Lewis and Clark Lake Sedimentation Issues

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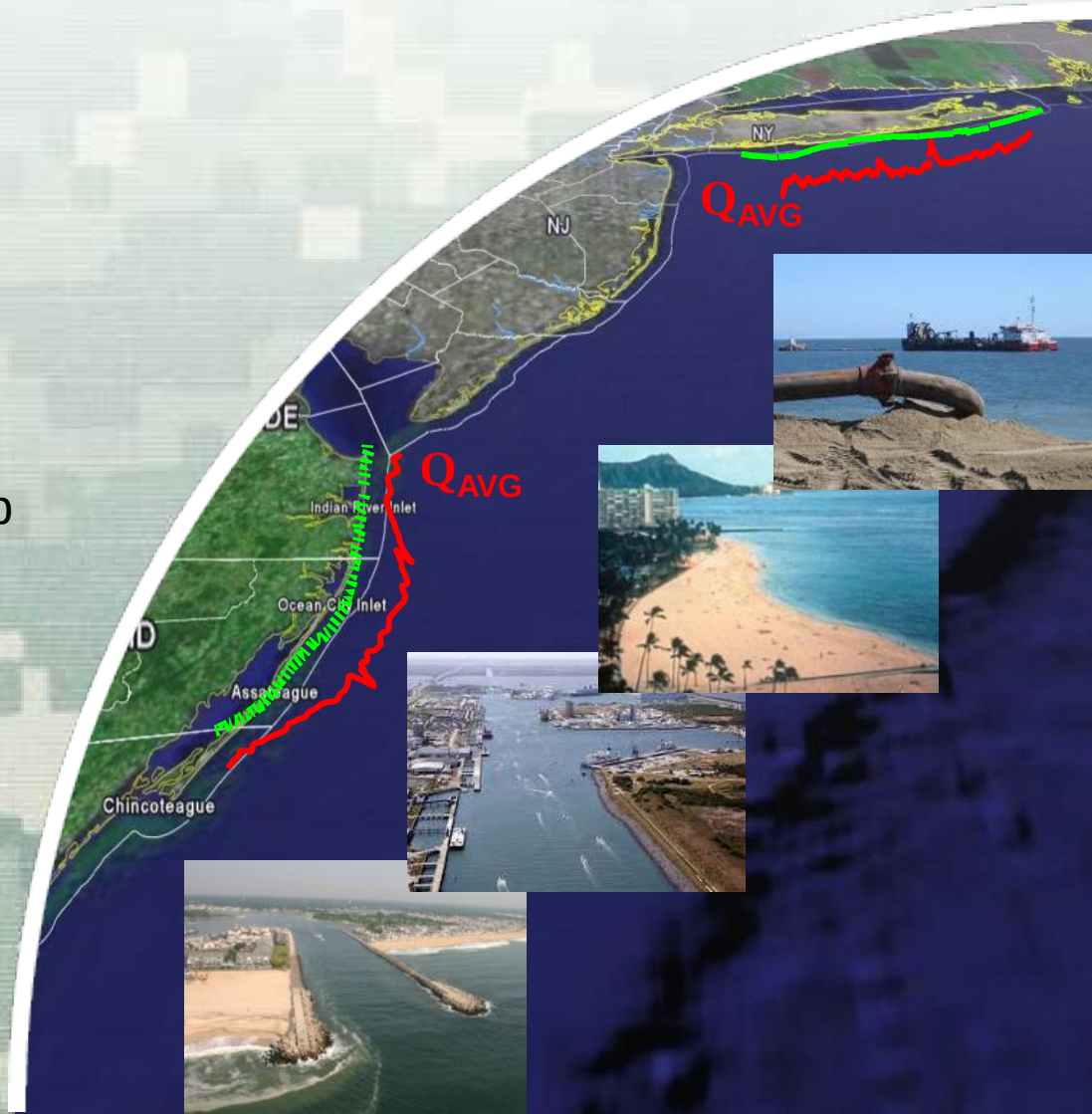
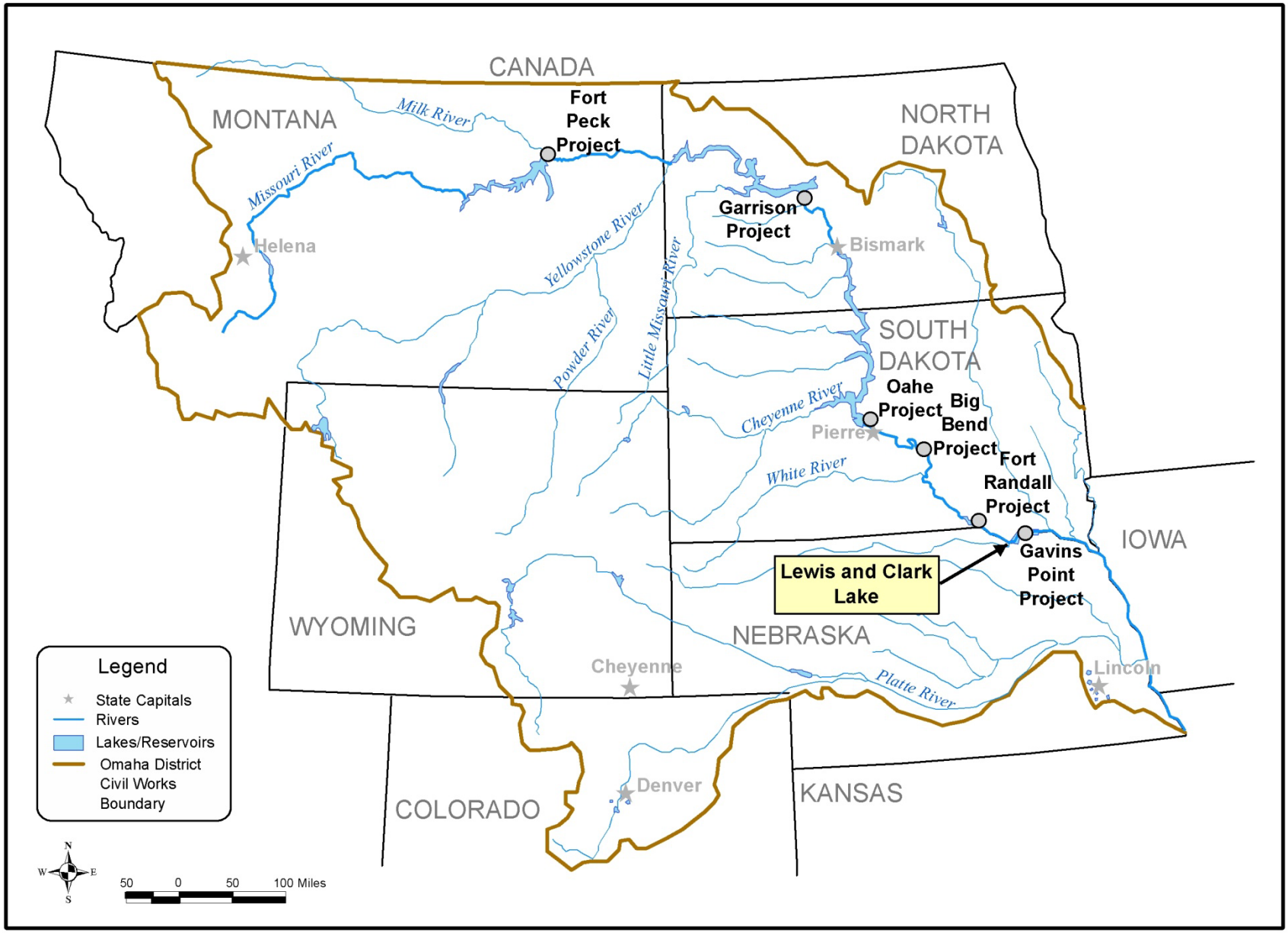
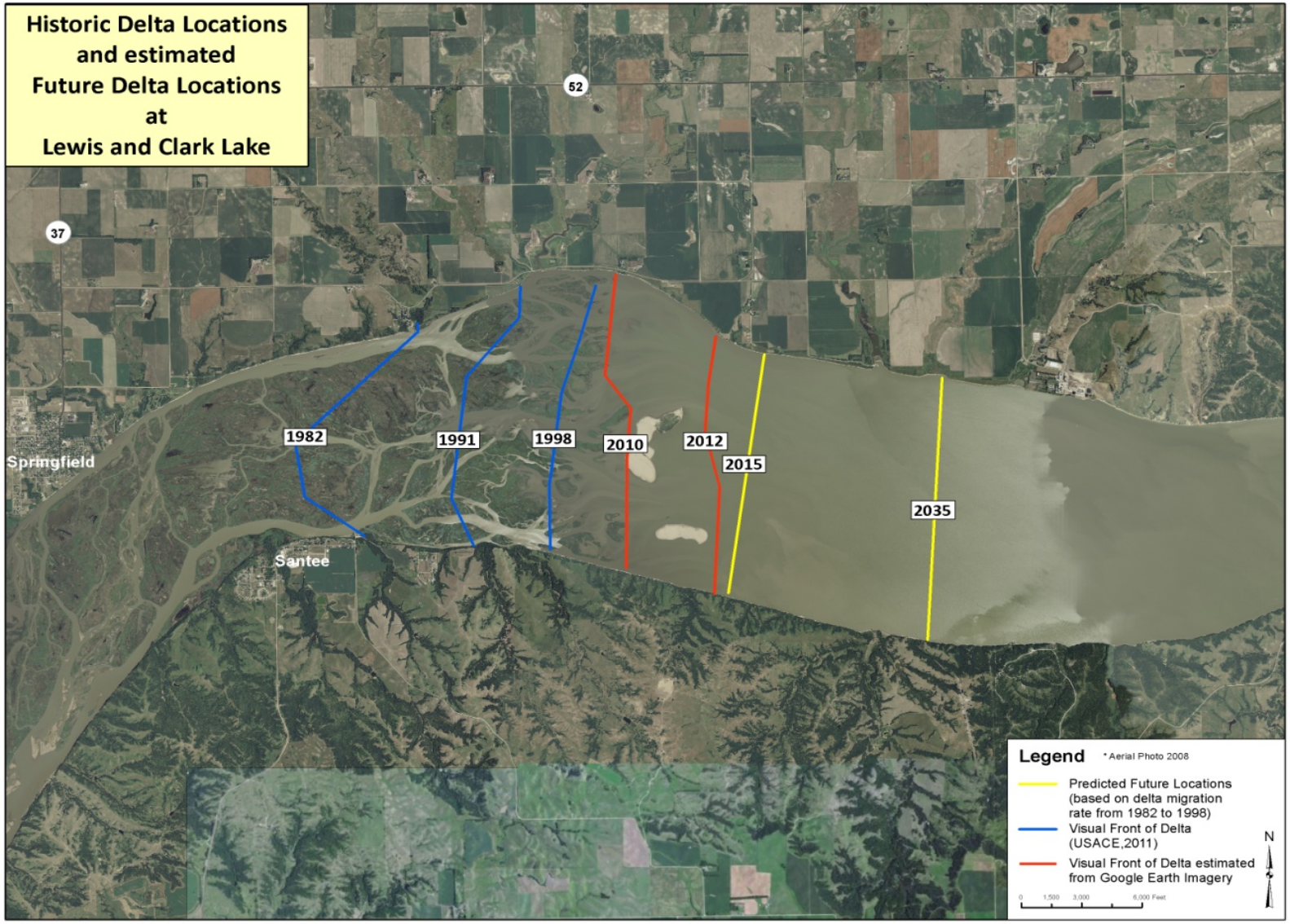
RSM and EWN Inland Workshop
29 April – 1 May 2014
Omaha, Nebraska

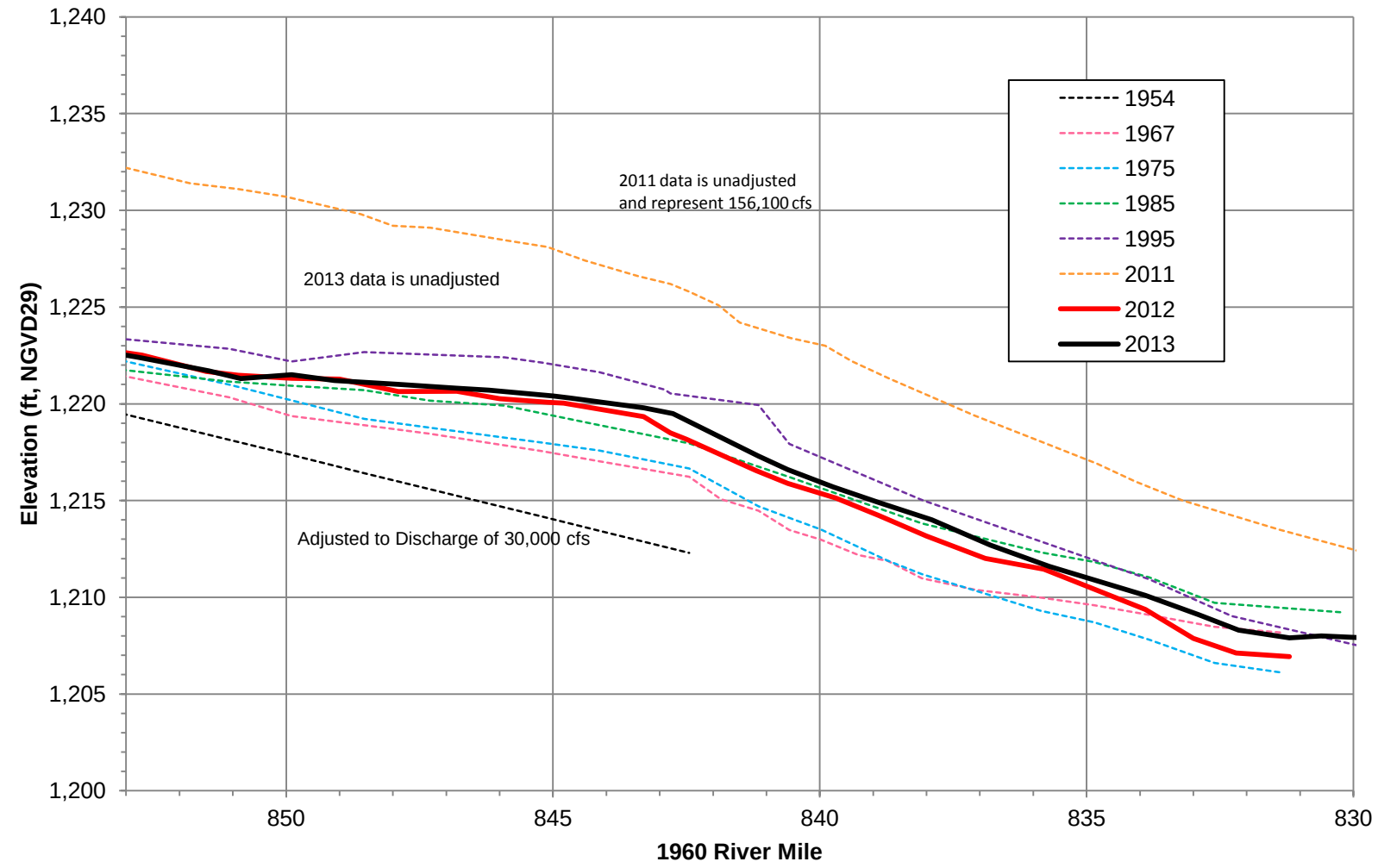


US Army Corps of Engineers
BUILDING STRONG®

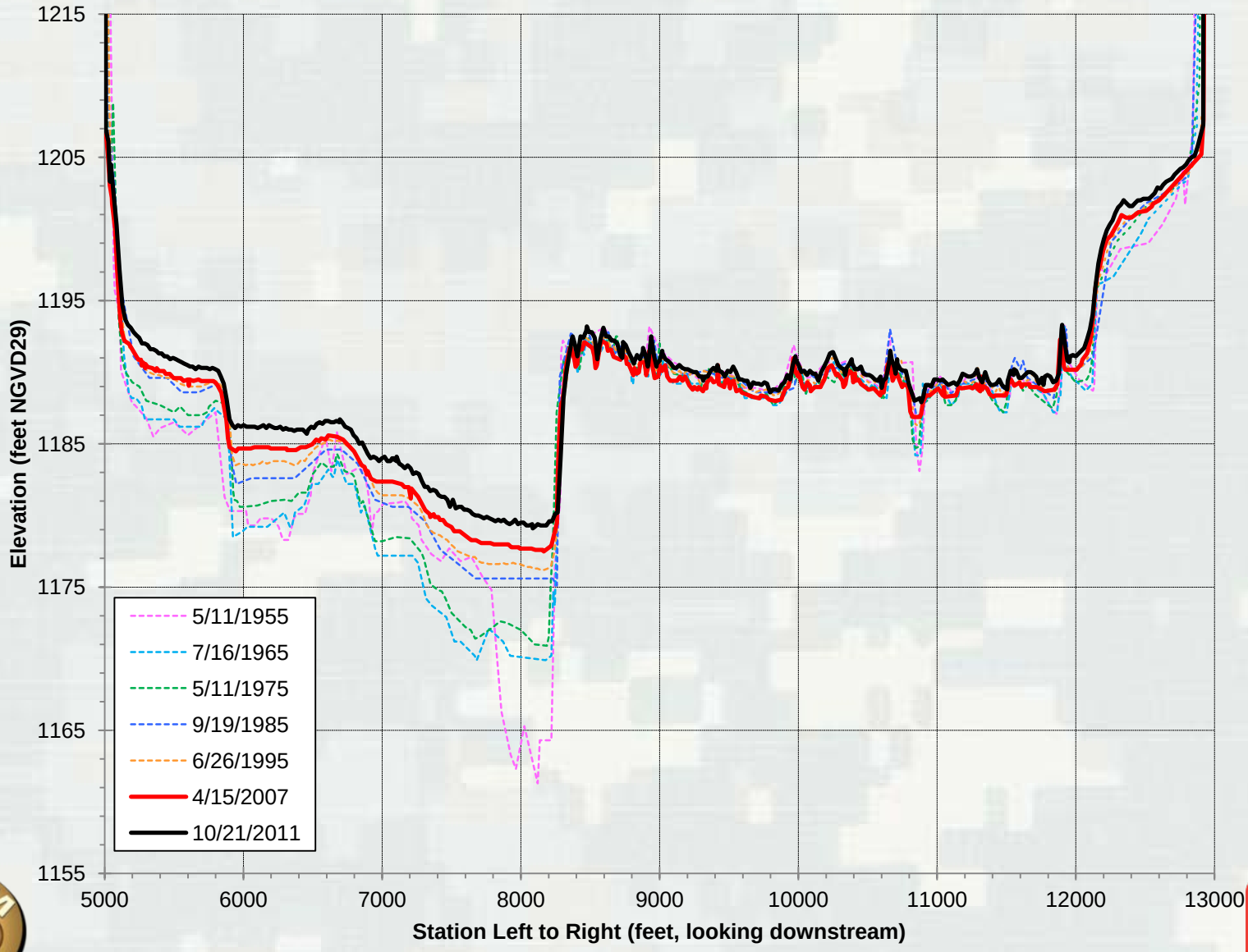

CANADA
MONTANA
NORTH DAKOTA
SOUTH DAKOTA
WYOMING
NEBRASKA
IOWA
COLORADO
KANSAS
Milk River
Missouri River
Yellowstone River
Powder River
Little Missouri River
Cheyenne River
White River
Platte River
Fort Peck Project
Garrison Project
Oahe Project
Big Bend Project
Fort Randall Project
Gavins Point Project
Lewis and Clark Lake
Helena
Bismark
Pierre
Cheyenne
Denver
Lincoln
Legend
State Capitals
Rivers
Lakes/Reservoirs
Omaha District Civil Works Boundary
N
W
E
S
50
0
50
100 Miles


Historic Delta Locations
and estimated
Future Delta Locations
at
Lewis and Clark Lake
52
37
Springfield
Santee
1982
1991
1998
2010
2012
2015
2035
Legend
* Aerial Photo 2008
Predicted Future Locations (based on delta migration rate from 1982 to 1998)
Visual Front of Delta (USACE,2011)
Visual Front of Delta estimated from Google Earth Imagery
N
0 1,500 3,000 6,000 Feet

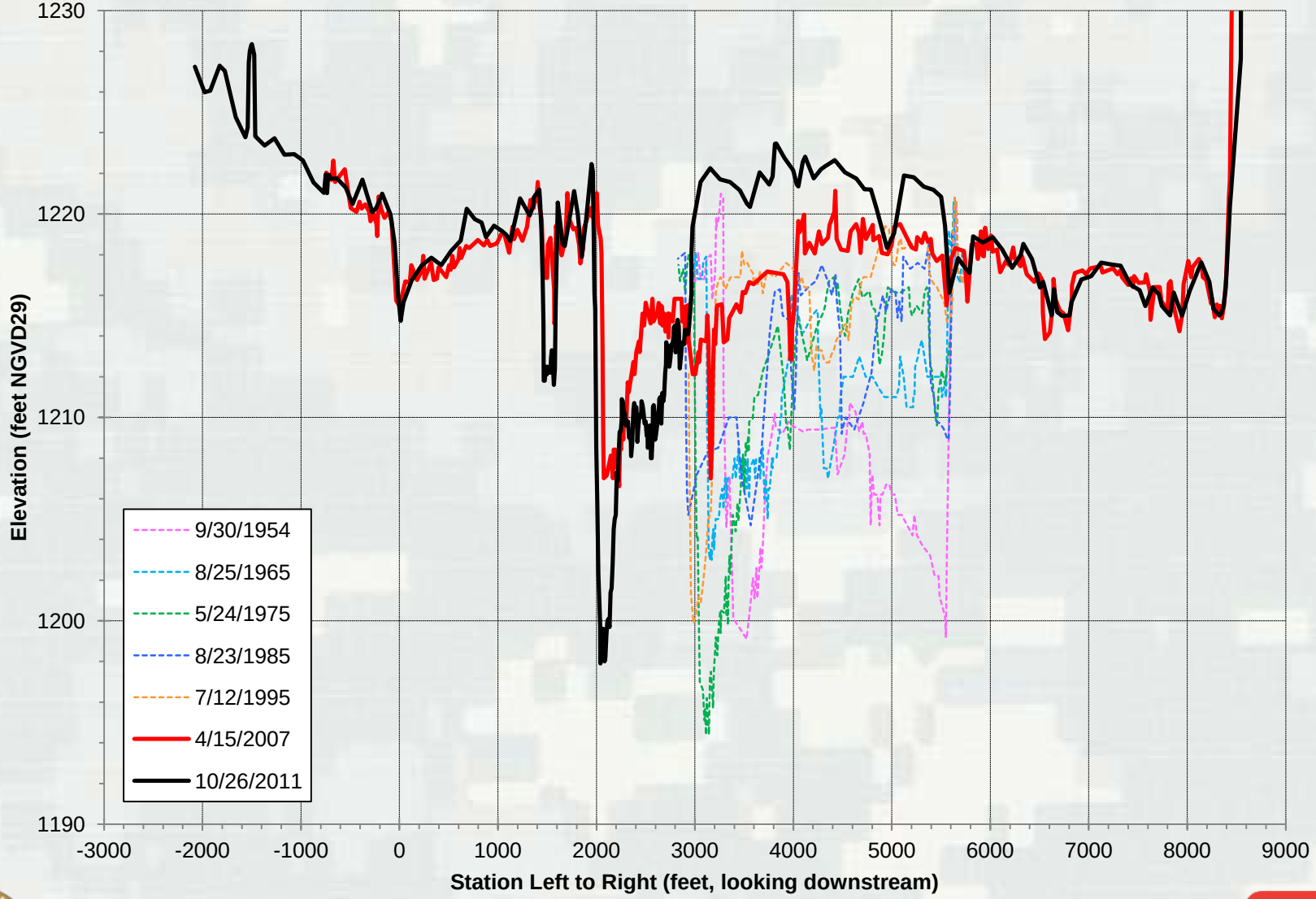
30,000 cfs Water Surface Profile above Lewis and Clark Lake

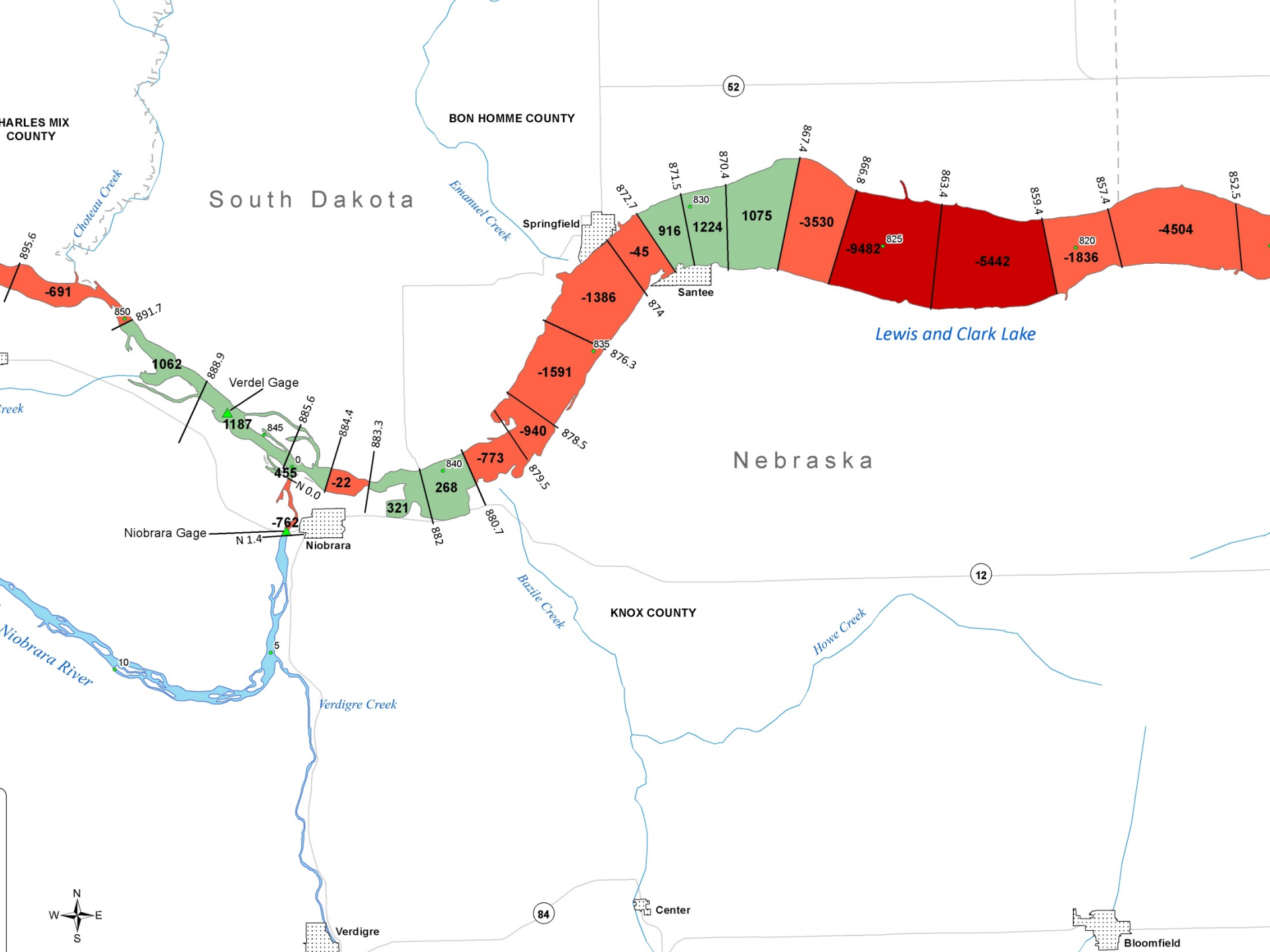


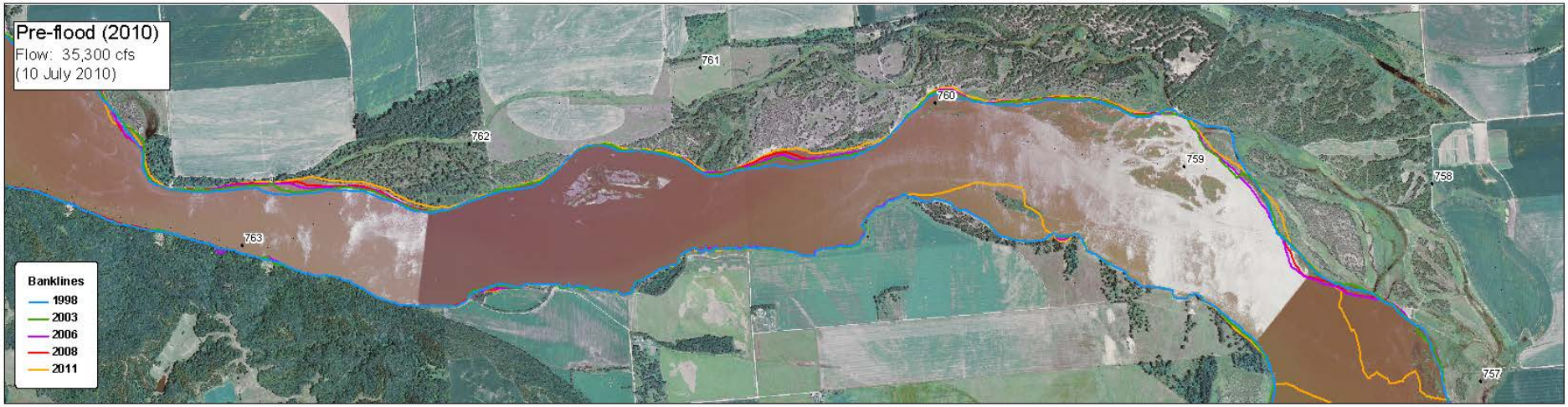
1960 RM 819.0

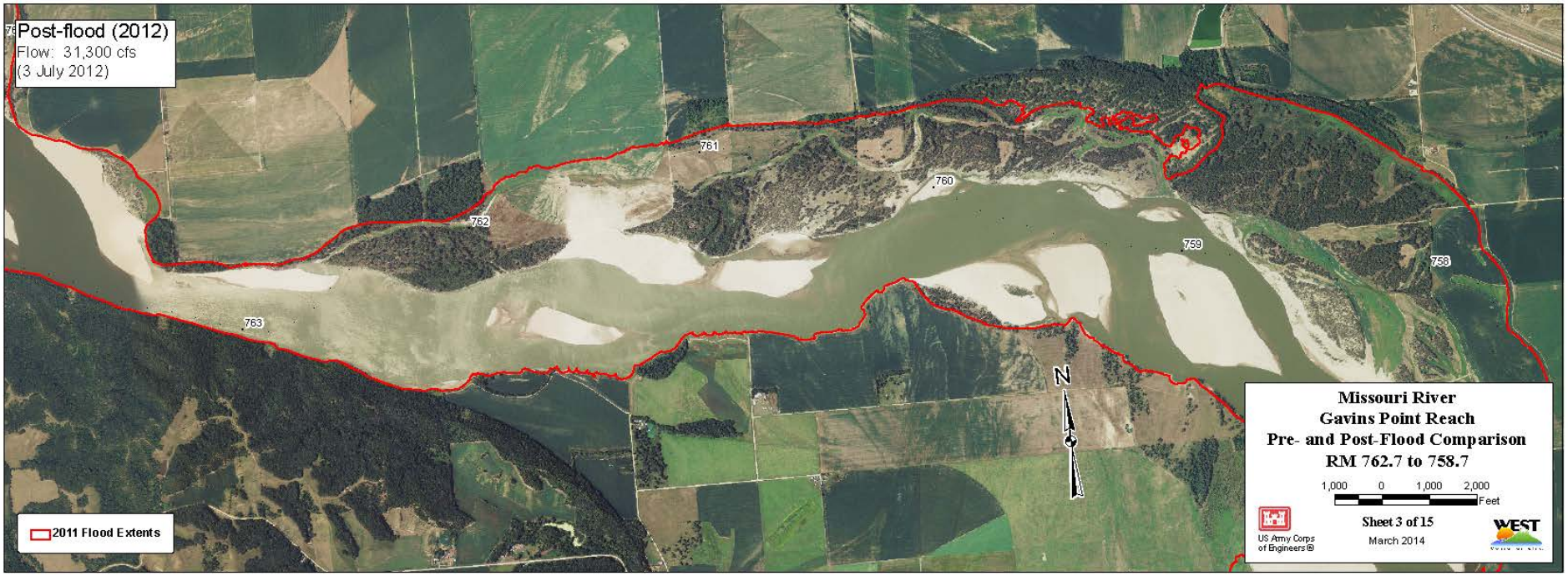

1215
1205
1195
1185
1175
1165
1155
Elevation (feet NGVD29)
5000
6000
7000
8000
9000
10000
11000
12000
13000
Station Left to Right (feet, looking downstream)
5/11/1955
7/16/1965
5/11/1975
9/19/1985
6/26/1995
4/15/2007
10/21/2011

1960 RM 842.4


1230
1220
1210
1200
1190
Elevation (feet NGVD29)
-3000
-2000
-1000
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
Station Left to Right (feet, looking downstream)
9/30/1954
8/25/1965
5/24/1975
8/23/1985
7/12/1995
4/15/2007
10/26/2011


HARLES MIX COUNTY
BON HOMME COUNTY
South Dakota
Nebraska
KNOX COUNTY
Choteau Creek
Emanuel Creek
Springfield
Santee
Lewis and Clark Lake
Verdel Gage
Niobrara Gage
Niobrara
Niobrara River
Verdigre Creek
Bazile Creek
Howe Creek
Verdigre
Center
Bloomfield
52
12
84
895.6
891.7
888.9
885.6
884.4
883.3
882
880.7
879.5
878.5
876.3
874
872.7
871.5
870.4
867.4
866.8
863.4
859.4
857.4
852.5
-691
1062
1187
455
-22
321
268
-773
-940
-1591
-1386
-45
916
1224
1075
-3530
-9482
-5442
-1836
-4504
-762
N 0.0
N 1.4
850
845
840
835
830
825
820
0
5
10
N
W
E
S


Pre-flood (2010)
Flow: 35,300 cfs
(10 July 2010)
761
760
762
759
758
763
757
Banklines
1998
2003
2006
2008
2011


Post-flood (2012)
Flow: 31,300 cfs
(3 July 2012)
761
760
762
759
758
763
N
2011 Flood Extents
Missouri River
Gavins Point Reach
Pre- and Post-Flood Comparison
RM 762.7 to 758.7
1,000 0 1,000 2,000
Feet
Sheet 3 of 15
March 2014
US Army Corps of Engineers®
WEST

Past and Current Projects

Niobrara River Regional Sediment Management Study

Niobrara River Regional Sediment Management Plan

Phase 1

Prepared for

U.S. Army Corps of Engineers
Omaha District
Omaha, Nebraska

AYRES ASSOCIATES

Regional Sediment Management Demonstration Project, Niobrara River Basin, Nebraska and South Dakota, Phase II

Prepared for:

United States Army Corps of Engineers
Omaha District
1616 Capitol Avenue, Suite 9000
Omaha, NE 68102-4901

Prepared by:

WEST CONSULTANTS, INC.

WEST Consultants, Inc.
8950 South 52nd Street, Suite 210
Tempe, AZ 85284

February 2010

WEST Project No. 1105C01

Regional Sediment Management Demonstration Project Niobrara River Basin, Nebraska and South Dakota
Phase II Supplement

Prepared for:
United States Army Corps of Engineers
Omaha District
1616 Capitol Avenue, Suite 9000
Omaha, NE 68102-4901

Prepared by:

WEST CONSULTANTS, INC.

WEST Consultants, Inc.
8950 South 52nd Street, Suite 210
Tempe, AZ 85284

November 2010

WEST Project No. USAC001016

Niobrara River Regional Sediment Management Study and Outcomes

- Phase I – develop data availability list, data gap list, and a data collection plan to address gaps.
- Phase II – basin wide sediment yield analysis, determine impacts of basin-wide sediment management practices.

- Phase II Supplement – survey of specific sediment mediation actions from stakeholder input. Evaluation of benefits and basic costs.
- Phase III – stakeholder interest groups and final RSM plan – not funded

Lewis and Clark Lake Sediment Management Study (LCLSMS) Overview

- Phase I – Numerical modeling of high discharges with reservoir drawdown to examine immediate sediment transport
- Phase II – Numerical modeling of ‘normal’ discharges with repeated reservoir drawdown to examine long-term management implications of sediment transport
- Dredging Cost – develop real world cost estimate for resuming sediment transport past Gavins Point Dam

LCLSMS Project Goals

- Evaluate the engineering viability of using varying discharges and stages through/in Lewis and Clark Lake to transport currently deposited sediments in the lake to/through Gavins Point Dam
- Develop modeling tools that will allow for analysis of most upstream and downstream flow and sediment transport scenarios
- Design a test flow that would verify the model (there is no physical test as part of this study)
- Draw conclusions about the viability of the flow alternatives modeled

Phase I - Flow Scenarios Modeled

(guidance from 2002 Conceptual Analysis Report and Public Input)

Scenario no.	spillway	Days of main flushing	Gavins Point Dam Discharge (cubic feet per second)
I-1	Existing	8	176,000
I-2	Existing	10	88,000
I-3	Existing	Until 2,600 ac-ft of sediment flushed	88,000
I-4	Modified	8	176,000
I-5	Modified	Until 2,600 ac-ft of sediment flushed	88,000

Phase I - Summary of Sediment Transport

Scenario no.	Total operation days	Cumulative water past Gavins Point Dam		Cumulative sediment transport past Gavins Point Dam		Ratio of discharged sediment / water
		Billion cu-ft	Million ac-ft	Million tons	(1,000 ac-ft)*	
1	25	229	5.26**	99.7	95.4	0.018
2	25	116	2.66**	72.0	68.8	0.026
3 & 5	8	27	0.62	3.9	3.8	0.0062
4	25	230	5.28**	178.4	170.6	0.032

*Density of 48 lb/ft^3 due to silt and clay, **transport may vary up to 50%** due to model variables

**Base flow of 30,000 cfs would require 1.49 Million ac-ft

- All scenarios predict the discharge of sediment past Gavins Point Dam
- Scenario 2 uses ½ the volume of water of Scenario 1, discharges ¾ the volume of sediment

Phase I - Reservoir Modeling Conclusions

- The GTARS4 model predicts that all scenarios would discharge scoured sediments at the Gavins Point Dam spillway
- The sediment is comprised of only silt and clay sized particles
- Sand size sediments are deposited in the deeper lake behind the dam
- Repeated flushing would continue to fill the deeper lake, but longer travel distance may reduce efficiency
- Flows would likely cause moderate to extreme flooding depending on location
- Flushed sediment is not highly suitable to ESH & SWH needs: silts and clays
- Sediment flushed below Gavins Point Dam generally transports through the reach and moves to the navigation channel
- Only large, single event flushing flows were modeled
- Environmental, social, political, economic impacts WERE NOT considered in this study

Phase II - Project Plan

- Based on results of Phase I, many questions raised about other scenarios
- Phase II moves Lewis and Clark Lake model from GSTARS4 to HEC-RAS (developed by HEC as part of R&D effort to develop reservoir control and flushing tools)
- Downstream model will remain in HEC-RAS
- Models calibrated through 2011 flood and use post-flood geometry for scenario testing

Phase II- Flow Scenarios Modeled

(guidance from Phase I results and stakeholder input)

Scenario	Flushing Flow	Flushing Duration	Description
II-1	None	None	No Action – to determine delta progression through 2064
II-2	60,000 cfs	7 days	Base alternative – Single drawdown flushing event
II-3	60,000 cfs	7 days	Scenario II-2 with 2064 geometry
II-4	60,000 cfs	7 days	Seven spillway gate inverts lowered to 1,170 ft
II-5	30,000 cfs	7 days	Half magnitude version of II-2
II-6a	60,000 cfs	7 days	Low Elevation Tunnels (invert 1,157 ft)
II-6b	30,000 cfs	7 days	Low Elevation Tunnels (invert 1,157 ft)
II-7a	180,000 cfs	~8 days	Repeat of Scenario I-1 from Phase I
II-7b	88,000 cfs	~10 days	Repeat of Scenario I-2 from Phase I
II-8	30,000 cfs	7 day repeating	Annual flushing event through 2064
II-9	30,000 cfs	7 day repeating	Annual flushing event with longitudinal revetment through 2064
II-10	30,000 cfs	7 days	Annual flushing event with dredging 675 tons per day through 2064

Dredging Cost Analysis

- Develop real world cost estimate for resuming sediment transport past Gavins Point Dam
- Examine technologies to move delta sediments to below the dam and reintroduce to river by:
  - Mechanical Dredging with barge transport
  - Staged Dredging
  - Dredging with Booster Pumps
- Production rates:
  - 10,000 tons/day (918 ac-ft/yr)
  - 20,000 tons/day (1836 ac-ft/yr)
  - 30,000 tons/day (2755 ac-ft/yr)

Dredge in Delta

Discharge below Dam

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Questions?