsh populations of *Spartina patens*. All three populations exhibited increased anaerobic respiration in response to waterlogging, and only the marsh stands reached maximal aerenchyma formation. This shows that metabolic adaptations are the most important short-term adaptations to waterlogging stress, while aerenchyma formation is a critical long-term adaptation to prolonged waterlogging. Maximal aerenchyma development was apparently incapable of providing enough root ventilation to adequately support root metabolism, so marsh plants still relied heavily on anaerobic respiration, a condition that is indicative of stress.

plant processes

Burdick, D. M., and I. A. Mendelssohn. 1990. Relationship between anatomical and metabolic responses to soil waterlogging in the coastal grass *Spartina patens*. Journal of Experimental Botany 41(223):223-228.

The results of this paper show that upon initiation of flooding, the roots of *Spartina patens* are able to maintain respiration using anaerobic pathways until the morphological change (aerenchyma development) can accomplish greater root aeration. The combination of these two processes can sustain the roots under waterlogged conditions. Under prolonged submergence, however, the maximum development of aerenchyma is unable to supply the complete oxygen demand in the roots, so the plants remain in a stressed condition.

plant processes

Burdick, D. M., I. A. Mendelssohn, and K. L. McKee. 1989. Live standing crop and metabolism of the marsh grass *Spartina patens* as related to edaphic factors in a brackish, mixed marsh community in Louisiana. Estuaries 12(3):195-204.

In this study, differences in end-of-season live standing crop were not significantly related to any single factor (soil Eh, moisture, interstitial salinity, pH, nitrogen, or sulfide concentration). A combination of factors led to high standing crop of *Spartina patens* on the levee berm, lower standing crop on the stream edge, and lowest standing crop in the interior areas of the marsh.

plant processes

Byrnes, M. R., R. A. McBride, Q. Tao, and L. Duvic. 1995. Historical shoreline dynamics along the Chenier Plain of southwestern Louisiana. Gulf Coast Association of Geological Societies Transactions XLV:113-122.

Computer-based mapping was used to analyze changes in the historical shoreline between Sabine and Southwest passes from 1883 to 1994. This study revealed shifts between shoreline retreat and advance due primarily to the Atchafalaya River mudstream, erosion of marsh/chenier deposits, and shoreline orientation relative to storm and wave conditions.

land loss/ regional geologic processes

Cahoon, D. R., and C. G. Groat. 1990. A study of marsh management practice in coastal Louisiana, volumes I-IV. OCS Study/MMS 90-0075. Minerals Management Service.

This report surveys the impacts of marsh management practices (water level and salinity control) across the coast, with specific attention paid to Rockefeller Refuge and Fina LaTerre. Management in two *Spartina patens* marshes led to reductions in water level fluctuations, vertical accretion, soil bulk density, accumulation of mineral and organic matter, ingress and egress of marine transient species during drawdown years, and water, sediment, and nutrient import. Although some increased production in *S. patens* is possible in the short term after marsh management, long-term, cumulative consequences may lead to enhanced degradation. The authors noted several reasons for the observed trends, and presented a great deal of useful information for hypothesis generation, as well as a fairly current bibliography.

ecology/ marsh management/ plant processes/ soil processes

Cahoon, D. R., J. C. Lynch, and R. M. Knaus. 1996. Improved cryogenic coring device for sampling wetland soils. Journal of Sedimentary Research 66(5):1025-1027.

This paper describes a custom coring device that is capable of removing small undisturbed "cores" in a highly undisturbed state, including overlying water, by freezing with liquid nitrogen. The device seems to be valuable for detailed examination of surface soil profiles in extremely fragile soil environments

soil processes

Cahoon, D. R., D. J. Reed, and J. W. Day, Jr. 1995. Estimating shallow subsidence in microtidal salt marshes of the southeastern United States: Kaye and Barghoorn revisited. Marine Geology 128:1-9.

This paper examines rates of accretion and shallow subsidence in four marshes, two of which are in Region 2 (Terrebonne Basin). A rapidly deteriorating salt marsh at Bayou Chitigue, although accreting at a rapid rate, suffered elevation deficits over the course of the study. A healthy salt marsh at Old Oyster Bayou also had lower elevation increases than vertical accretion, but the elevation increase was more closely approximated by vertical accretion. Potential marsh loss should therefore be evaluated in terms of elevation deficits rather than accretion deficits so that all soil processes are taken into account.

soil processes

Cahoon, D. R., and R. E. Turner. 1989. Accretion and canal impacts in a rapidly subsiding wetland ii: feldspar marker horizon technique. Estuaries 12(4):260-268.

The objective of this paper was to compare sediment accretion and accumulation rates in the vicinity of natural waterways and man-made canals in coastal Louisiana. Sediment accretion rates in a *Spartina alterniflora* marsh in the Mississippi deltaic plain were significantly greater in a transect adjacent to a canal compared to a transect adjacent to a natural waterway. Vertical accretion rates were the same for both natural waterways and canals in a hydrologically restricted *S. patens* marsh on the chenier plain. However, accretion rates for a nearby nonhydrologically restricted natural waterway were significantly greater than those of the hydrologically restricted waterways.

canal/ soil processes

Callaway, J. C., R. D. DeLaune, and W. H. Patrick, Jr. 1997. Sediment accretion rates from four coastal wetlands along the Gulf of Mexico. Journal of Coastal Research 13(1):281-191.

Although this paper does not specifically deal with Louisiana wetlands, it does examine factors that are important to marsh vertical accretion in low tidal range areas. The main finding was that vertical accretion is most highly correlated with organic matter accumulation in the soil, but mineral inputs are also necessary to maintain good soil structure. There is an excellent list of references.

soil processes

Callaway, J. C., J. A. Nyman, and R. D. DeLaune. 1996. Sediment accretion in coastal wetlands: a review and simulation model of processes. Current Topics in Wetland Biogeochemistry 2:2-23.

This paper presents a good review of sediment processes important in marsh accretion, and attempts to model these processes for two sediment cores. Good model agreement with data was found (the model was partially calibrated with observed data from the cores), and predictive capability was shown to be very good with one of the cores. The paper also points out a distinct lack of knowledge concerning the below-ground processes that affect vertical accretion balances (sediment structure, depth-dependent organic matter production and oxidation, etc.). A good resource overall, this paper contains a reference to the LSU dissertation in which the entire FORTRAN code can be found. The closest marsh to Louisiana that is studied is an organic marsh in Biloxi, Miss.

soil processes

Chabreck, R. H. 1972. Vegetation, water, and soil characteristics of the Louisiana coastal region. Louisiana State University and Agricultural and Mechanical College Agricultural Experiment Station, Baton Rouge. 72 pp.

This work is the first in a series of efforts to characterize the vegetative shifts in the Louisiana coastal zone. North-south transects spaced at 7.5 minutes of longitude intervals were flown and vegetation was sampled every half mile. Soils were also sampled at 2-mi intervals. The 1968 data provide a very useful baseline from which to monitor changes over the past 30 years. (1978, 1988, and 1997 data are unpublished, although Dr. Chabreck has given us access to the data and it is readily available in GIS format.)

ecology

Cowan, J. H., Jr., R. E. Turner, and D. R. Cahoon. 1988. Marsh management plans in practice: do they work in coastal Louisiana, USA? Environmental Management 12(1):37-53.

This paper presents an overview of marsh management plans (MMPs) in Louisiana, with particular emphasis on the Chenier Plain. By interviewing many people directly involved in the development and implementation of MMPs, including landowners and state and federal employees, the authors conclude that MMPs are at best marginally successful in achieving stated goals. The authors point out several areas that need improvement in the permitting process and encourage further cooperation between all parties involved.

marsh management

Day, R. H., R. K. Holz, and J. W. Day, Jr. 1990. An inventory of wetland impoundments in the coastal zone of Louisiana, USA: historical trends. Environmental Management 14(2):229-240.

This article surveys intentional impoundments throughout the Louisiana coastal zone over the past century, synthesizing all data available up to 1985. As such it is a valuable baseline when considering future wetland losses to impoundment failures. Briefly, the authors found that the rate of intentional impoundment substantially increased throughout the 20th century, as have impoundment failures. Failures may be related to impoundment age, which may also be a function of impoundment type (most early impoundments were for agriculture).

land loss/ marsh management

DeLaune, R. D., R. H. Baumann, and J. G. Gosselink. 1983a. Relationships among vertical accretion, coastal submergence, and erosion in a Louisiana Gulf Coast marsh. Journal of Sedimentary Petrology 53(1):147-157.

Marsh aggradation rates in the East Cove Marsh area of the Sabine National Wildlife Refuge adjacent to Calcasieu Lake are measured by ^{137}Cs and feldspar marker horizon techniques. The measured rate (0.8 cm/year) is substantially less than coastal submergence rates (1.2 cm/year). Possible reasons given are dredging of the Calcasieu Ship Channel, which moved the main course of the Calcasieu River to the west, and subsurface fluid withdrawals, primarily water. This paper also gives an excellent brief history of the Calcasieu Lake region.

Calcasieu/ soil processes

DeLaune, R. D., R. J. Buresh, and W. H. Patrick, Jr. 1979. Relationship of soil properties to standing crop biomass of *Spartina alterniflora* in a Louisiana marsh. Estuarine and Coastal Marine Science 8:477-487.

This field study showed that production of *Spartina alterniflora* was directly related to bulk density of sediments, presumably because nutrients were more concentrated on a volume basis. This was the explanation for the higher biomass of streamside *S. alterniflora* as compared to interior plants.

plant processes

DeLaune, R. D., J. A. Nyman, and W. H. Patrick, Jr. 1994. Peat collapse, ponding, and wetland loss in a rapidly submerging coastal marsh. Journal of Coastal Research 10(4):1021-1030.

Although the study was not done in Region 4, it does document the immediate effect of plant die-off, notably the collapse of peat supported by live plant roots, which leads to rapid ponding (7.5 cm decrease in elevation per year). This is due to the loss of the large amounts of air space present as aerenchyma in the roots of living plants. This loss occurs after any processes that contribute to plant death (e.g., salt intrusion, increased submergence, etc.) have taken their toll.

soil processes/ land loss

DeLaune, R. D., S. R. Pezeshki, and W. H. Patrick, Jr. 1993. Response of coastal vegetation to flooding and salinity: a case study in the rapidly subsiding Mississippi River deltaic plain, USA. Pages 211-229 i*n* M. B. Jackson and C. R. Black, eds. Interacting stresses on plants in a changing climate. Springer-Verlag, New York.

This is a fairly good review of wetland plant responses to adverse conditions, such as salt intrusion, excessive flooding, and low redox potentials. There are a few typographical errors, so careful reading is required, but the overall information and references provide a valuable introduction and starting place if more information on these issues is needed.

plant processes

DeLaune, R. D., C. J. Smith, and W. H. Patrick, Jr. 1983b. Relationship of marsh elevation, redox potential, and sulfide to *Spartina alterniflora* productivity. Soil Science Society of America Journal 47:930-935.

This field study, which was performed in Barataria marshes, found that low redox potential led to higher sulfide concentrations, resulting in lower NH^4 uptake by *Spartina alterniflora* in interior marshes as compared to streamside areas. These factors were then related to higher plant stress, resulting in decreased plant height and rooting depth in the interior areas.

plant processes

DeLaune, R. D., J. H. Whitcomb, W. H. Patrick, Jr., J. H. Pardue, and S. R. Pezeshki. 1989. Accretion and canal impacts in a rapidly subsiding wetland. I. ^{137}Cs and ^{210}Pb techniques. Estuaries 12(4):247-259.

A component of this study was performed in the North Calcasieu Lake area, near Bayou Bois Connine, but there were also two other sites, one in Terrebonne and one in Lafourche. In the Chenier Plain, no statistical differences were found in accretion rates between areas adjacent to natural streams and those adjacent to artificial canals. However, marsh accretion in these sites was insufficient to maintain elevation against relative sea level rise. In addition, the soils adjacent to both the natural stream and the canal were accreting, with properties that are incompatible to support of brackish water vegetation, so further increases in salinity, or maintenance at higher than 2-3 ppt, would cause accelerated marsh die-off.

Calcasieu/ canal/ soil processes

Demcheck, D. K., C. R. Demas, and C. R. Garrison. 1990. Chemical, tissue, and physical data from water and bottom material in the lower Calcasieu River, Louisiana, 1985-1988. USGS Open-File Report 89-420. U.S. Geological Survey, Baton Rouge, La. 281 pp.

This report presents four years of water quality data from the Lower Calcasieu River (Gulf Coast to Lake Charles). Some of the data may be incorrect, specifically the oxidation-reduction potential reported seems to lack correction for the standard electrode potential.

Calcasieu

Dunbar, J. B., L. D. Britsch, and E. B. Kemp. 1992. Land loss rates; report 3, Louisiana coastal plain. Technical Report GL-90-2. U.S. Army Engineer District, New Orleans, La. 28 pp. plus appendices.

This technical report details the land loss rates and trends throughout the Louisiana coastal plain. Land loss rates for 62 quadrangles were defined for four time periods: 1930s to 1956-58, 1956-58 to 1974, 1974-1983, and 1983-1990. On a regional scale, the land loss rate for coastal Louisiana has decreased from 41.83 mi^2 from 1956-58 to 1974, to 25.34 mi^2 from 1983 to 1990.

land loss

Dunn, D. D., R. S. Solis, and D. J. Ockerman. 1997. Discharge measurement in tidally affected channels during a hydrographic estuarine survey of Sabine Lake, Texas. USGS Fact Sheet FS-157-97. U.S. Geological Survey, Austin, Tex. 8 pp.

This fact sheet describes the use of automatic data recorders in the collection of river stage and velocity data for statistical analysis and conversion to discharge measurements for three streams emptying into Sabine Lake. Good correlation was found between statistically calculated discharge and measured discharge rates. The methods were believed to reduce data collection errors associated with human error and missing values.

Sabine

Evers, D. E., G. O. Holm, G. W. Peterson, E. M. Swenson, J. M. Visser, and C. E. Sasser. 1998. Vegetation, hydrologic, and substrate characteristics of the marshes in the White Lake region of the Chenier Plain, Louisiana. U.S. Environmental Protection Agency, Dallas. Tex. 72 pp. plus appendices.

This report details vegetation and soil characteristics of three areas surrounding White Lake. These areas were thought to have floating marsh mats in them, and some were classified as such by O'Neil (1949). Although hydrology and soil characteristics were conducive to the formation of floating marshes, little evidence for floatation was found. This is probably due to the deep rooting nature of the vegetation and the lack of sufficient upward force (i.e., rapid subsidence) to dislodge the mats. The report hypothesizes that these mats might be intermittently or seasonally floating marshes.

plant processes/ soil processes/ White Lake

Ewing, K., K. L. McKee, and I. A. Mendelssohn. 1997. A field comparison of indicators of sublethal stress in the salt-marsh grass *Spartina patens*. Estuaries 20(1):48-65.

This field study, performed in Region 3, compared field indicators of sublethal stress in *Spartina patens* among salinity gradients, burned versus unburned marsh, and distance from a stream. Adenine nucleotide concentrations, leaf proline concentrations, leaf spectral reflectance, and shoot elongation were studied. Relationships among these indicators and environmental stresses were complex, and each seemed to respond more closely to different stresses. Shoot elongation was the most dependable indicator of stress, although it was less sensitive and more integrative. The other indicators need substantially more field testing and validation for dependable use as predictors of stress.

plant processes

Ewing, K., K. L. McKee, I. A. Mendelssohn, and M. Hester. 1995. A comparison of indicators of sublethal salinity stress in the salt marsh grass, *Spartina patens* (Ait.) Muhl. Aquatic Botany 52:59-74.

Field-collected plants were subjected in the laboratory to different salinity levels (0-28 ppt) and several indicators of sublethal stress were evaluated. CO_2 exchange gave the most rapid response and remained a significant indicator of stress throughout the 42-day study. Leaf expansion, an integrative indicator of stress, was the easiest and cheapest indicator, but it needed a longer time to show significant responses (14-42 days).

plant processes

Flynn, K. M., K. L. McKee, and I. A. Mendelssohn. 1995. Recovery of freshwater marsh vegetation after a saltwater intrusion event. Oecologia 103:63-72.

This laboratory mesocosm study showed that freshwater marsh communities have some ability to recover from saltwater intrusion events that kill all the emergent vegetation. This recovery is limited, however, by post-dieback conditions, with maintained elevations in salinity and submergence leading to substantially less regrowth by fewer species and a community shift toward more salt- and flood-tolerant species. This recovery was based on seeds and seedlings present in the seedbank.

plant processes

Fogarty, M. J. 1965. Biological studies within the coastal marsh area east of Calcasieu Lake, Louisiana. M.S. thesis, Louisiana State University, Baton Rouge. 105 pp.

This thesis monitored water salinity and soil salinity in the Calcasieu Ship Channel, Calcasieu Lake, and the Grand Bayou/ Lambert Bayou system. As expected, the ship channel was the primary source of saltwater in the system. Salt was predominantly confined to the natural channels in the marsh complex, because of low tidal fluctuations during the study period. Soil salinities were not believed to be representative because of heavy rainfall. Four east-west vegetation transects were also established from Calcasieu Lake to Hwy. 27, and they exhibited distinct vegetational zonation attributed to salinity and water level. This is a good source of data for vegetation in the Cameron-Creole Watershed mapping unit 35 years ago.

Calcasieu/ Sabine

Gambrell, R. P., R. D. DeLaune, and W. H. Patrick, Jr. 1991. Redox processes in soils following oxygen depletion. Pages 101-117 *in* M. B. Jackson, D. D. Davies, and H. Lambers, eds. Plant life under oxygen deprivation. Academic Publishing, The Hague, The Netherlands.

This is a useful introduction to soils processes. The paper covers redox transformations and measurements as they apply to plant productivity.

soil processes

Gosselink, J. G., C. L. Cordes, and J. W. Parsons. 1979. An ecological characterization study of the Chenier Plain coastal ecosystem of Louisiana and Texas. FWS/OBS-78/9. U. S. Fish and Wildlife Service Office of Biological Services. Three volumes.

An excellent source for background functioning of the chenier plain ecosystem, as well as a good analysis of socioeconomic factors. Provides a good history of the system, and some of the data may be useable as a “baseline.” An original or first-generation copy would be helpful, as would the accompanying two volumes. Volume 2 has appendices with valuable data, and volume 3 has 11 image plates, which could prove useful.

ecology

Gosselink, J. G., and R. E. Turner. 1978. The role of hydrology in freshwater wetland ecosystems. Pages 63-78 i*n* R. E. Good, D. F. Whigham, and R. L. Simpson, eds. Freshwater wetlands: ecological processes and management potential. 1978. New Brunswick, NJ. Academic Press, New York.

This is a very brief introduction to the importance of hydrology to freshwater wetlands. It mentions coastal Louisiana but is not very specific for Region 4.

plant processes

Gough, L., and J. B. Grace. 1998. Effects of flooding, salinity and herbivory on coastal plant communities, Louisiana, United States. Oecologia 117:527-535.

This two-year field experiment analyzed the effects of flooding, salinity, and herbivory on coastal marsh communities dominated by either *Sagittaria lancifolia* or *Spartina patens*. For the purposes of the HICP study, the effects of flooding on these marsh communities were of primary concern. The lowering of *S. lancifolia* and *S. patens* sods 10 cm for more than 25 months resulted in decreased plant biomass for both species (although not significantly different from control). The authors suggested that *S. lancifolia* was relatively flood-tolerant and that decreases in biomass may be attributed to increased dominance of *S. patens*.

plant processes

Grace, J. B., and M. A. Ford. 1996. The potential impact of herbivores on the susceptibility of the marsh plant *Sagittaria lancifolia* to saltwater intrusion in coastal wetlands. Estuaries 19(1):13-20.

This field experiment analyzed the potential effects of herbivory on *S. lancifolia* plants subjected to flooding and saltwater intrusion. For the purposes of the HICP study, the effects of flooding on *S. lancifolia* was of primary concern. *S. lancifolia* biomass increased following seven months of flooding (although not significantly different from control). The authors determined that short-term "increased flooding of up to 20 cm is insufficient to have long-term detrimental effects" on *S. lancifolia*.

plant processes

Gunter, G., and W. E. Shell, Jr. 1958. A study of an estuarine area with water-level control in the Louisiana marsh. The Proceedings of the Louisiana Academy of Sciences 21:5-34.

This paper reports on species of fish and crustaceans in Grand and White lakes and Little Bay in the years immediately following the construction of the Mermentau River Project. Results indicated that there was still a dominance of marine organisms, with very few freshwater fauna found in the lakes at any time. The authors recommended leaving the control structures open as much as possible so that the semi-natural condition could be maintained, as long as it did not interfere with rice farming or navigation.

ecology / Grand Lake/ White Lake

Hatton, R. S., R. D. Delaune, and W. H. Patrick, Jr. 1983. Sedimentation, accretion and subsidence in marshes of Barataria Basin, Louisiana. Limnology and Oceanography 28(3):494-502.

This study determined vertical accretion and sediment accumulation rates for freshwater, intermediate, brackish, and salt marshes in the Barataria Basin. From the distribution of ^{137}Cs in cores, the authors found greater accretion rates adjacent to levees as compared to back marshes. They found accretion rates to be equivalent in areas of the same marsh type. Subsidence rates were greater than accretion rates, except in areas adjacent to natural levees.

soil processes

Herke, W. H., E. E. Knudsen, P. A. Knudsen, and B. D. Rogers. 1992. Effects of semi-impoundment of Louisiana marsh on fish and crustacean nursery use and export. North American Journal of Fisheries Management 12:151-160.

This study examined the effects of a fixed-crest weir on fisheries production in shallow ponds near Calcasieu Lake. Important fishery species showed drastic decreases in numbers and biomass in the semi-impounded area as compared to the control. This effect should be even greater in most of the semi-impoundments of Louisiana because the experimental weir was set at 30 cm below the marsh surface instead of the customary 15 cm. This study did not examine the effect of weirs on primary production or soil processes.

Calcasieu/ ecology

Howard, R. J., and I. A. Mendelssohn. 1995. Effect of increased water depth on growth of a common perennial freshwater-intermediate marsh species in coastal Louisiana. Wetlands 15(1):82-91.

This field study showed that *Sagittaria lancifolia* responds to increased flooding with an altered growth form (increased leaf height with no increase in biomass) and a decrease in root-shoot ratio. This is presumably a result of reduced Eh and elevated sulfide in the root zone.

plant processes

Knaus, R. M., and D. L. Van Gent. 1989. Accretion and canal impacts in a rapidly subsiding wetland III: a new soil horizon marker method for measuring recent accretion. Estuaries 12(4):269-283.

The cryogenic REE-INAA method of sampling and measuring marsh accretion was described in this report. Accretion was measured in saltwater, brackish, and freshwater marshes at six-month and one-year time frames. Differences in short-term accretion rates in brackish and saltwater marshes were not statistically significant in the presence or absence of man-made canals. Also, differences in sediment depositions were not statistically significant for all marsh types in natural or man-made waterways.

canal/ soil processes

Koch, M. S., and I. A. Mendelssohn. 1989. Sulphide as a soil phytotoxin: differential responses in two marsh species. Journal of Ecology 77:565-578.

This laboratory study showed that sulfide is a phytotoxin in *Spartina alterniflora* and *Panicum hemitomon*. Direct addition of sulfide was used to show the decrease in biomass production, as opposed to the previous correlative studies proposing sulfide toxicity as a reason for decreased plant production.

plant processes

Koch, M. S., I. A. Mendelssohn, and K. L. McKee. 1990. Mechanism for the hydrogen sulfide-induced growth limitation in wetland macrophytes. Limnology and Oceanography 35(2):399-408.

This laboratory study provides an explanation for sulfide-induced decreases in nitrogen uptake by wetland plants. Sulfide inhibits alcohol dehydrogenase, an enzyme critical to the anaerobic fermentative metabolism of wetland plants. This leads to an impaired energy status and lowered nitrogen uptake (energy-dependent). This inhibition was more severe in *Panicum hemitomon* (a freshwater plant) than in *Spartina alterniflora* (a salt-tolerant plant).

plant processes

Laine, S. C., and E. W. Ramsey, III . 1998. Change analysis within the Mermentau River Basin of coastal Louisiana. U. S. Dept of Commerce, National Oceanic and Atmospheric Administration. Charleston, S.C. 9 pp. plus figures, tables, and plates.

This report details a GIS effort to map changes in land cover in the Mermentau River Basin from 1990 to 1996. The study area is the entire basin, so the coastal section is only a small subset. The most important information to come out of this report is the existence of a "comprehensive, standardized GIS to detect and assess changes in land cover and habitat in the MRB" that was delivered to NOAA.

land loss/ Mermentau

LDNR. 1998. Coastal Wetlands Planning, Protection, and Restoration Act. Summary of priority project lists 1-7. Louisiana Department of Natural Resources. Baton Rouge. 180 pp. plus appendices.

This report is a brief overview of previous CWPPRA projects.

marsh management

Louisiana Coastal Wetlands Conservation and Restoration Task Force. 1993. Louisiana coastal wetlands restoration plan: Mermentau Basin, appendix H. Baton Rouge, La. 128 pp.

Prepared in association with the Louisiana Coastal Wetlands Restoration Plan, this appendix details the geology and basin-wide problems in the Mermentau Basin. The report also details problems at specific sites proposed for project implementation.

Mermentau

Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority. 1998. Coast 2050: toward a sustainable coastal Louisiana. Baton Rouge, La. 162 pp.

The coastal planning document for the state of Louisiana, this report details the geology and socioeconomic climate of Louisiana and sets out a set of strategies to reduce future wetland loss. A set of appendices, one specific to Region 4.

marsh management

Lovelace, J. K., and P. M. Johnson. 1996. Water use in Louisiana, 1995. Water Resources Special Report No. 11. Louisiana Department of Transportation and Development, Baton Rouge.

This report details water use for all of Louisiana, broken down by parish, according to use and source (ground vs. surface). Some historical data are presented.

Calcasieu/ Cameron Parish/ Mermentau

Marotz, B. L. 1984. Seasonal movements of penaeid shrimp, Atlantic croaker, and gulf menhaden through three marshland migration routes surrounding Calcasieu Lake. Master's thesis, Louisiana State University, Baton Rouge. 192 pp.

Presents data on three commercially important species in the Calcasieu Lake area, and an extensive fisheries bibliography in the literature cited section. If HICP needs fishery data, this would be a useful starting point for data up to 1984.

Calcasieu/ ecology

Marotz, B. L., W. H. Herke, and B. D. Rogers. 1990. Movement of gulf menhaden through three marshland routes in southwestern Louisiana. *North American Journal of Fisheries Management* 10:408-417.

This paper is a subsection of Marotz's 1984 master's thesis (also in this bibliography). Gulf menhaden heavily use the brackish marshes around Calcasieu Lake, and the authors recommend that no water control structures be installed if the primary management objective is maintenance of estuarine-dependent fisheries. If other management objectives are paramount, however, weirs should at least have some permanent means of egress for these commercially important species, such as a vertical slot allowing passage at all depths of the water column, so that all species are able to make use of the semi-impounded areas.

Calcasieu/ ecology

Martin, J. C., and S. Serdengecti. 1984. Subsidence over oil and gas fields. Reviews in Engineering Geology 6:23-34.

This paper reports the results of modeling efforts to constrain the maximum surface subsidence over oil and gas fields in Louisiana. Maximum subsidence over Louisiana oil and gas fields is expected to be no more than 2-4 cm.

land loss

McKee, K. L., and I. A. Mendelssohn. 1989. Response of a freshwater marsh plant community to increased salinity and increased water level. Aquatic Botany 34:301-316.

This field and greenhouse study showed that rapid increases in salinity to 15 ppt. quickly killed *Panicum hemitomon*, *Leersia oryzoides*, and *Saggitaria lancifolia*. However, gradual increases in salinity allowed plants to survive at higher salinities for a short period of time. The study showed that gradual increases in salinity in the field would not necessarily lead to loss of wetland habitat if seedlings or propagules of more salt-tolerant plants are available to colonize the area. Increased flood duration decreased live aboveground biomass and stem density in the field.

plant processes

McKee, K. L., I. A. Mendelssohn, and D. M. Burdick. 1989. Effect of long-term flooding on root metabolic response in five freshwater marsh plant species. Canadian Journal of Botany 67:3446-3452.

Species-specific differences in metabolic and anatomical responses to flooding were noted for five species of freshwater marsh plants: *Scolochloa festucacea*, *Scirpus acutus*, *Scirpus validus*, *Typha glauca*, and *Phragmites australis*. Less flood-tolerant species had higher alcohol dehydrogenase activities and root-specific gravity but lower malate concentrations, indicating an inability to effectively aerate their root zone and prevent the buildup of toxic metabolic products. These differences were most evident in the least flood-tolerant plant, *S. festucacea*, and were still evident after one year, indicating a lack of adaptability.

plant processes

Mendelssohn, I. A., and D. M. Burdick. 1988. The relationship of soil parameters and root metabolism to primary production in periodically inundated soils. Pages 398-428 i*n* D.D. Hook et al., eds. The ecology and management of wetlands volume 1: ecology of wetlands. Croom Helm Ltd., Breckenham, U.K.

This paper reviews the pertinent literature up until 1988 concerning wetland plant adaptation to saturated environments and the constraints imposed upon them. The information is still good but is a little incomplete. As such, it is a useful start to finding out about soil-plant interactions in wetland environments, especially those of *Spartina alterniflora*.

plant processes

Mendelssohn, I. A., and K. L. McKee. 1988. *Spartina alterniflora* die-back in Louisiana: time-course investigation of soil waterlogging effects. Journal of Ecology 76:509-521.

This experimental transplant study in Barataria Basin showed that increased inundation decreased redox potential and increased ammonium and sulfide concentration and root ADH activity. These combined to reduce standing crops in transplanted swards. In addition, swards transplanted to higher elevations recovered because of amelioration of these stresses.

plant processes

Mendelssohn, I. A., K. L. McKee, and W. H. Patrick, Jr. 1981. Oxygen deficiency in *Spartina alterniflora* roots: metabolic adaptation to anoxia. Science 214:439-441.

Spartina alterniflora is able to respire predominantly aerobically in moderately reduced soils, but not in highly reduced soils. Plants growing in prolonged saturated soils respire predominantly anaerobically, with concomitant decreased growth.

plant processes

Morris, J. T., and W. B. Bowden. 1986. A mechanistic, numerical model of sedimentation, mineralization, and decomposition for marsh sediments. Soil Science Society of America Journal 50:96-105.

Although this model was developed in a fresh to brackish New England tidal marsh, its model parameters are sufficiently general to allow for generalization to many marsh ecosystems with the proper parameterization. The model integrated effects of sedimentation, nutrient mineralization, and decomposition of organic matter by using year-class (depth) cohorts to monitor changes in the soil profile and was "solved" with existing data.

soil processes

Morton, T. 1973. The ecological effects of water-control structures on an estuarine area, White Lake, Louisiana, 1972-1973. M.S. thesis, University of Southwestern Louisiana, Lafayette.

Good follow-up to Gunter and Shell (1958). Morton found that the low-salinity estuary of the 1950s had changed to a freshwater-dominated ecosystem after the construction of Schooner Bayou Lock.

ecology/ White Lake

Neill, C., and R. E. Turner. 1987. Backfilling canals to mitigate wetland dredging in Louisiana coastal marshes. Environmental Management 11(6):823-836.

This paper examined the ecological benefits of backfilling 33 canals, some of which were located in the chenier plain. Results indicated that backfilling canals in the Louisiana Chenier Plain is an effective means of habitat restoration, especially in canals less than 5 or greater than 20 years old. Canals dredged through soils higher in mineral content were also more effectively restored. Although the disturbed hydrology was not completely restored, there were significant improvements in benthic and shallow pond ecology. Dredge operator proficiency is an extremely important indicator of potential gains when backfilling canals.

canal/ ecology/ land loss

NOAA-Texas A&M University Sea Grant. 1997. Sabine Lake conference. Where Texas and Louisiana come together. 13-14 Sep. 1996. Beaumont, Tex. TAMU-SG-97-101. Texas A&M University, College Station, Tex. 66 pp.

This collection of short presentation summaries from the conference is extremely variable in terms of usefulness. The best parts may be the references associated with some of the summaries and the historical information contained within.

Sabine

Nyman, J. A., M. Carloss, R. D. DeLaune, and W. H. Patrick, Jr. 1994. Erosion rather than plant dieback as the mechanism of marsh loss in an estuarine system. Earth Surface Processes and Landforms 19:69-84.

Erosion of *Spartina patens* marshes on Marsh Island was found to be a result of erosion, as indicated by steep vertical marsh/water interfaces and plants in the deteriorating marsh that were of indistinguishable physiological status from unbroken marsh. This study underscores the fact that there are multiple causes of wetland loss, and even marshes that are healthy may be subjected to physical degradation, necessitating different remedial measures.

land loss

Nyman, J. A., and R. H. Chabreck. 1995. Fire in coastal marshes: history and recent concerns. Pages 134-141 *in* S. I. Cerulean and R. T. Engstrom, eds. Fire in wetlands: a management perspective. Proceedings of the Tall Timbers Fire Ecology Conference, no. 19. Tall Timbers Research Station, Tallahassee, Fla.

A useful review and analysis of marsh burning strategies that points out that we do not know how this management strategy affects vertical accretion.

marsh management

Nyman, J. A., and R. D. DeLaune. 1991. CO_2 emission and soil Eh responses to different hydrological conditions in fresh, brackish, and saline marsh soils. Limnology and Oceanography 36(7):1406-1414.

The main finding of this paper is that CO_2 emissions, and therefore presumably organic matter decomposition rates, are not different under continuously or intermittently drained conditions in fresh, brackish, or saline soil cores. Emissions were higher in fresh and saline cores than in brackish cores, however, indicating that drawdown in fresh areas may lead to excessive oxidation of peat. It remains to be seen if the differences between marsh type are due to the presence of different vegetation types (varying decomposition rates) and also whether or not the increased oxidation in fresh soils under periodically or permanently drained soils would be offset by increased plant production as a result of higher redox potential in the rooting zone.

soil processes

Nyman, J. A., R. D. DeLaune, and W. H. Patrick, Jr. 1990. Wetland soil formation in the rapidly subsiding Mississippi River deltaic plain: mineral and organic matter relationships. Estuarine, Coastal and Shelf Science 31:57-69.

Although this paper does not deal with marsh soils in Region 4, it does compare fresh, brackish, and saline marshes in the active and inactive delta plains. The main finding pertinent to the fresh marshes of the chenier plain is that organic matter production is four times more important to wetland soil formation than is mineral matter introduction. This is directly applicable in the Mermentau Basin (within limits), where there is abundant water but little sediment and most of the marshes are fresh to intermediate. Some mineral input is

necessary for structural purposes and as a nutrient supply if no other nutrient sources (P, N, cations, etc.) are available.

soil processes

O'Neil, T. 1949. The muskrat in the Louisiana coastal marshes: a study of the ecological, geological, biological, tidal, and climatic factors governing the production and management of the muskrat in Louisiana. Louisiana Department of Wildlife and Fisheries, New Orleans. 152 pp.

This work represents one of the earliest habitat descriptions of the entire coastal zone. It serves as the basis of assessment of habitat shifts since the late 1940s.

ecology/ plant processes

Palmisano, A. W. 1970. Plant community-soil relationships in Louisiana coastal marshes. Ph.D. dissertation, Louisiana State University, Baton Rouge. 98 pp.

This dissertation made an in-depth analysis of several flight lines from the 1968 Chabreck vegetation data (published as a report in 1972), three of which were in Region 4. Relationships between soil parameters and plant community structure were established and the effects of salinity and cation concentrations on seed germination were studied.

ecology/ plant processes

Perry, G. W. 1978. Distribution of fish in the Rockefeller-Grand Lake tidal bayou complex, southwest Louisiana. The Proceedings of the Louisiana Academy of Science XLI: 101-114.

Trawl samples were collected from nine sampling stations in a canal system connecting the Gulf of Mexico to Grand Lake. A total of 50 fish species were represented in the sampling conducted twice monthly from 1965 to 1966. The percentage of total fish caught in brackish, intermediate, or fresh marsh was reported, as well as minimum-maximum salinity data for each species and frequency of occurrence.

ecology/ Grand Lake/ Rockefeller Refuge

Pezeshki, S. R., and R. D. DeLaune. 1988. Carbon assimilation in contrasting streamside and inland *Spartina alterniflora* salt marsh. Vegetatio 76:55-61.

Inland *Spartina alterniflora* showed significantly lower production than streamside plants, a condition that worsened as the growing season progressed. This was attributed to soil waterlogging, anaerobic root respiration, sulfides, and restricted nutrient uptake, or a combination of these.

plant processes

Pezeshki, S. R., and R. D. DeLaune. 1996a. Factors controlling coastal wetland formation and losses in the northern Gulf of Mexico, USA. Recent Research Developments in Coastal Research 1:13-27.

This short literature review is a fairly useful brief introduction to the processes involved in wetland loss. It contains a useful bibliography, but not much detail on any of the points it discusses.

land loss/ soil processes

Pezeshki, S. R., and R. D. DeLaune. 1996b. Responses of *Spartina alterniflora* and *Spartina patens* to rhizosphere oxygen deficiency. Acta Oecologia 17(5):365-378.

This laboratory study compared growth parameters in the two marsh species. *Spartina patens* root production, root-shoot ratio, net photosynthesis, and foliage production were all significantly decreased by reducing soil conditions (-60 mV and below). *Spartina alterniflora* was less affected.

plant processes

Pezeshki, S. R., R. D.DeLaune, and S. Z. Pan. 1991. Relationship of soil hydrogen sulfide level to net carbon assimilation of *Panicum hemitomon* and *Spartina patens*. Vegetatio 95:159-166.

This laboratory study under controlled Eh showed that carbon assimilation was reduced in *Panicum hemitomon* and *Spartina patens* at 0.22 and 0.34 mg L^{-1}, respectively. These levels are not relevant in typical fresh marshes where *P. hemitomon* is found, but sulfide levels in the brackish marsh habitats of *S. patens* may be detrimental to growth.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1987a. Effects of flooding and salinity on photosynthesis of *Sagittaria lancifolia*. Marine Ecology Progress Series 41:87-91.

Exposure of bulltongue, *Sagittaria lancifolia*, to salt (equivalent to 2.9 ppt) for one month significantly lowered photosynthesis, and the effect was enhanced by flooding. Flooding alone had a very slight effect on the studied species.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1987b. Response of baldcypress (*Taxodium distichum* L. var. *distichum*) to increases in flooding salinity in Louisiana's Mississippi River deltaic plain. Wetlands 7:1-10.

This laboratory study concluded that increased flooding and salinity brought about by subsidence would have severe negative consequences for bald cypress. Increases in flooding

and salinity would drastically decrease production, especially if the salinity is maintained above 3 ppt.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1987c. Response of *Spartina patens* to increasing levels of salinity in rapidly subsiding marshes of the Mississippi River deltaic plain. Estuarine, Coastal and Shelf Science 24:389-399.

This laboratory study subjected field-collected plants (brackish marsh) to salinity stresses ranging from 4 to 22 ppt. Stomatal conductance and net photosynthesis both decreased significantly as salinity rose, responses that occurred within one day and were maintained throughout the study. These stresses lead to lower productivity and could lead to dieback in marsh areas subjected to prolonged periods of salt exposure, as would be possible in rapidly subsiding marshes or in marshes subjected to greater salt through increased tidal influence.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1987d. Response of the freshwater marsh species, *Panicum hemitomon* Schult., to increased salinity. Freshwater Biology 17:195-200.

Laboratory-maintained specimens of field-collected (fresh marsh) *Panicum hemitomon* showed reduced stomatal conductance and net photosynthesis within 24 h at elevated salinity (5-7 ppt). Further increases in salinity (10-12 ppt) not only resulted in further decreases in these two factors, but also in tissue death within four days. All reductions in stomatal conductance and net photosynthesis remained throughout the study.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1989a. Assessment of saltwater intrusion impact on gas exchange behavior of Louisiana Gulf Coast wetland species. Wetlands Ecology and Management 1(1):21-30.

A useful review of freshwater plant responses to salt intrusion. May be a little outdated.

plant processes

Pezeshki, S. R., W. H. Patrick, Jr., R. D. DeLaune, and E. D.Moser.1989b. Effects of waterlogging and salinity interaction on *Nyssa aquatica* seedlings. Forest Ecology and Management 27:41-51.

This laboratory study showed that production and survivability of tupelo gum seedlings were impaired by increases in flooding and salinity.

plant processes

Pezeshki, S. R., R. D. DeLaune, and W. H. Patrick, Jr. 1990. Flooding and saltwater intrusion: potential effects on survival and productivity of wetland forests along the U.S. Gulf Coast. Forest Ecology and Management 33/34:287-301.

This review article summarizes up the potential effects on wetland forests due to salt intrusion. At salinity above 3 ppt, reduced net carbon assimilation, increased leaf burning, and increased seedling mortality would be expected. This leads to a general decline in habitat quality.

plant processes

Reddy, K. R., and W. H. Patrick, Jr. 1975. Effect of alternate aerobic and anaerobic conditions on redox potential, organic matter decomposition and nitrogen loss in a flooded soil. Soil Biology and Biochemistry 7:87-94.

This laboratory study indicated that length of alternating aerobic/anaerobic periods did not have very large impacts on degradation of organic matter over the course of the 128-day study. Soils incubated under anaerobic conditions days had ~0.8% organic carbon as compared to ~0.6% in fully aerobic soils at the end of the study. All other combinations were intermediate.

soil processes

Reed, D. J. 1992. Effect of weirs on sediment deposition in Louisiana coastal marshes. Environmental Management 16(1):55-65.

This report analyzed sediment deposition patterns related to weirs. The studied marshes were not managed in any other way. Sediment deposition patterns were similar between inside and outside stations, although deposition rates at the inside stations were usually lower. Backmarsh stations accumulated sediment slower than streamside marsh. Large quantities of sediment could be placed on the inside of the weir if other hydrologic conditions were adequate (proximity to a large bay or lake, a nearby stream that is unregulated, etc.).

marsh management

Roberts, H. H. 1998. Delta switching: early responses to the Atchafalaya River diversion. Journal of Coastal Research 14(3):882-899.

This paper details the shoreline adjustments associated with the increased flow of water from the Mississippi River down the Atchafalaya River, beginning in the first half of this century. This diversion of sediment-laden Atchafalaya River water has initiated mudflat and marsh progradation of the downdrift chenier plain.

regional geologic processes

Rogers, D. R., B. D. Rogers, and W. H. Herke. 1992a. Some potential effects of the Cameron-Creole marsh management plan on fishery organisms. School of Forestry, Wildlife, and Fisheries, Louisiana State University, Baton Rouge. 79 pp. plus appendices.

Presents excellent fisheries and hydrographic data for a six-year period spanning pre- and post-construction of the Cameron-Creole Marsh Management Plan in the East Cove Marsh area of the Calcasieu Lake region.

Calcasieu/ ecology/ marsh management

Rogers, D. R., B. D. Rogers, and W. H. Herke. 1992b. Effects of a marsh management plan on fishery communities in coastal Louisiana. Wetlands 12(1):53-62.

This paper is one from Cahoon and Groat (1990). The goals of the management plan were to reduce salinities and improve circulation, but these goals were not met during the drawdown period. The salinity buffering and circulation did improve during non-drawdown periods. This possibly led to an increase in submerged aquatic vegetation, a habitat shift that selects against marine transient species and for resident species such as grass shrimp. The overall landings indicate more organisms of fewer species in the managed areas than unmanaged ones.

ecology

Sasser, C. E. 1977. Distribution of vegetation in Louisiana coastal marshes as a response to tidal flooding. M.S. thesis, Louisiana State University, Baton Rouge. 40 pp.

This thesis examined the effects of flooding frequency, duration, elevation relative to mean water level, and salinity on the vegetation found at a particular point. Duration of flooding was found to be the most significant factor in this study determining where plants and plant assemblages occurred.

plant processes

Schmalzer, P. A., and C. R. Hinkle. 1992. Soil dynamics following fire in *Juncus* and *Spartina* marshes. Wetlands 12(1):8-21.

This report analyzes soil characteristics before, and for one year after, a fire in two seasonally flooded marshes. The burns were conducted with 30 cm of water on the marsh, and significant changes were observed in nitrogen dynamics, Ca, Mg, and K content, and pH. Cations and pH all increased and remained elevated for months in the burned marshes as a result of the ash input from the burnt plants. This paper also gives good references to research articles on marsh burning.

marsh management/ soil processes

Schroeder, R. H., Jr. 1991. New Orleans District, USACE. Letter To: Division Engineer, Lower Mississippi River Division, Vicksburg, MS. Sep 30. 20 pp.

This memo details the operations of the locks around the Mermentau Basin, and several alternative structural plans to drain water from the Lakes Sub-basin more efficiently. None of the proposed plans were found to be economically viable. In addition, it was found that gulf water levels exceed Lakes Sub-basin water levels at Catfish Point 74% of the time. It may be beneficial to find the reports and modeling information that came out of this study.

marsh management/ Mermentau

Stephens, J. C., L. H. Allen, and E. Chen. 1984. Organic soil subsidence. Reviews in Engineering Geology 6:107-122.

This paper does not specifically detail soil processes in Region 4, but an application of the concepts presented would be useful in Region 4 organic soils. Organic soil subsidence is due to densification (loss of buoyancy, shrinkage, and compaction) and loss of mass (biological oxidation, burning, hydrolysis and leaching, erosion, and mining). Prevention of subsidence due to these factors necessitates a thorough understanding of the inter-relationships of these processes in a particular area and management decisions based on minimizing the relevant impacts.

soil processes

Stone, J. H., L. M. Bahr, Jr., and J. W. Day, Jr. 1978. Effects of canals on marshes in coastal Louisiana and implications for management. Pages 299-320 *in* R. E. Good, D. F. Whigham, and R. L. Simpson, eds. Freshwater wetlands: ecological processes and management potential. 1977. Academic Press, New York.

Results from early modeling efforts demonstrate up to a 35% reduction in normal water flow across sections of marsh impacted by canaling and impounding activity. In addition, it is postulated that canals contribute to eutrophication of surrounding water bodies through direct input of nutrients from disturbed sediments and channelization of flow, preventing the normal biological removal of nutrients.

canal/ marsh management

Templet, P. H., and K. J. Meyer-Arendt. 1988. Louisiana wetland loss: a regional water management approach to the problem. Environmental Management 12(2):181-192.

This paper presents a brief history of wetland loss in Louisiana, with specific policies and procedures to combat the losses. The paper takes the point of view that decreased sedimentation is the problem that most, if not all, of the wetlands need to overcome. Some of the information is a little outdated.

land loss/ marsh management

Turner, D. D. 1966. Distribution and abundance of fishes in impoundments of Lacassine and Sabine Refuges. M.S. thesis, Louisiana State University, Baton Rouge. 52 pp.

This thesis obtained standing stock estimates from impoundments in Sabine and Lacassine National Wildlife Refuges. Species composition and size were recorded. Hydrologic data is missing, but the fishery data may be useful in comparisons.

ecology/ Lacassine/ Sabine

Turner, R. E. 1990. Landscape development and coastal wetland losses in the northern Gulf of Mexico. American Zoologist 30:89-105.

This brief paper outlines the potential reasons for wetland loss due to anthropogenic influences. The paper outlines the effects of altered hydrology on wetland plants in a general way. This paper was part of a MMS study dated 1987 (OCS study/MMS 87-0119).

land loss/ plant processes

Turner, R. E. 1997. Wetland loss in the northern Gulf of Mexico: multiple working hypotheses. Estuaries 20(1):1-13.

This paper presents an analysis of possible causes of wetland loss in the Louisiana coastal zone. Among the four hypotheses tested, the construction of an extensive dredged canal and spoil bank network was found to be the most valid, whereas a decline in sediment availability in the Mississippi River, construction of Mississippi River flood protection levees, and salinity changes were all more or less rejected as causes for the majority of wetland loss, although they may be important on a local level. The accepted hypothesis necessitates a revision of the paradigm of "more sediment equals more wetlands" to an ecological model emphasizing the importance of hydrology on plant community health.

canal/ marsh management

Turner, R. E., E. M. Swenson, and J. M. Lee. 1994. A rationale for coastal wetland restoration through spoil bank management in Louisiana, USA. Environmental Management 18(2):271-282.

Although not carried out in Region 4, this study indicated that breaching of spoil banks (~5% of the perimeter of impounded areas) in small areas would dramatically increase habitat health in the affected areas. This may be related to the hydrologic restoration of these intermediate marsh areas, but may also be related to increased sedimentation.

canal/ marsh management

Turnipseed, D. P. 1986. Spatial and temporal analysis of coastal wetland loss with remote sensing. M.S. thesis, Louisiana State University, Baton Rouge. 101 pp.

GIS analysis of the Cameron-Creole Watershed mapping unit over the time period 1933-84 indicated extensive and accelerating land loss. This loss was associated with length of impoundment and soil type. Use of Landsat Thematic Mapping data was utilized for the 1984 data set, and the author recommends further use of this data medium in future studies of this type because of its convenience and ready availability to GIS format.

Cameron Parish/ land loss/ Sabine

USACE. 1976. Draft composite environmental impact statement for operation and maintenance of three projects in the Teche-Vermilion Basin: Bayou Teche, Bayou Teche and Vermilion River, and Freshwater Bayou, Louisiana. U.S. Army Corps of Engineers, New Orleans, La. 178 pp. plus appendices.

This report contains some basic hydrologic and biological data for the Freshwater Bayou area as it relates to maintenance dredging of the area. This is not a final report, so there may have been some changes made after this was published.

Mermentau

USACE. 1983. Grand and White Lakes water management study, Louisiana. U.S. Army Corps of Engineers, New Orleans, La. 93 pp.

This report analyzes the problems attributed to the Grand and White lake system and presents several solutions. This is a good narrative to introduce the history of the system (shorter and less specific than Gosselink et al. 1979) and several operational strategies to combat high water levels. The study went through feasibility analysis but was later terminated in the Schroeder (1991) letter summarized in this database.

Grand Lake/ Mermentau/ White Lake

USACE. 1996. Black Bayou diversion, Louisiana—reconnaissance report. U.S. Army Corps of Engineers, New Orleans, La. 73 pp. plus appendices.

This report presents a good mini-review of the perceived problems in the Lakes sub-basin of the Mermentau River Basin. The problem addressed in this report is excessively high water levels, and several alternative solutions are proposed, including a new lock system

at Calcasieu Lock and increased drainage in the Pecan Island area. Good basic ecosystem characterization, with limited water quality data in appendices.

marsh management/ Mermentau

USDA. 1995. Soil survey of Cameron Parish, Louisiana. U.S. Department of Agriculture, Soil Conservation Service, Alexandria, La. 135 pp. plus plates.

This survey details the presence and location of different soils within Cameron Parish and describes the properties, specific uses, and predicted behaviors associated with each soil series.

Cameron Parish

USDA. 1951. A report on the relationship of agricultural use of wetlands to the conservation of wildlife in Cameron Parish, Louisiana. U.S. Department of Agriculture, Soil Conservation Service. Fort Worth, Tex. 9 pp. plus appendices.

This work presents a brief outline of the conflicting uses of wetlands, with an emphasis on proper use of soils for agriculture and wildlife. The most useful section of this report is an appendix containing a map of different marsh types with limited speciation.

Cameron Parish/ ecology

USDA. 1993. Calcasieu-Sabine cooperative river basin study. U.S. Department of Agriculture, Natural Resources Conservation Service, Alexandria, La. 151 pp. plus appendices.

This study was authorized to investigate and document problems confronting the wetland resources of the Calcasieu-Sabine River Basin and to develop strategies to conserve, restore, and enhance those resources. The following four alternative solutions were analyzed: 1) no action, 2) basin-wide control structures, 3) hydrologic unit treatment, and 4) extended hydrologic unit treatment. The hydrologic unit treatment was determined to be the most cost-effective approach.

Calcasieu/ Sabine

USDA. 1997. Mermentau: cooperative river basin study report. U.S. Department of Agriculture, Natural Resources Conservation Service, Alexandria, La. 80 pp. plus appendices.

This report breaks the Mermentau River Basin into 86 hydrologic units and details the soils and specific wetland loss problems facing each of them. By and large, the units can be grouped into the Coast 2050 mapping units. The maps do not provide very good detail.

Mermentau

Visser, J. M., R. H. Chabreck, and R. G. Linscombe. 2000. Marsh vegetation types of the Chenier Plain, Louisiana, USA. Estuaries 23(3):318-327.

This paper reports the results of a TWINSPAN analysis that identified seven major vegetation types in the chenier plain in 1997 that expanded on those habitats previously described for this region by Chabreck (1970, 1972): fresh bulltongue, fresh maidencane, oligohaline bullwhip, oligohaline paspalum, oligohaline wiregrass, mesohaline wiregrass, and mesohaline mixture. Comparison to the O'Neil (1949) vegetation characterization revealed the disappearance of the saw grass habitat. The overall trend seemed to indicate an "increase of oligohaline marsh at the expense of mesohaline wiregrass marsh."

ecology/ plant processes

Webb, E. C., and I. A. Mendelssohn. 1996. Factors affecting vegetation dieback of an oligohaline marsh in coastal Louisiana: field manipulation of salinity and submergence. American Journal of Botany 83(11):1429-1434.

A good field manipulation study examining the effects and interactions of saltwater intrusion and increased submergence on production and survival in *Sagittaria lancifolia*. Other factors examined were interstitial salinity, sulfide concentration, major cations, and soluble P. The authors found that small increases in salinity may be beneficial to production, dependent on tolerance levels of the plants, but submergence and salt intrusion had very large negative effects on production.

plant processes

Wells, J. T., and G. P. Kemp. 1981. Atchafalaya mud stream and recent mudflat progradation: Louisiana Chenier Plain. Transactions - Gulf Coast Association of Geological Societies 31:409-416.

This paper details the recent chenier plain shoreline changes and the processes that govern this behavior. Available satellite imagery, color infrared photography, and current-meter data indicated that mudflat sedimentation is increasing to the west of Atchafalaya Bay. The authors speculate that shoreline progradation will increase as the Atchafalaya Bay becomes sediment-filled, thereby allowing a greater volume of sediments to enter the mud stream.

regional geologic processes

Wells, J. T., and G. P. Kemp. 1982. Mudflat and marsh progradation along Louisiana's Chenier Plain: a natural reversal in coastal erosion. Proceedings of the conference on coastal erosion and wetland modification in Louisiana: causes, consequences, and options. FWS/OBS-82/59:39-51. U.S. Fish and Wildlife Service.

This proceeding outlines present and future trends in the progradation of mudflats along a segment of chenier plain shoreline from Freshwater Bayou Canal to Rollover Bayou.

Similar to the previous reference (Wells and Kemp 1981), the authors provide insight on the pattern and time frame of mudflat sedimentation west of Atchafalaya Bay.

regional geologic processes

White, C. J. 1975. Effects of 1973 river flood waters on brown shrimp in Louisiana estuaries. LDWF Oysters, Water Bottoms, and Seafoods Division Technical Bulletin No. 16. Louisiana Wildlife and Fisheries Commission, New Orleans. 24 pp.

This report presents data for four years (1970-73) of brown shrimp recruitment into Louisiana estuaries, including Region 4. Extreme flooding in 1973 led to nearly freshwater conditions in the estuaries and unusually cold water temperatures, resulting in a subsequent 40% decline in brown shrimp production.

ecology

White, C. J., and W. S. Perret. 1974. Efforts to re-establish oyster tonging reefs in Calcasieu Lake, Louisiana. LDWF Oysters, Water Bottoms, and Seafoods Division Technical Bulletin No. 11. Louisiana Wildlife and Fisheries Commission, New Orleans. 15 pp.

Following the crash of the oyster fishery in Calcasieu Lake in the early 1960s (loosely attributed in this report to construction of the ship channel, and to possible industrial pollution), an attempt was made to reestablish oyster tonging reefs in three locations in the lake. Despite the presence of healthy oyster populations nearby and suitable temperature and salinity regimes, artificial reefs constructed of clamshell were unable to recruit significant numbers of oysters.

Calcasieu/ ecology

Wicker, K. M. 1981. Chenier Plain region ecological characterization: a habitat mapping study. A user's guide to the habitat maps. Louisiana Coastal Resources Program, Louisiana Department of Natural Resources, Baton Rouge. 55 pp. plus appendices.

This user's guide accompanies 53 1:24000 habitat maps for 1978 compiled from NASA color infrared photography. On its own, the report is a useful guide to interpreting CIR photography for habitat mapping purposes.

ecology

Wicker, K. M., D. Davis, and D. Roberts. 1983. Rockefeller State Wildlife Refuge and Game Preserve: evaluation of wetland management techniques. Coastal Management Division, Louisiana Department of Natural Resources, Baton Rouge. 93 pp. plus appendices.

This report gives an excellent history of Rockefeller Refuge, relying in part on marsh managers who worked in the area for up to 40 years. It gives fairly detailed descriptions of

the habitats in the refuge, the changes that have occurred, and reasons for these changes. The report also gives analyses of the different marsh management techniques employed throughout the area. Some detailed hydrologic information is contained in the report.

marsh management/ Rockefeller Refuge

Wilsey, B. J., K. L. McKee, and I. A. Mendelssohn.1992. Effects of increased elevation and macro- and micronutrient additions on *Spartina alterniflora* transplant success in salt-marsh dieback areas in Louisiana. Environmental Management 16:505-511.

In a field study in Barataria Basin, *Spartina alterniflora* was transplanted from healthy marsh to degrading marsh at both ambient and +30 cm (relative to degrading marsh level) elevations. In addition, the study monitored the effects of adding macro- and micronutrients. Results indicated that transplanting healthy plants into degraded marsh is a viable strategy to mitigate loss, but only if elevation is increased (presumably to decrease waterlogging stress). Fertilization had no effects in transplants at ambient marsh level, but addition of nutrients further increased production and standing crop in the elevated transplants.

plant processes